CHILDREN’S EXPLORATORIUM

AN ARCHITECTURAL THESIS EXPLORING:

"Education through Interaction"

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Abstract

When architecture is conceived or designed from within a vacuum, it is destined to fail. If an architect's ego controls a design, it will become a reflection of himself rather than an architecture for people. I believe that it is up to the architect to find an architecture cut of the human and natural forces which exist within a given environment. This architecture should respond to these forces by utilizing them as latent opportunities. If a space evolves as a response to these forces, it has the ability to step beyond space and become "place". If properly utilized, these forces can enable a "place" to be perceived as a rich, powerful or provocative experience. When a space is intended for children, a new layer of decisions must be addressed. If these are also viewed as opportunities, the architecture can become even richer.

My thesis involves the exploration of architectural manipulation of human and natural forces. The goal is to develop a design methodology for the creation of events utilizing these forces.

My selection of a children's exploratorium* as a vehicle for testing this thesis was derived from an educational standpoint. The facility could actually become an educational tool allowing children to learn in an environment created for play.

*Graphic from: Rundle Children's Museum

Note: The use of the word "Exploratorium" is from "The Exploratorium" located in San Francisco.
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In May 1984, I began my internship with an architect who specialized in environmentally responsive designs. My intentions, at that point, were not to work with a specialist, but rather to gain experience. It wasn't long before I became fascinated with the many facets and complexities involved in environmentally responsive architecture. Although budget constraints usually restricted the implementation of the "ideal" solution, the goal of the office was still to strive for innovative solutions to energy issues. I began thinking about how architecture could best respond to such issues on an ideal level, where money and programmatic necessities were not the primary shapers of a building. Unlike an academic exercise, it is critical to design within the constraints of available materials. Due to the economics of manufacturing construction materials, most are some variation of a rectangular volume. Thus, most buildings become an accumulation of rectangular volumes neatly packaged into a larger rectangular volume which respond to a client's needs. It was my hope that I would be able to work within the realistic boundaries of conventional building materials, but allow the environment and human performance needs to shape the building rather than the economics of the orthogonal design. To take this a step further, I pursued the potential of not only having the building be an ideal response to the environment, but to create events within the architecture caused by human and environmental forces. These events varied greatly from an educational experience, to a dramatic conversation piece, to a rhythmic experience in sound and light.

There are three important architectural
"A great building, in my opinion, must begin with the unmeasurable, must go through measurable means when it is being designed, and in the end must be unmeasurable."

Louis I. Kahn
issues I addressed during this process. The first, is how natural forces affect and interact with architecture. The second issue was to explore my ability to create events using these natural forces. As I have previously described, these events would be thought of as an educational tool as well as a source of entertainment.

The final issue was to develop an architectural solution which creates a desirable environment. In other words, I had to develop an architectural vocabulary responding to these "energies", while creating a sense of place.

These three issues created the basis for the primary issue, which was addressed by my project education through architecture. The connotation of the word "education" is perhaps too institutional for what I was trying to accomplish. Rather than developing a traditional educational exhibit, I sought to create an interactive environment. Breaking away from traditional educational approaches, I was testing the ability of children to learn in an environment created for play. More succinctly, I developed an architecture which responds to its environment in such a way that it creates "natural" events. These events occurred within the architecture at a child's scale with the ultimate goal being a learning experience.

There were several important questions which had to be addressed in this thesis. Among them - how can architecture respond directly to environmental forces without becoming a "piece-meal" solution? Related to this, is the question of how architecture can be manipulated to create events without appearing forced. Finally, does architecture have the ability to educate as an entity in itself?

In determining the best vehicle to test my
thesis, I felt the project should address a community need, perhaps becoming a catalyst of development. It should also be enjoyed and experienced by as many people as possible.
Since its goal is education, and I wanted to avoid an institutional approach, I determined that a children's exploratorium would be the best method to test my ideas...
I wish to thank the following individuals for their continued support, guidance, and encouragement during the past year:

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Site

Lafayette was founded at the head of navigation on the Wabash River in 1825. It was sited at the closest point to the river, but still out of the flood plain, affording protection and easy access to the river's traffic. Transportation continued to be the primary growth influence for Lafayette. In the 1840's the Wabash and Erie Canal passed through the town. Because of its prominence, Lafayette became one of the nodes for which railroad construction was begun in the 1850's. The railroads made the canal obsolete, but assured Lafayette's standing in the area as a major marketplace for the exchange of crops and manufactured goods. Lafayette's potential was recognized early by the State of Indiana, and was made the Tippecanoe County seat in 1829, the first of two major focal points in the area. The second was Purdue University, founded across the river in 1869. With these two centers of expansion, Lafayette and West Lafayette grew to their present forms on either side of the Wabash, and finally out into the floodplain between the two cities.
THE CATALYSTS

The following design studies utilize natural phenomena (sun, wind, water) as generators of space. Each is dealt with at an ideal level, essentially existing within a vacuum. The studies represent a catalog of design potentials integrated into a single space. Elements from each were introduced into the final design scheme of the exploratorium.

LIGHT STUDY

Natural light is constantly variable. A glint of sun can create dynamic results by established means.

In my initial explorations, I determined that the angle of light by establishing the module's plane. Since the sun travels along an axis and points at the module at the equinox, I based on the winter solstice. This generated a symbolic module's shape.

The symmetrical forms, increasing in size, were abstracted from the module. An original model of the sunset at the
LIGHT STUDY

Natural light in architecture is a constantly variant element, which, if utilized, can create dynamic movement through various means.

In my investigation of allowing light to determine the space, on an ideal level, I began by establishing a module of a given height. Since the sun's path is symmetrical about an axis and point, I established a column as the module at the intersection between a line and a point. This became the ordering device. Then based on the sun's path on the winter solstice, I generated a plane that was defined by the module's shadow.

The symmetric path of the sun, with an increasing altitude till noon, was then abstracted by decreasing the height of the original module along the axis of sunrise and sunset at the winter solstice. I used five elements to represent hour increments, based on the amount of daylight on this particular day and the implied hierarchy with noon representing the pinnacle.

The extremes of the summer solstice determined the termination of the vertical planes used to create the space.

The theoretical space I created is entered through the "absent" plane on the east perimeter. The absence of an element corresponds to the idea of birth as does my notion of entry. This space then flows into the movement space, where the sun's path can be traced, based on the established concentric grid on the ground plane. This space is defined by the plane created from the module. I refer to the shadows in this space as "positive", because the modules create the shadows. The third space is the "exit" on the west portion of the space. Analogies to death could be suggested, but this
has no relevance to the space. A second plane is introduced beginning at the limits of the winter solstice and tapering to the limits of the summer solstice. Openings are punched into this plane creating "negative" shadows or highlights. As the plane tapers, the punched openings also step down, so each highlight gets closer to the base of the plane, again corresponding to the idea of termination. The outer wall follows a radius based on the interior circle's radius (shadow cast at noon on the shortest day of the year) plus one module measured horizontally. The taper of the plane corresponds to the s-curve path of the sun's altitude.

Therefore this space began with a point of reference which, as a result of the potential of the sun, established the rationale and form of the final space.
WIND STUDY

Wind, relative to other natural forces, cannot be seen as an isolated entity. It has no dimension that can be measured. Thus it is essentially invisible. In developing a space generated by wind, therefore, other mediums must be brought in to "visualize" wind. I believed other senses had the capability of further capturing the essence of wind - sight, sound and motion.

The space I created is divided into four quadrants. Each of these quadrants utilizes a different medium to illustrate different properties of wind. At the center of these areas is an orientation device which, relative to wind direction, points at the ancient Greek names of the various winds. Many ancient cultures had religious and spiritual beliefs and rituals about wind. Often temples or shrines were built to wind gods. This orientation device is an abstraction of this principle at a very basic level.

Wind is considered either a hindrance or asset depending on the season. Therefore, the mediums I selected to illustrate wind in the quadrants became dependent upon the "typical" seasonal direction of the wind.

The northwest quadrant is winter. The wind phenomenon I am illustrating is wind shadows created by vertical surfaces. This zone is a sheltered area and its size is directly related to the height/shape of the vertical surface. The shadow is shown by a series of three propeller elements. The propeller closest to the wall will not turn (theoretically) when the wind passes through this quadrant.

The southwest quadrant is summer. Here, I am illustrating the cooling effect created when wind passes over a body of water. In addition I introduced a series of wind tubes which could be filled to vary the pitch of the tube. These make the sounds...

The northern section is since the wind... Here I introduced... Various shapes show how wind interacts with objects. These given intervals are sculptural elements.

The final... to show heat techniques...

"tower" it is vacuum created velocity, four heights. To visitors will
Principle at a glance. Therefore, the wind and its shadow zone is a correctly related visual surface. In the three zones closest to (or closest to actually) when the sun is up, summer. Here, I have created a vacuum created when the wind interacts with the "tower" it is forced up and out because of a directional velocity, four propellers will rise to various heights. To create an experiential space, visitors will be allowed to move up the tower.

...filled to various heights with water to vary the pitch of the tone created by wind passing over the tube. The body of water should also help to make the sound more audible.

The northeast quadrant is fall or spring, since the wind is variable during these seasons. Here I introduced sand as a sculptural medium. Various shapes can be moved around the space to show how wind actually interacts with these objects. The arrangement could be changed at given intervals to provide a constantly changing sculptural event.

The final quadrant, the southeast, is used to show heat stratification and ventilation techniques. As the wind interacts with the "tower" it is forced up and out because of a vacuum, depending on the directional velocity, four propellers will rise to various heights. To create an experiential space, visitors will be allowed to move up the tower (both inside and outside) to show how heat and air move within the tube.

Further insights could be obtained by observing how residual wind reacts in the spaces. I realize this could be confusing; thus the orientation element becomes critical to understanding the space and its dynamics.
WATER STUDY

Water has so many different potentials, all of forms and character. In this study, I attempt to present some of the potentials I see in the form of a "liquid space." This is not an abstraction on the history of water, but a reflection on the highest point of the spout of water. The flow line of water is a succession of the flow line. This abstractions of death, there is an evaporative...
WATER STUDY

Water has the potential to assume a variety of forms and characteristics. In this design study, I attempted to exhibit as many of the characteristics and as much of the potential of this medium. Water, in its liquid form, can spout, flow or fall. To develop these three potentials I related each to the other in the form of a "line" which winds its way through the space. This line was intended to also pick up on the historical notions of water. At its highest point, the line of water is "born" by a spout of water. The water then falls through a succession of basins until it is dropped into a flow line. This water continues to flow until it reaches the ground, where there is another spout. This spout is enclosed by a kiosk - an abstraction of the idea, death. Yet through death, there is a life, as in the case of the evaporative cycle of water. So the cycle begins once again.

The "line of life" weaves its way through the water space, creating alcoves, for more personal secluded interaction with the water. Since this is a children's space, these alcoves prove successful for younger children who might be intimidated by the major activity area. Allowing the children to float objects in the "Flow" portion of the line could be used to demonstrate further properties of water.

The inner portion of the line, which defines a circular space, is intended as a reflecting pool. The limited access to this space reinforces the meditative quality of the pool. Reflections of light and adjacent space will be depicted both in the pool itself as well as the white walls surrounding it.

The central sculptural element is intended to show how water reacts and interacts with solid elements. In addition, as water is
collected at the base of the sculpture, it is dropped over a water wheel. This illustrates the ability of water to create motion, which then could be translated any number of ways. These various events are unified by two large circles of water. This represents, perhaps, the greatest architectural potential of water - as a unifying element of space and objects. These two circles will chronicle the interactions which occur within the wave patterns, reflections, etc.

The five "columns" are interactive elements which could take a variety of forms. For example, they could be filled with colored water, be a water organ, or simply fountains.
ORDERING RATIONALE

Perhaps the most important aspect of my design process was the determination of an appropriate ordering system. This was very important because it had to be identifiable and understandable for children. This moved me in the direction of a very simple system.

Since my thesis uses natural and human forces to create events within the architecture, the first system I looked at was based on axes based on these forces. These axes, which I will describe in more detail later, were then imposed on the site and manipulated until I arrived at an apparent harmony.

I began by first looking at visual axes and their termination. As an automobile crosses the light at the five-street intersection, West of the sight, and proceeds down Brown Street, there is a definite axis which currently has no termination. To terminate this view and draw people toward the exploratorium, I felt some type of vertical element was necessary. The placement of the element(s) along Brown Street becomes important because this is the highest point of the city. Thus, the element(s) selected become the identifying image for the rest of the city. Furthermore, the point where Brown Street currently ends is at a bend in the Wabash River. This further emphasizes the prominence of the vertical element.

The second visual axis is toward the dome of the courthouse which can be seen in all seasons. As a result of on-site investigation, I determined that the optimum view, besides that from the end of Brown Street, was looking from any point on an axis which ran from the northwest corner to the southeast corner of the site. This also, initially, seemed to be a logical path of entry to the site based on parking location, drop-off, etc. This axis had some flexibility as the fixed point axis could correspond to the beginning of the winter. The axis could then be established from them.

The third axis was the direction
This axis should be for natural throughout the
Street axis might be the
So I established
point where
Then, using
som flexibility to be shifted, using the dome as the fixed terminus. The "final" placement of this axis was manifested by allowing it to correspond to the rising of the sun on the day of the winter solstice. (See Light Study). The axis could further correspond to the direction of winter winds and the need for protection from them.

The third axis introduced corresponded to the direction of the desirable summer breezes. This axis should represent an openness to allow for natural cooling within the building and throughout the site. If this axis extended through the site, it would intersect the Brown Street axis. I felt the intersection of the two might be the best location for the vertical element to terminate the view down Brown Street. So I established one point on the axis at the point where the bend occurs in the Wabash. Then, using that as the "fixed" point, I ran the axis through the site, allowing its angle to be determined by the sunset on the winter solstice.

Where the two angled axes meet, a suggestion of hierarchy of that point became apparent. Whether the point would become a generating tool for the exploratorium or symbolize the heart of the site had to then be investigated. Then, assuming the point would have some significance, I establish a secondary set of axes. These axes address the urban fabric of the city, and thus run north/south and east/west. They are not critical, however, considering the context of the site.

When West Lafayette was established, the first street was laid out at the edge of the flood plane. It basically runs parallel to the base of a hill. The first bridge connecting the two cities was built for industrial purposes - connecting two similar zones of the cities.

As a result, Brown Street (Lafayette side)
became the logical street to continue into West Lafayette. Since Lafayette has different flood plane characteristics, it was laid out in the traditional orthogonal method. Brown Street thus ran east/west and its extension into Lafayette also ran east/west. The point at which the first two streets in West Lafayette met obviously became the catalyst of the cities' growth. Its importance is maintained today and actually marks the start of the entry sequence to my project.

The second bridge connecting the two cities was established as a connection to the civic area of Lafayette. As a result, from the point where the first two streets met, another road was established by using the courthouse as a visual terminus. This road, State Street, was angled and had to meet the established grid. This connection was awkward and represented the beginning of traffic problems within the area.

When one looks at a current map of West Lafayette, it is apparent that streets laid out on the hill in West Lafayette addressed the river and its flood plane. However, once the city grew beyond that point, it followed an orthogonal growth pattern.

My choice to use Brown Street as the primary entrance is a product of historical reference as well as a logical choice for safety purposes.

It is interesting to note that both bridges will be obsolete by 1990. The Brown Street bridge was closed in 1972 and the State Street bridge will be closed in 1990. Part of my project will involve the maintenance of the still intact State Street bridge as an aqueduct and pedestrian link between the two cities.
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cities.
ORDERING RATIONALE

ORGANIZATIONAL PLAN

The organization of plans could result in parallel planes which would be appreciated.

CHILDREN'S DIMENSIONS

As I look at the spectrums of the systems, which match dimensional manipulation, a very basic massing seems to be adopted.
METHODS OF DEALING WITH ORDERING RATIONALE

As I worked through the design process, which methods I would use with the ordering systems became critical to the buildings, massing, articulation and footprint.

I approached the problem from two ends of the spectrum. Each carried advantages and disadvantages. I looked at the problem from a very basic level, namely, idealistic manipulation of a two dimensional plane or three dimensional volume. Then I looked at a specific (children's architecture) level, keeping in mind that the spaces would be used by children.

The ordering axes I established could also be approached from two extremes; each could result in a rigid, traditional solution. They could literally be used as "the law", where planes and columns had to respond to them in a parallel, perpendicular or radial fashion. My first impulse was that this was the appropriate method of dealing with the system, because the building was designed for children, and in order for a child to understand a space or system, it has to be well defined. Designing within these parameters was actually quite easy. I could always rely on the strict ordering rules. It appeared to be a viable approach, where each "event" corresponded to a single, one-dimensional interaction. In evaluating this approach, it became apparent that even though my design had a very non-traditional look, in many ways it was just as traditional and institutional as the buildings my thesis was responding against.

My early design studies, dynamic in appearance, were actually very static, inflexible and awkward. The user group was almost literally being taken by the hand, with all surprises and excitement being forced upon them.
At the other extreme of this heavy-handed design, was the use of the ordering systems as a subtle, less tangible "over-lay". The events still occurred, but the interaction between them was not overtly designed. Rather than dealing with the axes in a parallel, perpendicular or radial manner, they could be dealt with to any degree or a combination of the three. Thus the perception of the event could become unpredictable and flexible.

Designing completely in this mode can become a rationalization for unresponsive design. The designer can do whatever he wants without justification. All four extremes I've discussed can lead to weak architecture. It is my hope that I will be able to design somewhere within them, using each to its greatest advantage.

The issue is struggle that does this center exist? What are its boundaries? Does the center have a relationship to the child? Are the boundaries of the center separate from the child? The architectural qualities of the center are those of a miniature town; a miniature town cannot exist without a natural environment. The natural environment of a center is obvious; it is the size and shape of the center compared to the surrounding environment.

There are many factors that influence the design of a center, including the intended use of the space, the budget, and the client's expectations. The designer must carefully consider these factors to create a space that is both functional and aesthetically pleasing. The design of the center should be a reflection of the client's vision and should be tailored to meet the needs of the users.
SCALE

The issue of scale remained a constant struggle throughout this thesis investigation. Many questions were raised, but unfortunately, very few could be answered to any degree of satisfaction. At the most basic level, scale is the comparison of something with/to something else. Thus, the first question becomes: to what does this children's exploratorium compare itself? It would seem appropriate to compare it to a child's scale, but what does that mean, and what are its ramifications? A child actually is a miniature version of an adult. Does an architecture for children become a miniature version of adult "scaled" architecture - obviously not. Scale is not the same thing as size; scale is relative size. The scale can only become evident when two elements are compared to each other.

There are many possibilities for comparing scales. Since buildings are made up of parts, the size of the parts relative to the whole could constitute a scale. Within the parts, a single "piece" could be made larger or smaller to indicate a hierarchy. The scale of a particular piece becomes relative to other pieces. If a particular piece is made larger or smaller than accepted convention, this becomes a scale relative to the "usual" size.

Perhaps the most common comparison made is scale relative to human size, where the size of a component is based on a dimension of the human body.

It would have been very easy for me to hide behind such phrases as child's scale in the development of an architectural expression. But simply stating that this facility was designed at a child's scale would not necessarily make it a learning experience. A humanist approach actually lies more in the realm of shape than of
scale, particularly shapes that have human meaning. If a building uses shapes that possess human meaning, it is more likely to feel human than the building that tries to replicate the dimensions of the body.

As a result, my primary concern was not so much the size of the building, but rather how it related to a children, and made them feel comfortable.
DESIGN PROCESS

My initial thoughts regarding the design process as I began this thesis were that it was mostly a linear process. During my first four years in the Ball State program, most projects followed a very traditional approach. We would receive a program on the first day of a project and be expected to spend a week researching; then proceed to schematic development and on to design development. I did not realize until this year that this process was a product of the Bauhaus curriculum existing at Ball State. Since many of my professors had also been educated through a similar curriculum, this linear approach to design was not questioned by me. During a fourth year studio, however, I began reading about the design process as a spiral. It still resembled a basic linear concept, however. Recognition was given to the importance of not finalizing any aspect of the design process prematurely simply for the sake of moving on to the next step.

There are several possible traps if an architect follows a linear approach, even in the spiral form. The most dangerous of these is the failure to recognize how the mind works. The more time an architect spends on a project, the more he discovers how much there is to learn. If the architect is set in a regimented progression, theoretically he must essentially block out irrelevant information which doesn't pertain to the next step in the process.

I was not introduced to the idea of a "free-fall" design process until this year. Unlike the linear process, an "adaptive" process is much more difficult to manage from an organizational point of view. There is a continually widening body of information and ideas which should be addressed at some level. This is a difficult thing to do when there isn't
a "safety net" of organization built into the process, as exists with a linear process.

My thesis is, among other things, an investigation of a free-fall design process.

Designing within this free-fall mode, the most difficult aspect is taking the plunge into the process. The analogy which quickly came to mind was diving into a pool of a huge body of information, ideas and preconceptions. Rather than ignoring aspects I felt were irrelevant, I tried to pursue as many as I could. Often, this led me far from architecture. Yet at some level it helped me to gain an insight into some aspect of my investigation.

In reading through my daily log, it amazes me that I ever managed to end up where I have. Most of my first quarter was spent reading, watching, listening and experimenting with and about children, architecture and the environment.

Determining a hierarchy of topics didn't seem appropriate, because at that point I really wasn't sure which ideas, if any, should control or dominate the architectural expression.

During the following quarters, I was no longer dealing with my investigation at an ideal level. Each influential aspect of the design represented a filter that could potentially dilute the essence of the process. The application to design becomes the true test of the strength of the thesis.

As the design progresses, free-fall investigation manifests itself by necessitating the designer to simultaneously design at both macro and micro levels. Often, in the course of one day, I may have looked at my facility as a component of an urban network and questioned the appropriate method of how a handrail should engage a column. This incredible stratification makes design a rich, exciting and challenging experience.
PROCESS SKETCHES

[Diagrams of process sketches]
SYNTHESIS SKETCHES
Volumetric Explorations

The following is a compilation of three-dimensional design studies dealing with volumetric manipulation in response to natural and human forces.
Initial Form Study

Form attempts to address all forces acting upon it in a very literal manner. Primary issues:

1. Entry
2. Solar Dynamics
3. Wind Dynamics
4. Water Collection
Initial Form Study II

Primary issues addressed in literal fashion:

1. Desirable winter sun zone
2. Desirable summer breezes
3. Undesirable winter winds
4. Orientation element
5. Entry
6. Water collection
Overlay Form Study

Initial ideas of collision between two forms are studied. One addresses existing urban/historical patterns and the other becomes the interactive piece.
Overlay Form Study II

The integration of forms into a more homogeneous volume is studied. Issues include:

1. Structural articulation
2. Transition space between exterior and interior
Conceptual Study of Spatial Definers

This primarily deals with ground and surround. The model is a study of structural systems and planar collisions.
Collisionism Study

The articulation of the collision is addressed. Issues include

1. Entry
2. Solar access
3. Hierarchy of form

NORTH-EAST

SOUTH-WEST

TRADITIONAL PAVILION

POTENTIALS