An Architectural Thesis
By Kenneth J. Summers
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College of Architecture and Planning
Ball State University
Muncie, Indiana

Indiana Dunes
Environmental Center
ACKNOWLEDGEMENTS

Thesis Committee:

Chairperson:
J. Robert Taylor
Professor of Architecture

Member:
Robert J. Koester
Professor of Architecture

Consultant:
Eric Ehn
Landscape Architect/Indiana Dunes National Lakeshore

Consultant:
Lesley Smith
Assistant Professor of Landscape Architecture

A special thanks to my family, to whom this book is dedicated, for their encouragement and support through this thesis.
ABSTRACT

The "fit" of society's physical development in and among its "host", the natural environment should and can be improved. Nature offers interpretative patterns, potentials and limitations to more sensitively guide and direct man's design of built environments. If Nature's "design" is analyzed, understood, and respected, physical development, especially architecture, can more efficiently, effectively, and sympathetically serve human needs while supporting positive interaction and maintenance of our precious natural environment. Current environmental design theory seems to support a concept of zoning unlimited and environmentally harsh physical development in concentrated areas while attempting to balance it with quantities or zones of natural preservation. This thesis wishes to challenge such a notion by forwarding the hypothesis that useful, functional yet environmentally sensitive architectural development can be introduced into sensitive natural environments by simply discovering and following the design guidelines implicit in that natural environment.
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The interaction between nature and the built environment is a subject of growing focus in the field of Architectural Design. Through my studies as an architectural student, I've developed an interest in this concern for architecture that is strongly related to and respects the natural environment. This interest, I believe, is a result of growing up in the northwest industrialized region of Indiana. In this region stand refineries and mills which were built in total disregard of their natural surroundings. Beautiful woods and dunes once thrived where industry now exists. In our self-sufficient modern world we tend to neglect the importance of the natural world. This neglect of nature is occurring today primarily on a residential level in widespread developmental tracts. Land and trees are often destroyed in the name of architecture and profit. An attitude is needed among architects, one that appreciates nature and integrates it more with architectural solutions. More enjoyable places can be created when architecture and nature can exist in harmony.
THE THESIS

To summarize the thesis, architecture needs to be more integrated, responsive, and yet sympathetic to its natural environment while providing spaces for people to enjoy. This of course does not imply the planting of trees and shrubs after the building has been designed and "plopped down" on its site. A greater analysis needs to be made of existing natural features in and around the building's site. A positive response to these features must then be made while the building goes through its design phases.

In today's modern age, buildings have become more self-sufficient and less responsive to the natural environment in utilizing its energy benefits such as the trees for wind and sun control. Our natural resources are not only being wasted by inefficient buildings but by inefficiently building on the land. As architects we need to be more conscious of our natural resources as we design our buildings. We must continually question the impact our designs have on the natural environment. We should promote and encourage the existence of nature. Nature exists for our enjoyment and must be maintained wisely.

This thesis has attempted to explore several different ways for building positively in the natural environment. The project for testing the thesis, an environmental center, investigates some different ways in which architecture may respond to the natural environment while responding also to the programmatic needs.

THE PROJECT

The project for testing the thesis was an environmental center located in the Indiana Dunes State Park. The park currently has a nature center but it has become too small for housing a growing naturalist program. The environmental center would accommodate these needs incorporating opportunities for research as well as educational studies.

Over a million visitors frequent the park coming from Chicago and its suburbs and the Calumet Region of Indiana. Along with the general public, environmental researchers visit the park to study the diverse plant life found in the Indiana Dunes area. Included as part of the environmental center and an additional test for the thesis were retreat shelters for researchers and the general public as places to stay for a few days, living in the natural environment.

THE SITE

The site for the thesis project was in the Indiana Dunes State Park located in Chesterton, Indiana. The park stretches 3 miles along the southern edge of Lake Michigan between Gary and Michigan City. There is 2182 acres of primitive landscape, 1800 of which is wooded and contains the most diversified flora and fauna of the midwest. Other areas of the park are made up of drifting sand hills, peculiar to the region, and low lying marsh.
A careful analysis was made in order to locate the final site within the park. Initial studies suggested a location along the beach or at the top of the dunes which would provide distant views. These areas were eliminated early because of the instability of the sand dunes. Many homes built along this particular lakeshore have been lost to the lake because of the eroding shoreline and drifting sand dunes.

A second possible location for the final site was in the area of a low lying marsh which stretches east to west along the southern edge of the park. This area also was eliminated as a site for building because of its "soft" soil conditions.

The third and final location for the building included a stretch of park between the beach and marsh areas. This site included dunes that had been stabilized in their movement due to the establishment of mature oak trees and low lying brush. This area north of the marsh also contained existing parking and was at a point where existing trails came to a junction allowing easy circulation to other parts of the park. An existing nature center situated nearby also provided an opportunity for utility connections. This final site allows visitors coming to the environmental center to sample a more diverse landscape condition. The existing parking lot becomes an ideal starting point for visitors to begin a cross sectional trek of the park experiencing the different successional layers of plant life. Because of landforms and trees the site is protected from harsh winter winds blowing inland from the lake.
THE PROGRAM

The design of the environmental center incorporated many diverse functions. Generally, the center was to be a place where the public would come and gain a greater understanding of the natural environment. Educating the public then was the primary goal of the program. Therefore there was a need for an audio/visual space where a film could be shown which would introduce to the first time visitor some background information on the Indiana Dunes State Park. Exhibit spaces were also required as part of the program. These spaces would explain the surrounding natural environment. Classroom spaces were also required which could be used by groups who desire to come and learn more in depth about the natural environment from one of the park's naturalists.

Since groups and individuals would be visiting the environmental center, there was a need for some space where snacks or light lunches could be served on a daily basis. This space was to be strongly linked to outdoor deck spaces where visitors could sit and enjoy the outdoors.

There was a need for research spaces within the center where past research and current environmental information could be stored and available to people wishing to study the qualities of the Indiana Dunes area in greater detail. This space as a library would provide an area for reading. It had to be linked to administrative support zones of the building. The administrative spaces would include offices for naturalists and spaces for work activities, storage, and secretarial duties.

Detached to the center were shelters where the public and research persons could stay for brief periods of time, mainly for a few days. The shelters would include spaces for sleeping, eating, and research. A small bathing space was also required as well as some spaces for storage.

The following is a breakdown of all of the spacial requirements needed as part of the environmental complex.
<table>
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<tr>
<th><strong>Public Service Spaces</strong></th>
<th><strong>Size (sq. ft.)</strong></th>
<th><strong>Total Net Square Footage</strong></th>
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<td>Coatroom</td>
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<td>Exhibit Space</td>
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<td>Snack Area</td>
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<td><strong>2,050</strong></td>
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<td><strong>Special Service Spaces</strong></td>
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<td>Library</td>
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<td>Classrooms</td>
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<td>Living/Study Space</td>
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<td>Eating Area</td>
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<td>Bath</td>
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PROGRAMMATIC GUIDELINES

Programmatic guidelines for an environmental center suggest that the outdoors be the primary classroom for learning about the natural environment. The interpretive building is the focal point for administrative and program activities. A visit here will help to orient visitors and make them aware of what the center has to offer. The building should be flexible enough should expansion become necessary. The design should permit simultaneous use of the facilities by several groups.

An observation tower of some form may become part of the facility. This would offer visitors the opportunity to view the landscape from treetop level. Breezes through trees could also be experienced.

The following diagrams are suggestions for the design of an environmental center and an observation tower in a natural environment.

Careful design of the observation tower must occur so that it is compatible with its natural setting. Natural materials should be strongly considered. The tower can become a series of observation points.
HISTORICAL STUDY

"Nature" is a very ambiguous term, and has been interpreted in several different ways throughout the course of history.

Generally speaking though, nature consists of several distinct environmental forces, patterns, and processes that are all interrelated. Each natural environment is different depending on its geology, topography, soils, vegetation, and climatic factors, such as sun, wind, and moisture availability. Animal life is even a strong factor in the natural environment as it helps to maintain certain species of plant life. Architecture needs to respond to these forces in positive ways. The program for design must address them to create a more harmonious agreement.

The landscape or natural environment may be manipulated or used in a positive way to utilize existing energy resources more effectively and to conserve the limited amounts of energy which are available.

Primitive man lived according to nature and utilized the available natural resources, especially the sun. His only fuel was wood, the product of photosynthesis in his own time. His food he gathered himself during daylight. His shelter, in whatever region he resided, was built to use the desired natural elements, and shield out the excess. He lived in balance with nature and with the natural processes and elements.
Two main aspects of nature are persistent and recurring, despite their opposition. Nature is considered a model of regularity while at the same time it is a model of irregularity. Both of these views are based on ideas displaying a system of values. Emerson observed that "the views of nature held by any people seem to determine all their institutions. Each image a society has of nature involves a distinct notion of culture and society, and therefore of buildings, cities, and landscapes."

In both ancient and modern times, Western culture has had an image of physical nature that was regular in its changes, forces and forms. The geometry of nature was used as the basis of rational ethics and aesthetics. The works of man was considered to derive its beauty from regularity, for reason was assumed as rule and order.

The irregularity of nature has been greatly admired in the West since the 18th century. This admiration is expressed in the love of the picturesque, the wild, the rough, and the rude, the passionate and the primitive, the romantic. The painter Renoir, said that artists were "careful to proceed like nature. They are always respectful pupils, and are on guard never to transgress her fundamental law of irregularity."

In American history ideas of nature have had powerful influences on the built environment. Henry David Thoreau and Thomas Jefferson both had very strong ideas about nature and the built environment.

Thoreau encouraged a nature unmodified: "I wish to speak a word for nature, for absolute freedom and wildness, to regard men as an inhabitant or part and parcel of nature rather than as a member of society."
BUILDING TYPES STUDY

There are several possibilities for the relationship between buildings and their landscapes or landscapes and their buildings.

One possibility is that architecture should be formally independent of landscape, which it serves as a complement and foil. The integrity of the landscape is preserved, and the buildings do not seek intermediate gardens or terraces, serving as transitions between built form and natural or idealized nature. Implied in this contrast is a relationship of opposites.

Another possibility is that architecture and landscape be seen as continuous, without clear distinctions between the artifact and natural fact, between built form and natural form. Interpenetration is sought between architecture and its natural surroundings, in terms of space and materials. The building should appear to grow out of its site, to be part of the site, of it, not on it.
A third possibility is that architecture and landscape should modify each other, that indoor and outdoor space be organized together a formal geometric unity, defined by built forms such as terraces or walls, arcades, trellises, trees, and plant materials. The architectural potentials of this possibility are very diverse.

Ideas of nature are among the generating ideas of architecture, and man instinctively seeks for some formal continuity between indoors and outdoors.

A fourth and fifth way of building in the natural environment would be to cover partially or entirely the structure with earth. The architecture can become less obtrusive while the earth is utilized for its insulating qualities. Plant life is encouraged to grow up and over the architecture.
SITE POTENTIALS/DETERMINANTS

The site chosen for the environmental center offered many positive features that could be worked with to create a successful environmental center. The final site chosen for the building included a stabilized dunal area grown over with mature oak trees. An existing secondary road terminated at the location of the site. This road is connected to the main road into the park. An existing parking lot was utilized as the main parking place for the environmental center. This was beneficial in that no area around the site had to be improved for parking services, thus preventing the cutting down of additional trees. An existing marsh, which was a short walk from the parking lot, provided an enjoyable natural feature that could be experienced while in the area of the center. Birds are attracted to this marsh as well as raccoons. Ferns grow in abundance along the edges of the marsh and also certain rare orchids. The marsh provides a natural means for cooling the air in the summer months as bodies of water tend to temper the surrounding air. Large oak trees tend to shelter understory zones from the sun. In the winter, strong winds blowing inland from the lake tend to be buffered from surrounding landforms.

The isolation of the site from the busy beach areas enables visitors to enjoy a more quiet environment. A short drive to the parking area gives the visitor a chance to preview the surrounding natural environment. The site offers visitors trails which extend out to different areas of the state park. The center therefore can become a gateway or means of educating the visiting public on the certain natural qualities of the park. An existing nature center provides an opportunity for connecting the new environmental center to utilities needed. With the center located nearby, the existing nature center could become a residence for a permanent naturalist.
PROGRAM EVALUATION

The program for the environmental center was quite complex in that there were many spaces required that were somewhat different in their needs.

The control of people was a large factor in the design of the center. The concern was bringing the public into a natural environment for the purposes of study and enjoyment of nature, while at the same time minimizing the impact of these people on the natural environment. Containing people became the overriding desire for the center, especially before diffusing them onto the trail system.

The program suggested that the building be located in a way that requires visitors to walk far enough from the parking area in order for the landscape to be previewed and experienced before entering.

Strong views were one of the important requirements from inside the center. Building on the slopes of hills become focused generally in one direction out from the slope. At least this becomes most logical when a building projects outward in one direction.

The location of the building needed to be sited in a way that enabled views in several different directions. Therefore, open level areas were studied for their potential.

Constructability of the environmental center in the natural environment had to be analyzed to consider its overall impact on the environment.
EXPERIMENT #1

The initial design of the environmental center began with two distinct approaches. One solution was a totally above ground building which was on axis with the main trail leading into the interpretive section of the state park. Generous views to the outdoors were provided along the main exhibit corridor extending from the main entry to the assembly space at the opposite end of the building. This solution provided research offices and a laboratory near the main entry along a secondary circulation corridor perpendicular to the main circulation path. More public spaces terminated the main circulation path. These spaces included an assembly space (as mentioned), classrooms and an open common space which surrounds large fireplace. Adjacent to the common space is a small space for renting cross country skis during the winter months. This space for skis also is linked to the outdoors.

The first design sits upon the land and becomes more of an object. Panoramas are more easily achieved however the architecture is more obstructive. The linear circulation directs visitors more easily and provides changing views to the outdoors.
Freestanding exterior walls serve to frame special views in the landscape. Glimpses of the outside are experienced as visitors move through the exhibit spaces.
A second experiment involved an underground design. An observation tower was integrated with the building. The main exhibited space was centrally located with views directed upwards and out of the space through a glass skinned roof. The offices for administrative personnel along with classrooms, assembly spaces, and spaces for environmental research, were also organized around the exhibition space. The building which was earth covered, permitted nature to thrive over and around the architecture. The building organized on a grid served as a contrast and complement to its natural surroundings. The observation tower is entered from the central exhibition space. An elevator provides service to the top of the tower.

This second design, as a subterranean structure, enables nature to thrive above, and creates a more unobtrusive building profile in the natural landscape. The research spaces border the south edge of the structure and gathers in sunlight through large expanses of glass. Panoramas of the outdoors were difficult to achieve with this design. Views become primarily one directional. Access to the outdoors is another concern when building underground. This was also difficult to achieve with this design.
EXPERIMENT #3

A third experiment in the design of the environmental center is similar to the second design in that it incorporates an observation tower into the main exhibit space. This design though is located deeper into the woods from the main parking area thus requiring a longer walk and giving the visitor a greater preview of nature before entering the center. The plan is radial with all of the spaces respecting the center point where a hearth and the observation tower are located in the building. The tower itself rises up out of the main exhibit space which is enclosed by glass. Canvas blinds fit between the main structural members and can be adjusted by a pulley system to control the amount of sun entering the space which serves as a solar collector.

The climb up the observation tower begins within the interior of the exhibit space and then continues outside after opening a door which leads outside. The winding climb provides for a variety of views of the landscape. Different platforms or observation points along the climb focus out to the surrounding landscape. These points are enclosed by a trellis system grown over with vegetation. The upward trek ends at a main observation platform at the top which is partially enclosed by freestanding wood members.

This design is similar to the second experiment in that a layer of earth above the building serves to insulate the interior and promote vegetation. The earth around the building gradually follows the exterior wall upward until reaching the roof where it finally continues up over the roof. Circular windows are used for focusing and framing views to the outside.
The hearth located at the center of the exhibit space is integrated with the observation tower. The flue for the fireplace extends up through the tower itself. The fireplace serves to heat the building and provides a focus for gatherings of people visiting the center. The exhibit space contains displays and also becomes a greenhouse for plants and small trees.

Included within the design is an office, restrooms, classroom, research library, and research laboratory. A small terrace extends out from the classroom.

The environmental center would be constructed of reinforced concrete. Timbers would serve to structure the glazed roof of the exhibit space.

A trail would lead to the building. Other areas of the state park would be accessed by additional trails leading from the main exhibit space.
EXPERIMENT #1

Initial design of the research shelters investigated built forms which were totally earth covered. By doing so, the architecture became less obtrusive and blended in with the natural landscape. Wildlife is able to thrive over and around the architecture. The earth covering serves as a blanket of insulation helping the interior to maintain a constant temperature.
The materials of the shelter would consist of reinforced concrete. This way of building in a natural setting, however, may be difficult if there is no access for concrete mixers and earth moving equipment to reach the site. Initial scarring of the land must occur for inserting the structure into the earth. Time then would be the factor in restoring plant life around and above the structure.

These particular shelters would be located throughout the state park in areas where the dunes have stabilized with mature plant life. Space within each shelter would be provided for sleeping, eating, bathing, researching, and for displaying researched information. Access to each shelter would be provided by footpaths extending from the environmental center.
EXPERIMENT #2

A second design of a research shelter involved a more organic form compared to the first design which in section was a series of half spheres interconnected by circulation links. This second design, which also is totally earth covered, adapts itself to the form of the dunes. The design provides a sleeping loft and a bath, a research/food preparation space and a small recessed space for gathering around a woodburning stove which would be the main source of heat.

Entry into the shelter would occur on the loft level. Circulation to the lower level occurs through a series of steps projecting out from the wall of the shelter. The structure as a shell would consist of reinforced concrete. The shell form is desirable in that it is a very efficient means of supporting uniform loads of earth.

Access to the shelter would be provided by a footpath leading from the environmental center.
EXPERIMENT #3

A third research shelter design is one in which the architecture becomes integrated into a south facing stabilized dune. Fenestration would be made up of glazed areas projecting out and up to receive the sun. The skin of the building on the south undulates to form an alternating opaque skin and glazed opening. The skin also defines the two entries and then terminates in the form of planters.

The largest glazed opening defines the main research space within the shelter, allows for solar gain, and serves as a greenhouse for growing plants. Insulating shades are pulled down over the glazed openings to control the sun and trap the internal heat at night during the winter months. Woodburning stoves would also serve to heat the shelter.

The north wall of the shelter retains the earth which insulates the interior of the shelter. The roof would also be insulated by a layering of earth 2 to 3 feet thick and stabilized by vegetation. Ventilation would be provided by operable windows and skylights in the roof. Reinforced concrete would serve as the structure and as the exterior finished material.

Within this shelter are spaces for sleeping and bathing, and spaces for studying, researching, and food preparation.

Access to this shelter is also by footpaths leading from the environmental center.
REFINEMENT/REVISION

The final solution for the environmental center and the research shelters focused on the actual implementation of these buildings in the natural environment. As the exact location desired for the environmental center became more apparent, the materials and construction techniques were reconsidered for their feasibility in a natural and somewhat isolated setting.

As the concept for the center progressed, it became more and more obvious that a means of piecing the building together might be a more practical way of building than for instance if poured concrete construction techniques were used. In the case of poured concrete construction, large concrete mixers would be required to transverse some distance through woods to reach the building site. Although this may have been possible by driving down trails, the impact would have been too great.

Another means of construction requiring less cumbersome vehicles to reach the construction site is a combination wood framing and timber construction. In the previous designs of the environmental center, poured concrete construction was used mainly to support and retain heavy loads of soil in creating a more sheltered structure. This was an attempt to utilize the earth as insulation and to blend the architecture in with the natural setting. As mentioned before, the construction technique required large earth moving as well as concrete pouring equipment.

A decision was made to use wood as the main construction material. Pole construction techniques were considered for structuring the building. After much analysis this technique became the solution for constructing the environmental center. Pole construction allowed the building to adapt more favorably to existing landforms. The site had a series of elevation changes which was handled easily by raising the building up off the ground on poles, thus enabling the landforms to continue unaltered and permitting the building to maintain one level. Another reason for using pole and more generally wood construction was wood's ability to conform aesthetically to the natural setting. The cost of pole construction and the elimination of intensive site improvement was also economically more beneficial.

The observation tower which was incorporated into earlier designs was eliminated from the final solution. The final building site chosen is enclosed by surrounding high dunes and woods. An observation tower at this point would need to reach great heights in order to provide panoramas of the state park and views to Lake Michigan. It was decided that natural views from the tops of surrounding dunes could become observations points. Mt. Tom, the highest dune in the state park is 192 feet above the level of Lake Michigan. It would be reached by existing trails that would link up to the environmental center.
The research shelters were also reevaluated for their implementation possibilities. The early designs were poured concrete structures and were either partially or entirely earth covered. Since the scale of these shelters was smaller than the environmental center, they could still be somewhat earth covered. Smaller earth moving vehicles could reach the site of the shelters more easily. Concrete block, however, was chosen for wall construction. Large concrete vehicles were therefore not required. Smaller more portable concrete mixers could be used. Other means of structuring the shelters were light timbers which supported the roof and additional blanket of earth.

ENVIRONMENTAL CENTER

In the final design of the environmental center, the building is located in a way which requires a short introductory walk of the environment before entering the building from the parking area. An elevated (2 feet) deck walkway controls and directs the movement of visitors. The existing parking lot serving the environmental center was redesigned to provide a more efficient way of circulating vehicles in and out. A kiosk connecting the parking lot to the walkway system provides information about the park and houses an intercom system for communicating with the environmental center. An electric shuttle vehicle would be provided for handicapped persons needing assistance to the facility. A simple call to the environmental center would send the shuttle vehicle to the parking area to pick up the handicapped person.

The parking lot becomes the starting point for visitors to experience the different successional layers of plant life in the state park. The first layer being the plant life related to the marsh. The environmental center becomes a place along the journey through the park. From the center visitors can choose three different trails for hiking to different areas of the park. Trail #1 leads to the western areas which include the highest dunes. Trail #2 leads to ridges which parallel Lake Michigan. Trail #3 leads to the eastern areas of the park. This trail follows the low lying marsh area and terminates at the beach. All trails are out and back type systems of movement with each having an internal loop.
Trail #2 is of primary importance in the state park, providing the best sampling or cross section of plant life in the state park. This trail is maintained as the main circulation path through the environmental center. The path leads visitors into the center which contains a large, raised central gathering space where visitors can relax or wait for the assistance of a naturalist. A large stone fireplace becomes the focal point for the space. A recessed floor area around the fireplace defines the sitting area.

Other areas of the building can be accessed from the main central space. A reception desk occurs off the main circulation path and creates a control point for the people entering the administrative and research areas of the building. On the opposite side is an audio/visual space where films about the state park can be presented. The exhibit space is directly connected to the audio/visual space. These more public spaces introduce to first time visitors special features about the park.

The main central space offers light and ventilation through operable clerestory windows.

A picnic/snack area is located on the southwest corner of the building for exposure to the afternoon sun. It extends out from under the roof and becomes a system of terraced decks. This space can double as a place for gatherings such as classroom activities. Service access is provided from the backside (north edge) of the deck through a hinged wall panel which screens views into the service area. The panel would be secured at all times unless service access is needed.
Two classrooms on the northeast edge of the building are accessed from the main circulation path. A collapsible wall separates the two spaces. One large space can be created by removing the wall.

An outdoor orientation is provided as much as possible from inside. An outdoor deck along the east and south edge of the building serves as circulation around the building to trails in case the building is shutdown for some reason. Outdoor exhibit spaces become part of the deck system, as extensions of the internal exhibit spaces. The two classrooms would be accessible to the deck. Two wood framed structures encloses implied spaces where outdoor classrooms can be held.

The offices within the administrative area of the building have their own private deck located away from the more public side of the building. The location on the northwest side of the building offers more diffused lighting conditions.

Access to different trails occurs on the north side of the building. Each trail extends out from under an open air structure which serves as a gathering and secondary information point before beginning a hike. Each trail would begin as an elevated walk with exhibit spaces along the way explaining the distinct features of each trail. The elevated walkway would eventually breakdown to become a path at ground level.
Materials of the building consist primarily of wood. Pole construction techniques are used to structure the building. Constructability becomes easy then in this natural setting where heavy construction equipment has a difficult time reaching the site (especially if concrete construction methods were used). Insulation below the floor and between joists becomes essential with pole construction. Service areas where utilities enter the building must be insulated properly. The deck system around the building ties into the pole system as a means of support. The deck is partially enclosed with a low wood framed wall. The roof is a metal standing seam type. Rigid insulation insulates the roof zone. Gutters and downspouts extend along the fascia of the roof. Downspouts feed into gravel beds where rainwater percolates back into the surrounding earth. Service for the building would extend from the existing nature center. Service trenches would follow the elevated walkway system hiding incoming utilities consisting of water, natural gas, telephone, and electric lines.
RESEARCH SHELTERS

In the final design of the research shelters, constructability became a major issue, especially in a natural setting like that found in the Indiana Dunes State Park. Concrete block and light timber construction were finally chosen as building materials. As with the environmental center design, the elimination of heavy construction equipment from the job site was made possible. This reduced the construction impact on the natural setting.

The final design incorporates space for sleeping, eating, bathing, and for doing research. Two sleeping quarters are provided and are located on opposite ends of the shelter to provide greater privacy. The research space occupies the central area of the building.

The shelter has a south orientation to capture the sun's heat in the winter. Water filled tubes store heat during the daylight hours and then radiates the heat into the adjacent spaces. Sun screens can be pulled down over the glazed areas to control the sun. At night blankets are pulled down over the glazed areas to trap the internal heat. Woodburning stoves provide supplemental heat to the interior of the shelter.

During the summer months operable windows and skylights are adjusted to invite natural ventilation. The skylights over the interior of the shelter provide natural light.

A deck extending from the shelter on the south side serves as a place for sitting and enjoying the outdoors. A fire pit cut into the deck and lined with concrete would permit outdoor barbecuing.
The shelter would be built into a south-facing slope. The north wall would serve to retain the earth which would insulate the interior. A layer of earth would cover the roof providing another layer of insulation. A system of timber beams and wood decking would support the roof while 12" concrete block would make up the exterior walls. The roof timber would extend out from the roof and become exposed. They would frame a system of louvers that would control the sun in the summer months.

The shelters would be clustered around the existing nature center which would serve as a place for checking in and picking up supplies. Service to each shelter would extend from the existing nature center. Trails would lead to the shelters from the nature center.
This thesis has been an attempt to explore and highlight the ways in which architecture can be more integrated with and responsive to the natural environment. Several conclusions can be made as a result of this exploration. A number of questions have also arisen during this thesis that can lead to further study.

The natural environment is a complex world with a system of processes and patterns that are strongly interrelated. Plant and animal life combine to create a system of checks and balances. Certain species of animals exist where certain plant species are found. Certain species of plant life are maintained by certain animals. Plant forms mature and overtake other plant forms. Wind and rain combine to erode the soil.

Each natural setting is different depending on the region of the world. Inserting built forms into the natural setting must be done with care in order to minimize the disruption of the existing processes and patterns that exist in that particular setting.

There is a range of built forms that may result because of the response they make to nature. They range from architecture being a complement and foil to nature to architecture being a continuance where there is little distinction between nature and the built form. I would have to accept the range of these possibilities as being legitimate. The appropriateness of each is heavily dependent on the purpose of the building, however I would have to conclude that when the program is appropriate, and the environment conducive, underground or earthsheltered architecture is most advantageous.

Earth for the most part, as a surrounding insulating material is ideal for maintaining thermally comfortable interior living environments. The earth above and around the architecture encourages the growth of vegetation. The architecture becomes less visually obtrusive, which may be strongly desired in a setting where the visual enjoyment of trees and other vegetation is desired.

Certain forms can actually respect nature simply by complementing it. I believe though that when this is the case, a series of transitional spaces need to occur between the inside and outside. Initially I explored two extremes in the design of the environmental center. The first design (experiment #1) was designed below grade while the second design (experiment #2) was above ground and became more of a complement to nature. This design has a very strong response to nature simply by having a visually strong indoor/outdoor relationship. Natural ventilation was also more easily achieved by its above ground configuration. In the first design, the observation tower projecting up through the building became an architectural element or complement to nature.

In the third design of the environmental center (experiment #3) the observation tower became the overriding feature. In this case, the tower became somewhat overpowering. The exhibit space which became a space for collecting sun, opened the interior visually to the outside. The secondary spaces of this design were below a layer of earth. When this is the case skylights projecting up and out become a means for ventilation, collecting sunlight, and for providing views.
A major concern for building in the natural environment is the tolerance level of the environment at hand. The site for the environmental center was such that enabled building in that area. However, less than one-half mile away, the same building could not be achieved. The dunal areas near Lake Michigan are very unstable. Where the environmental center was planned, the same dunes had stabilized due to a heavy growth of vegetation occurring over the years. Each specific site must be understood for its potentials.

The program for the environmental center eventually became highly influential in the final design. An expanded program required a large facility for several activities. The building connection to the land was a problem in the earlier designs especially with the first and third experiments. In both cases, the buildings were designed as poured in place concrete structures because of the need to support heavy loads of earth. This construction method was not a problem where the building was located. However, the program encouraged the environmental center to be a greater distance from the parking area. This would create a longer walk to the building. Concrete construction of the magnitude used in the first and second experiments required the access to the site of heavy concrete mixing equipment.

The final solution reduces the impact on nature in a construction sense by eliminating heavy equipment from the job site. It uses pole construction techniques and timber framing to structure the building, thus eliminating the need for heavy construction equipment. Constructability in the natural environment could become the ultimate focus in further studies, in order to understand the impact of the different building techniques in the natural environment. Also, what impact does the movement of heavy equipment have or how can it be minimized? Under these conditions, how can plant life be protected?

Much study has been done on the actual building/nature relationship. Certain forms as investigated in this thesis may be appropriate such as below or above ground architecture. An issue of importance would be the actual implementation of these forms.

Servicing buildings in natural environments could also be the focus of further research. How are utilities delivered to a building to minimize the disruption of the land? One option would be to make the buildings self sufficient. In the case of the final solution, utilities are delivered to the building in trenches alongside an elevated walkway system, thus containing and restricting their impact along certain lines.

Sewage treatment could also be investigated further in order to understand or develop new ways for localizing this system. Septic systems are not always appropriate in certain natural settings because of high ground water or thick vegetation.

Overall the thesis began as an exploration of ways in which architecture can be more positively integrated with nature. Respecting nature includes not only energy and spatial responses but also the implementation of building in these environments in order to reduce their impacts. A strong integration with nature will occur when the more technical issues of building also respond to nature.
INITIAL PLANNING IDEA OF THE ENVIRONMENTAL CENTER

BUILDING AS GREENHOUSE

INITIAL TOWER STUDY
IMAGE AND PLANNING STUDIES
ORGANIZATIONAL STUDIES OF THE ENVIRONMENTAL CENTER

Plan Arrangement - Scheme 3  1-28-87  KSS

Plan Arrangement - Scheme 4  1-22-87  KSS

Plan Arrangement - Scheme 1  1-22-87  KSS

Plan Arrangement - Scheme 2  1-22-87  KSS
INITIAL STUDIES OF THE RESEARCH SHLETER
INITIAL STUDIES OF THE RESEARCH SHELTER
INITIAL PARKING/BUILDING RELATIONSHIP STUDY

SITE PLAN

SCHEME 1

SCHEME 2

SCHEME 3

SCHEME 4

SCHEME 5

SCHEME 6
PLAN VIEWS OF THE ENVIRONMENTAL CENTER
(Experiments #1 and #2)
VIEW OF OBSERVATION TOWER AND MAIN ENTRY
(ENVIRONMENTAL CENTER EXPERIMENT #3)
VIEW OF TRAIL EXIT AND OBSERVATION TOWER
(EENVIRONMENTAL CENTER EXPERIMENT #3)
FINAL DESIGN OF THE ENVIRONMENTAL CENTER
VIEWS OF RESEARCH SHELTER
(EXPERIMENT #2)
EXTERIOR VIEWS OF RESEARCH SHELTER
(EXPERIMENT #3)
VIEW OF ENTRY AND EXTERIOR
(EXPERIMENT #3)


