water responsive architecture - utilizing water and its resources
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multifamily residence - winona lake, indiana

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This thesis report offers a descriptive and graphical explanation to what might be seen as resource conscientious architectural design. As the title makes reference to water, the importance is to be placed on the concept of responsiveness to water and its valuable resource potential. Architecture has the ability to utilize water and its unlimited capacities as a resource to assist in the preservation of our natural environment.

The underlying foundation of this thesis is centralized around the question of how most architectural building types directly adjacent to waterfront property can react and interact with the water resource by extracting the water from the body, filtering/cleaning the water, utilizing the water in an architectural manner, and returning the cleansed water to the body. This process enables lakeside architectural structures to demonstrate their positive environmental potential.

The building type chosen for this thesis is a multifamily residence located on Winona Lake in Kosciusko County, Indiana. The past twenty years has shown an increase in the number of permanent lake side residents and a decrease in lakeside “weekenders”. This transition in resident types has had a major influence on the increasing costs of lake side property value. With the increasing cost of lake side property in Northern Indiana, due to decreasing amount of available property, the need for resource conscientious design is a must. The concept of a multifamily residence enables multiple families to enjoy the pristine beauty and recreational value that the lake provides without further depletion of the limited amount of valuable green space that remains.

This thesis report details a design concept centered on showing how resource conservation and utilization can be a determinant of architectural form and function. It is through this demonstrative approach that the realization of architecture that is creative as well as functional can come into being. It is the creative and functional attributes of the project that provide an example to the public of how architecture and nature can work together to promote a more positive living environment for all.
The lakeside community development of Winona Lake in north central Indiana provides as the landscape for the proposed multifamily residential design. The site is located on the eastern shoreline of Winona Lake, in Winona Lake, Indiana. The lake is the central core and livelihood of the community. The encompassing structures of the lake vary from quaint weekend resident dwellings to large capacity motels and camp houses. Through the placid nature of the lake and the lakeside residents, it is sometimes difficult to see the diversity of the culture that contributes to the lifestyle that the lakeside community represents. Young and old alike enjoy the opportunities of recreation and relaxation that the lake provides. From the ice capped calmness of the winter months to the white-capped waves of the Forth of July, Winona Lake provides a varied range of activities and opportunities for both residents and visitors to interact with each other and the lake.
Just as the historical value of the community has been preserved in the Village at Winona, an area of town with a large inventory of preserved historical homes, so must the historical and cultural value of the lake itself be preserved. Winona Lake has a rich history filled with memories of summers gone by. It is the responsibility of the current residents to continue its enriched lifestyle with progressive development that is respectful to themselves and their natural surroundings.

From the primary entrance to the Town of Winona Lake, a beautifully landscaped and sculpted town emerges from the placid surroundings of the lake. Continuing southward along the eastern shoreline the scenery transitions into a park setting filled with youthful activity and natural beauty. It is from this point southward along the eastern shoreline that Winona Lake transforms into clusters of similarly designed residential dwellings. It is the purpose of this multifamily residential design to break the mold of the currently accepted lakeside design by providing a new form from which a diverse mixture of art, architecture, and nature can grow. The new residential design will make reference to its surrounding historical context, while implementing the use of new technological construction methods and materials.
background
- concepts
- processes
- methods
- objectives
- site

The multifamily residence encompasses various ideas and concepts of sustainable and green architecture as they apply to an adjacent body of water and the surrounding lakeside community, i.e.; daylighting, wind, water usage, views, and various privacy issues. The proposed design explores the possibilities of designing residential architecture that can be utilized by year-around as well as weekend-getaway residents within the same household. The proposed household is based upon architectural design that is practical, economical, and environmentally mindful, while giving consideration to the given building edict of the property as dictated by the Kosciusko County Zoning Ordinances and the Winona Lake Zoning Ordinances and Pier Building Codes.

The critical nature of the importance of water resource management is vital for all living elements of our world. Just as water is one of our most vital resources, it is also vital that the design process for the multifamily residence explore various ways in which water can be utilized in architectural design. From the most basic elements of the design process to the intricate details of the completed design, it is essential to have an open-minded approach to design. An approach that carries the design through its conceptual basis into a three-dimensional reality.

Explorations in water and daylight uses and properties assist in defining the scope of the project as well as the spatial investigations of a multifamily dwelling. Water and daylight characteristic research was carried out through Ball State University’s Center for Energy Research / Education / Service (CERES).
The proposed Multi-Family Residence for Winona Lake is located on the eastern shoreline, south of the Village of Winona and the Winona Lake Park. The site is nestled back into the shoreline and is well shaded by mature growth deciduous trees. The site provides great opportunity for spectacular views of the lake and the natural beauty that makes up the surrounding community. A perspective from the northwest side of the property offers open green spaces as well as protected private spaces that open themselves to the lake. The site also provides a natural lakeside pier connection at the northern most edge as well as direct side-street connection to a public boat ramp, allowing immediate access to the lake and the recreational opportunities that it provides.
background
- spatial organization
- program summation

Spatial Diagram

Permanent Resident's Private Space
Shared Dining Rm and Kitchen
Pier Connection

Shared Recreation Space
Weekend Resident's Space

Gar.
Shared Living Room
Library / Study

Color-Coded Diagram

Permanent Res. Space
Shared Space
Weekender Space

Integrated Spatial Diagram w/ Multilevel Overlaying
Multi-Family Residence
Winona Lake
Winona Lake, Indiana

The residence is to be composed of the following spaces:

I. Shared Household Common Areas

1.0 Living Area 740 sq. ft.
2.0 Kitchen 330 sq. ft.
3.0 Dining Area 580 sq. ft.
4.0 Bathrooms: 2 @ 60 sq. ft. including
   bath / shower, sink, and toilet 120 sq. ft.
5.0 Activity Space 340 sq. ft.
6.0 Laundry Room: including two washers
   two washers and two dryers, folding tables, and ironing space 80 sq. ft.
7.0 Library / Study Space 200 sq. ft.

Household spaces are shared by both permanent and weekend residents.

II. Permanent Resident's Private Areas

1.0 Permanent Resident's Master Bedroom 370 sq. ft.
   1.1 Bedroom Space 250 sq. ft.
   1.2 Master Bathroom 55 sq. ft.
   1.3 Walk-in Closet 40 sq. ft.

2.0 Permanent Resident's Additional Bedrooms 695 sq. ft.
   2.1 Bedroom Space: 2 @ 240 sq. ft. 260 sq. ft.
   2.2 Adjoining Bathroom 55 sq. ft.
   2.3 Closets: 2 @ 10 sq. ft. 20 sq. ft.

The adjoining bathroom will be shared by the additional bedroom spaces.

3.0 Permanent Resident's Home Office 200 sq. ft.
   3.1 Office Space 115 sq. ft.
   3.2 Waiting Space 85 sq. ft.

Total Net Area of Permanent Resident's Space: 1165 sq. ft.

III. Weekend Resident's Private Areas

1.0 Bedrooms: 4 @ 175 sq. ft. 700 sq. ft.

2.0 Closets: 4 @ 10 sq. ft. 40 sq. ft.

Total Area of Weekend Resident's Space: 740 sq. ft.

Total Net Area of Spaces 5955 sq. ft.
Total Gross Area of Spaces 7443 sq. ft.
Mechanical Room 88 sq. ft.
Total Area of Residence 7530 sq. ft.
A diverse array of architectural projects were utilized in the research process of the thesis design. Architecture and its relationship to water most often stands alone as two separate elements. Finding examples of interactive, "water responsive" architecture proved to be an eye-opening experience filled with architecture and art that spanned the globe.

Water recycling was also investigated as a potential resource conservation strategy. This research led to the potential use of a Solar Aquatic System (SAS) for the purposes of cleansing wastewater from within the household or secondary lake water that is used to maintain the SAS. The gravitational processes of the SAS allows for the system to be segmented through the structure, thus becoming an architectural element integrated into the overall form. The SAS serves to provide discharge water for heating and cooling as well as a household plant cycle that help to amalgamate the form with its natural surroundings.

Research in the conceptual idea of water as a shading device was of primary interest throughout the design process. With the development of a water roof test fixture, the reality of this conceptual idea was put to the test. The findings of the experiment were quite different than what was anticipated (see page 19).

The overall form of the building is dictated by the proposed concepts of water usage inside and outside the building along with the spatial organization issues of security, privacy, and social interaction. The utilization of water from the incoming water supply provides for the most practical means of resource recycling. The incoming water is used throughout the residence. The wastewater produced by everyday usage is circulated and filtered through the Solar Aquatic System. The discharge water from the SAS is divided between its needs in the heating and cooling system and the water roof. The water that is utilized in the heating and cooling system is maintained within a closed loop system for a three month period of time before it is replaced with fresh SAS discharge water. The water that is directed to the water roof is allowed to free-fall down the slope of the wall. The downward end of the water roof is equipped with a series of cross-flow micro-hydro turbines that generate electricity that can be stored or used throughout the residence helping to offset the cost of the Solar Aquatic System.
Previous project water studies on the conceptual idea of water utilization as a shading device were further developed and tested in Ball State University's Center for Energy Research / Education / Service (CERES).

These images were taken outside in south-facing sunlight. The images show the implication of water providing shade. The images are inverted to highlight the percentage of shading possibilities.
The premise of the water wall concept is it could be used in architectural design to allow water to flow across a pane of insulating glass. The proposed purpose of the water wall is to decrease the amount of light transmitted through the underlying glazing system of the wall. The proposed purpose of the water wall is to decrease the amount of light transmitted through the underlying glazing system of the wall.

In testing the actuality of the proposed purposes of the water wall, it was found that the clear, filtered water decreased the amount of light transmittance by only 5%. In the proposed purpose of water used in cooling the surface of the glazing, it was found that there was a difference in temperature from the interior surface of the glazing to the exterior surface of the glazing to be approximately 1 degree Fahrenheit on both sides of the cooler surface of the interior.

The results of the study show that the proposed use of water to increase the capacity of the glazing surfaces by decreasing the amount of transmitted light does not provide adequate increased capacity. In the case of using clear, filtered water to assist in cooling the surface of the glazing, the capacity is not increased as much as was expected. A possible solution to the issue of decreased increased capacity in the glazing would be to use less filtered water and color to the water, provide a shading device on the exterior of the window system, or alter the type of window glazing used in the project design.

* A study conducted in 1990 at the University of Texas at Austin. Smart glazing was created from a mixture of copper plates and water to produce glass that becomes opaque when the temperature increases and becomes less opaque and then clear as the temperature decreases. (www.pagetests.net)
Initial study models exploring the spatial organization issues of permanent residents, weekend residents, and shared space. Issues of hierarchy and water roof concepts were explored as well.
A second study model was developed at a larger scale to explore floor plans, interior balcony spaces, rooftop spaces, zoning issues between interior spaces, exterior form proportions, structure, circulation, and water setback issues.
The investigation of spatial organizational issues, for the permanent residents and the visiting "weekend" residents, in combination with the primary thesis issues of "water responsiveness" dictated the overall form of the building in plan and elevation. The primary focus for the first floor was to integrate entrances, exits, and circulation into shared household spaces that didn't compromise the open-plan of the space. A comprehensive placement of pedestrian access from street side to lakeside was very important in the overall scheme of the plan. From the driveway entrance, providing adequate parking for residents and visitors, to the open pier connection, providing lake side recreational opportunity, the footprint of the building sits atop the lake surface reflecting the values of water conservation and recycling.
The second floor plan is designed around the practicality of shared household space in combination with immediate access to the visitor's private spaces. The third floor plan is centered around the hierarchical necessity of the permanent residents' private and office spaces that provide personal security for their belongings. Both the second and third floor plans have immediate terrace, pier, SAS room, rooftop, and primary entrance/exit access. The floor plans also offer ample opportunities for spectacular lake views and interaction between levels with open balconies that terminate at the first floor level.

The various balcony spaces also offer direct views of the overhead water roof system as the flows into the lake, creating a calming, therapeutic, relaxing space for all household members to enjoy.
The sectional view of the building provides access to interior zoning issues that are dictated from floor to floor. The sectional view also displays the structural system and 12' grid design of the building. The relationship of architecture and water is also prevalent in the sectional view, as the structural pile-grid that penetrates the lake bottom elevates the building above the water's surface, providing as a buffer during turbulent water conditions.
wall section displaying structural system, materials, context, and scale
The finalized form of the building makes reference to its traditional residential context with gabled roof forms that outline each vertical element of the structure. The gabled form is used in the primary stair tower entrance as well as the outdoor rooftop spaces that allow access to the Solar Aquatic System rooms. The core of the building is segmented between three primary units with the double-skinned glass roof resting at a 25 degree angle above them, providing extraordinary interior and exterior spaces to be enjoyed by residents and visitors alike.
The west side of the residence offers direct access to the lake and its endless recreational opportunities. The residential pier is connected to a series of outdoor terrace spaces with the use of an exterior stair tower. The pier serves as a means of public access to the residence much like the automobile driveway on the east side of the property. The rectilinear projection of the pier serves to provide spaces for social and recreational activities, while serving as a buffer for the building during unfavorable weather conditions.
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Northeast Perspective

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The cross-flow micro-hydro turbine system that generates electricity as part of the residential power supply is integrated into the double-skin glass roof structure. The waterfall that cascades from the rooftop into the lake enhances the outdoor patio space on the south side of the building.
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Shared Living Space

Shared Kitchen Space

water responsive architecture - utilizing water and its resources
results
- final model
water responsive architecture - utilizing water and its resources
This thesis project explored potential possibilities of how architecture and water can be used together to produce an experience that promotes wellness for both the built and natural environment. The proposed residential design incorporated the utilization of water and some of its potential resource uses. Exploration in theoretical water usage such as shading was tested in a laboratory environment as well as the natural environment so that multiple perspectives on the issue could be addressed. The results of the proposed water usage tests proved to demonstrate how the perceived characteristics of a material, man-made or natural, do not always work out the way in which they were intended to be used. It was through the use of hands-on, real-life experimentation and testing that the outcome of the initial proposed water usage designs were altered to accommodate the results of the tests in the design. The changes in design, as a result of the testing, provided for realistic design approaches and methods that could be used in the environment in which they were placed.

The concept of actualistic studies in architectural design helped to develop a project that was realistic functionally as well as structurally. Further development in design concepts is always a must. Further research in the conceptualized approach to a micro-hydro energy source with experimental studies in the amount of water needed, the appropriate slope of the water roof, and actual energy output of the system is needed. Structurally, issues of column sizing, lateral bracing, and glazing systems also need further research and development.

Overall, the project proved to be very interesting as well as educational. The knowledge gained from this project will be carried forward into "real world" of architecture with the intention of building upon these thoughts and ideas with a hope to eventually make them a reality.


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