Symbiosis: An Exploration into the Relationship Between Material and Building

University of Detroit Mercy
School of Architecture
Professor John Mueller
Darryn Horvath
Course 5100, 5110, 5200,5210
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Dedicated to my parents John & Maria Horvath
who have supported and pushed me
in the pursuit of my dreams

And

My loving girlfriend Leah Yanuszeski
who upon completion of my
Masters Thesis should
receive an award for having
to put up with me thru all 5 years
of my architecture studies.

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Abstract

This thesis is an exploration of the relationship between buildings and the materials they are made of. This thesis strives to bring this relationship to the forefront of the design process. The general use of materials as a decorative cover in most modern buildings rather than an integral part of the building has diminished the role of materials in the design process while also creating a lack of understanding of how to work with those materials. By acknowledging that a building and a material can have a meaningful relationship a new design approach can be used in which the material drives the design. This isn't to say that the relationship is strictly in the aesthetic qualities of the material and building. A truly successful relationship between Material and Building requires a more in-depth understanding of what it means to be that material and use that material, not just its aesthetic qualities. Once an in-depth analysis of the material has been done, ideas of that material can be brought to the forefront in the design of the building. If done successfully the building and material will exhibit a symbiotic relationship in which the building helps define to the user/occupant what it means to be constructed of the material the building is made of, while the material the building is constructed of helps define to the user/occupant what it means to be that building.

It is the development and demonstration of this idea that a material and building can have a symbiotic relationship, in which the material and building help define each other, and is the goal that drives this thesis.

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Material and the built world have a relationship of great importance and the architect is the intermediary between the two. An architect is the designer of the built world. The very definition of being built is to be material and as such to be able to successfully design a built world an architect must evoke his skill in the use of material. From the onset of civilization, material has been key to the success of the human species. Materials have allowed us to create things from basic nomadic people's huts to the intricate intertwined fabrics of today's modern cities. Materials have played such an important role in the development of the human species that whole eras have been referred to by material names. These names of the eras are the materials that played the most important role in progressing society during those eras. Stone was responsible for progression in the Stone Age, Bronze in the Bronze Age, Iron in the Iron Age. Even the industrial age, although not named after a specific material, could not have been achieved without the discovery and understanding of how materials can be used. In today's world we still find new ways to use materials and create new materials that allow us to develop things once thought impossible ranging from the smallest of microprocessors to buildings over half a mile high and bridges spanning miles upon miles. In a built material world, material is the vehicle for human success and the architect is the person who ideally has mastered the skill of creating the built world through the vehicle of material. From this importance that material has to the very fabric of society it is often surprising that material importance is often negligible in the design process. Material choice often takes a backseat in the design process. Materials are chosen after most other decisions about the design have been made. This leaves the materials lacking in importance in the final design as they often feel as if just applied at the end of the process as a decorative covering. The general use of materials as a decorative cover in most modern buildings rather than an integral part of the building has diminished the role of materials in the design process while also creating a lack of understanding of how to work with those materials. Materials deserve more than this decorative covering treatment in architecture as they are the most important aspect to all facets of a design. In every step of the design process decisions about materials have to be made. Schematic design, structural design, functional design, durability, sustainable, site, cost, construction, architectural design, acoustic design, mechanical design, and lighting are all interconnected by the fact

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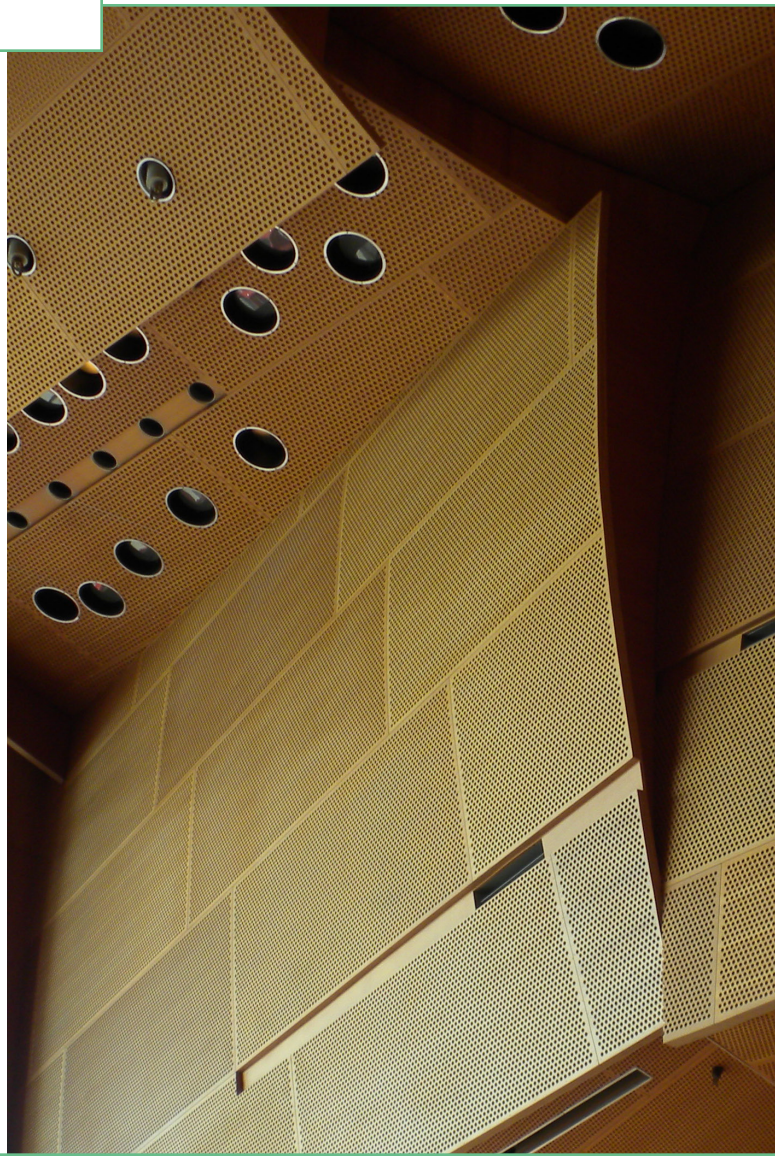
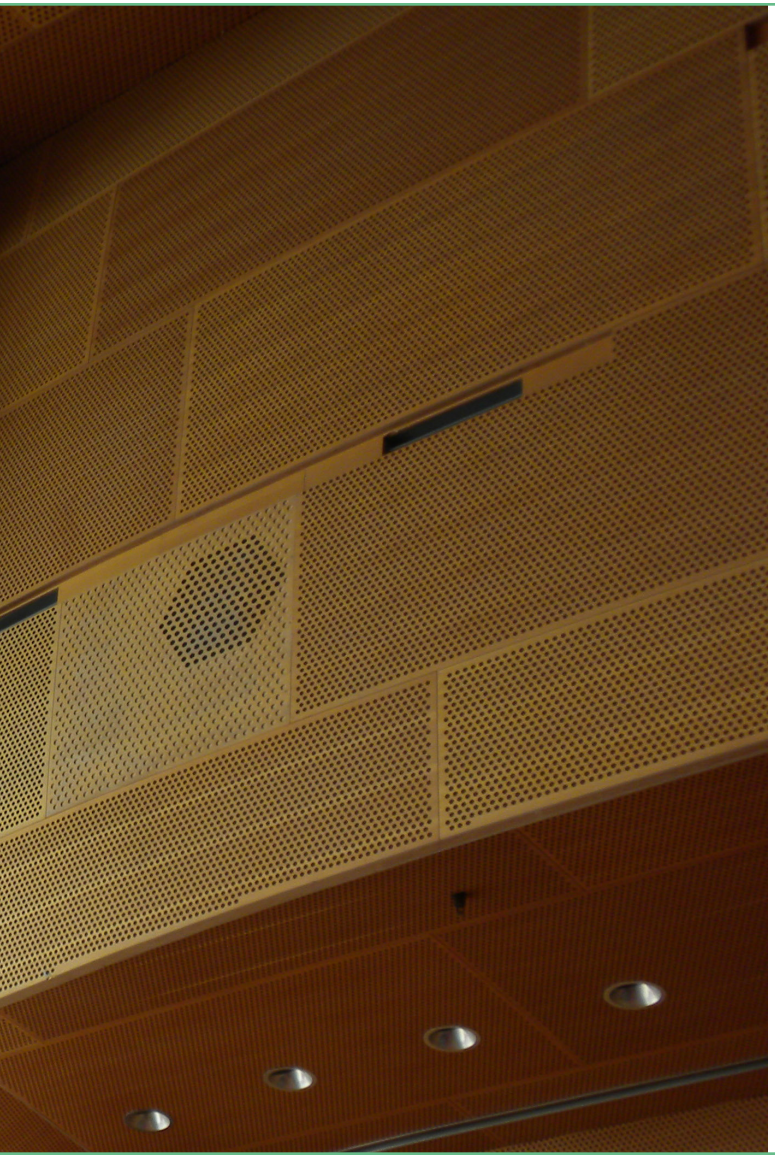
they have material decisions that have to be made. By acknowledging that a building and a material can have a meaningful relationship a new design approach can be used in which the material drives the design. This isn't to say that the relationship is strictly in the aesthetic qualities of the material and building. A truly successful relationship between material and building requires a more in-depth understanding of what it means to be that material and use that material, not just its aesthetic qualities. Once an in-depth analysis of the material has been done, ideas of that material can be brought to the forefront in the design of the building. If done successfully the building and material will exhibit a symbiotic relationship in which the building helps define to the user/occupant what it means to be constructed of the material the building is made of, while the material the building is constructed of helps define to the user/occupant what it means to be that building. The material thus becomes the central focus of the design and a greater understanding of that material can be reestablished in the society in which it was forgotten.

To begin to understand the relationship between building and material, one can look at buildings which seem to evoke an emphasis on a certain





material. The Riddel Hall, Huski Hotel, Basque Health Headquarters, and O-14 Tower are four such buildings. The Riddel Hall is a traditional red brick masonry structure while the Huski Hotel is a modern ski resort hotel with an emphasis on wood. The Basque Health Headquarters is a modern glass office building and the O-14 Tower is a skyscraper rapped in a sunshade double skin made of concrete. By analyzing the role of the main material in each of these buildings a better understanding of what is needed to create a successful symbiotic relationship between material and building can be deduced. The analysis of these four buildings through the lens of Photoshop manipulation and creating a product that has only one material remaining, begins to show us what parts of the relationship between building and material are typically weak. Typical buildings and ones that use one material almost explicitly, often do not place the design emphasis on the relationship between material and building but do what all building have done. Buildings, even if constructed of mostly one material, tend to still put an emphasis on an abstract organizational system not on the materials relationship with the building. This shows that materials, in their current use, are often simply placed into an abstract organizational system (the design) rather than the materials and building

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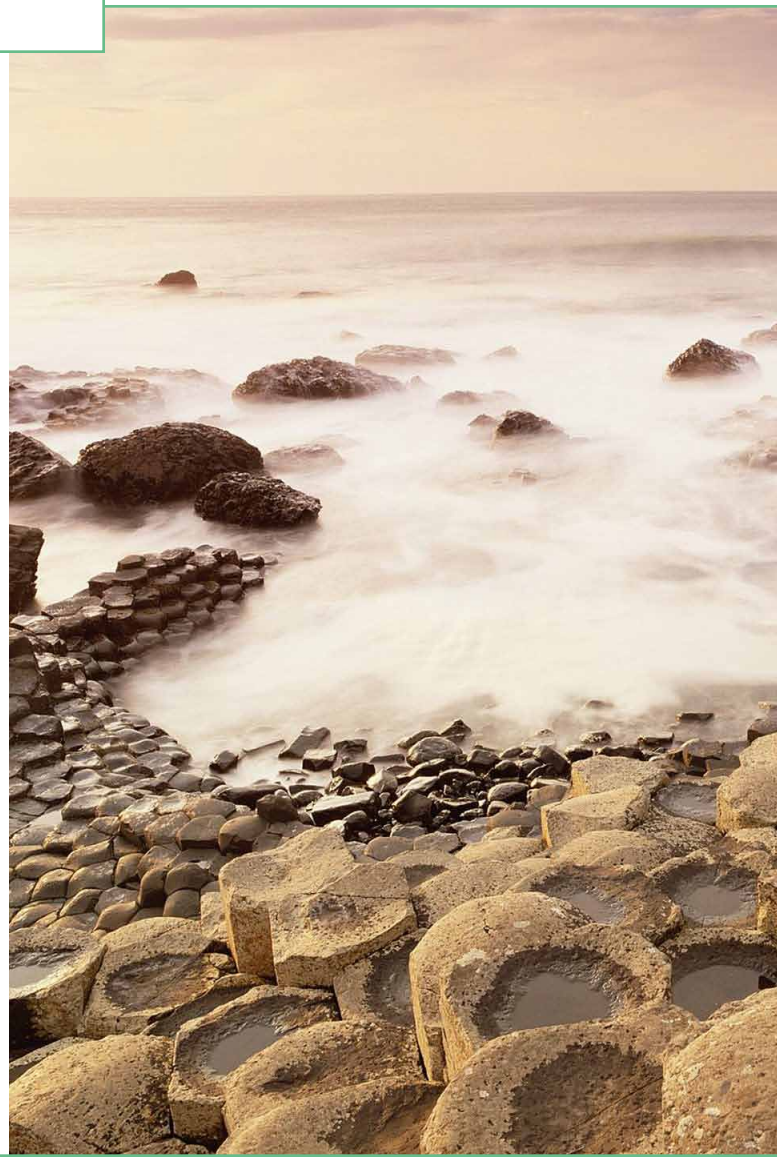
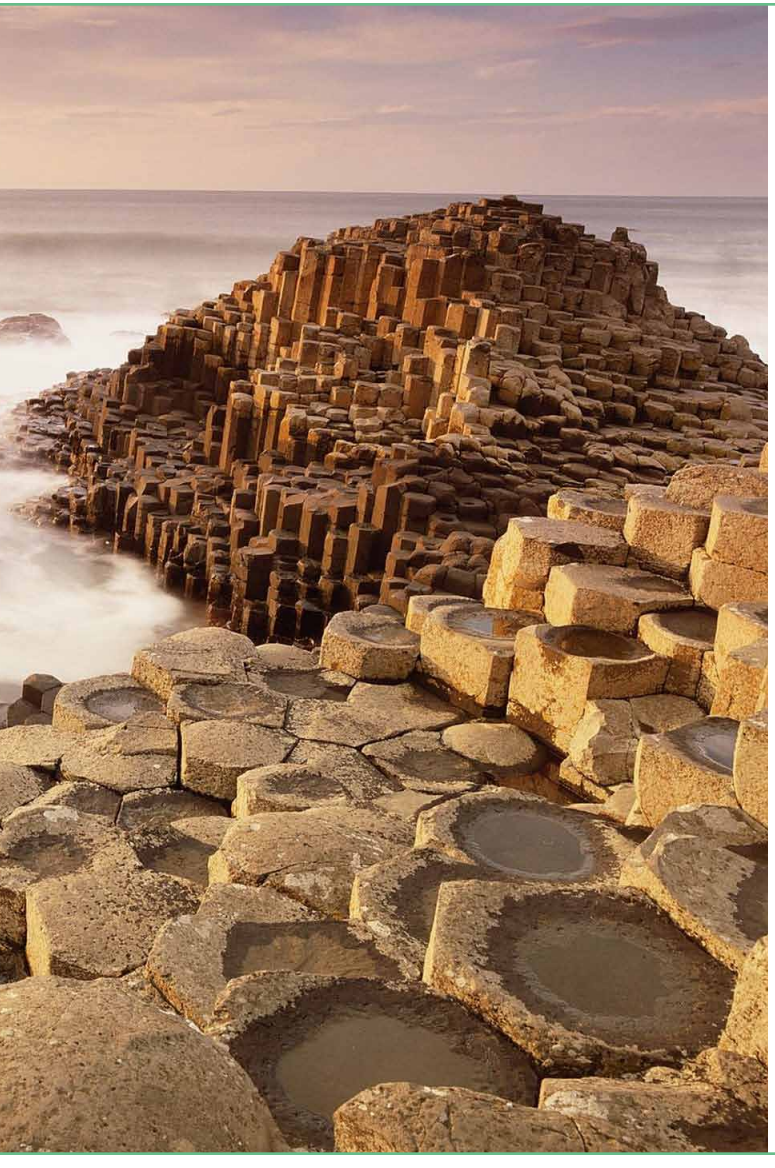
creating a symbiotic relationship where one party effects the other to create the design. For this relationship between material and building to truly be emphasized in the final design of the building, the design in all its aspects must be derived from the material and how it helps define what it means to be that building and the building helping to define what it means to be that material. By choosing a material and basing all design decisions on its relationship with the building a design can successfully present this idea to its occupants and the material will help define the building to the occupants and also the building will help define the material to the occupants. This idea has been explored through a demonstration of choosing a material and designing for the creation of a symbiotic relationship between building and material later in this thesis in the form of a wooden sawmill.

To begin to look at how a material can have a symbiotic relationship with a building, one has to look no further than the basalt formations in Iceland. Iceland sits on a very large basalt deposit along the Mid-Atlantic Ridge where the North American and Eurasian Tectonic Plates meet. The colliding of the continental plates creates a lot of volcanic activity in the area which in turn melts the basalt deposits deep





in the earth's crust and turns them into magma. When eruptions occur the molten basalt is released. In the conditions that exist in the Icelandic environment a phenomena occurs when the basalt hardens. The conditions of the surrounding environment allow the molten basalt to cool in just the right way that causes very rigid geometric formations. The basalt hardens into hexagonal prisms which protrude in the direction the lava was flowing. These hexagonal prisms are about 1 foot in diameter and form side by side in stepping patterns. These basalt formations have become a national symbol in Iceland and a huge asset for tourism. Due to these basalt formations being so important to Icelandic culture they became a great inspiration for the design of Iceland's main cathedral Hallgrímskirkja (http://visitreykjavik.is/hallgrimskirkja-church, 2013). The architects chose basalt as the starting point for the design and wanted to express basalt in the design to give emphasis to how important basalt is to Iceland. The architects analyzed the basalt and its formations for any clues on how to find a motif from these rocks. What they found was a building block. They used the section and column nature of the basalt formations to create a way of constructing the walls for the cathedral. By using the profile of the basalt formations as a guide and the building

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blocks of hexagonal prism columns they successfully built a cathedral that evokes what basalt is. The hexagonal prism columns build up towards the steeple in the same stepping pattern found in the natural basalt formations. Hallgrímskirkja is successful in its analysis of a material for a design motif but does suffer in one main regard, it does not actually use basalt in its construction. It is because of this that the cathedral does not represent architecture which has a symbiotic relationship between material and building. Although the building helps define what it means to be basalt through its aesthetic motifs, the material does not help define what it means to be a cathedral nor does the material create a relationship based on the fact it is actually concrete. Hallgrímskirkja does not complete this final step but is a good example of how one can chose a material and make design decisions through an analysis of that material and begin to create a relationship between a building and a material.

To understand this way of deriving a motif from a material selection one has to look no further than Gaudi. Although Gaudi did not derive the motifs for his designs from materials his way of deriving motifs from nature can be viewed as a precursor example of how one could start deriving motifs from

materials for design decisions. Gaudi was fascinated with nature and its inherent predictable chaos. He viewed nature as a mathematical equation. In all its chaos there was a predictable pattern to nature. Gaudi analyzed nature to find these hidden organizational systems. These patterns know as fractals became the very building blocks which Gaudi used to create his buildings (Gesimondo & Postell, 2011). His buildings now have a relationship with nature by being derived from nature. How Gaudi's buildings help us understand a relationship with nature by this process of designing by deriving from nature, designing by deriving from materials will help us understand how a relationship between materials and buildings could be formed. Designing by deriving from materials will create a building which exudes the relationship of what it means to be that chosen material in relation to the building design. Although designing by deriving from a material is often associated with aesthetic qualities, for a building to have a truly symbiotic relationship between it and the material it is constructed of it must derive from other aspects of the material that are not strictly aesthetic in nature, such as motifs based on the essence of the material.

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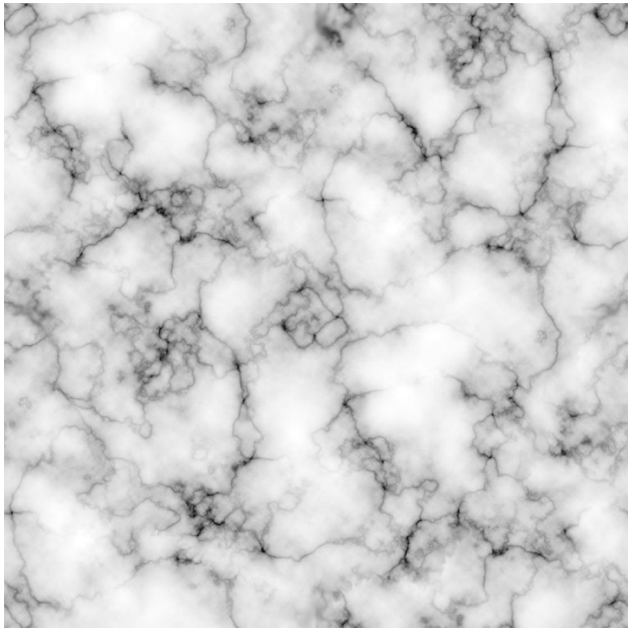
To design a building that presents the relationship between material and building a material must first be chosen. This is so that one can derive a design motif from the material itself and then develop a relationship between the building and material that is emphasized based on these ideas derived from the material. The material is now the first step in the design process. Once a material is chosen, a method of analysis can be implemented so that the material guides the designer through what it means to be that material. This method of analysis starts with analyzing the material for more conceptual design implications and gradually moving towards more detailed design implications. The goal is to try to express these qualities thru a symbiotic relationship with the building.



There are two main routes in which to look for ideas about a material that can be expressed thru a meaningful and successful symbiotic relationship with a building. There is aesthetic motifs from the material and the essence motifs of the material. For a relationship between building and material to be successful and symbiotic both are needed. Aesthetic motifs will help visually show occupants how a material helps define the building and the building helps define the material, while the essence motifs will

philosophically inform the occupants of how a material can help define the building and building define the material. Essence motifs tend to lead to more conceptual design implications whereas aesthetic motifs tend to lead towards more detailed design components. This is not always the case but is a good way to begin to understand the two different motif's roles in the development of a symbiotic relationship between the building and the material it is constructed of. Essence motifs in materials include but are not limited to: nature of the material, properties of the material, methods of use of the material, physical structure of the material, knowledge of the material, etc... . Aesthetic motifs in materials include but are not limited to: mass and void relationships, patterns, paths, volume of elements, hierarchy of elements, structure, etc... .

When analyzing a material for essence or aesthetic motifs, it may happen that certain analysis cannot derive a motif for design from the material. This shows that certain motifs are more important fundamentally to certain materials while other motifs are not. The motifs that can be derived from that material are unique to that material and must be expressed in the relationship between that material and the building that is constructed of that material. If these motifs

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are not part of the design a strong symbiotic relationship, in which a material helps to define the building and the building helps to define the material, cannot be developed.

By flipping the design process on its head and choosing a material as the first step of the design process and then analyzing that material for essence and aesthetic motifs one can successfully create a relationship between the material and building constructed of that material that takes on the form of a symbiotic relationship. The building and material will exhibit this symbiotic relationship in which the building helps define to the user/occupant what it means to be constructed of the material the building is made of, while the material the building is constructed of helps define to the user/occupant what it means to be that building. If this relationship is prevalent in a design, then the design has successfully portrayed the idea of a symbiotic relationship between building and material. This way of designing increases the understanding of the material and how to work with it and brings the relationship between material and building to the forefront of the design process. This acknowledgment that a building and a material can partake in a symbiotic relationship can spur a new design approach in which we begin to understand and view materials differently than the way we may have originally understood them to exist. It can also lead to a new understanding of buildings and building types associated with the materials involved.

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Material Studies

To further look into this idea of a relationship between material and building, a series of studies can be introduced. In the first set of studies, Material Emphasis Precedent Studies, an effort is made to understand the relationship between material and building in buildings that have a dominant material in their design. In the second set of studies, Material Aesthetic Motif Studies, demonstrations of ways in which an aesthetic motif can be derived from a material and implemented into a design are shown. Both sets of studies help to bring to light how and what is needed to design for a relationship between a material and a building that is symbiotic in nature.

Material Studies: Material Emphasis Precedent Studies

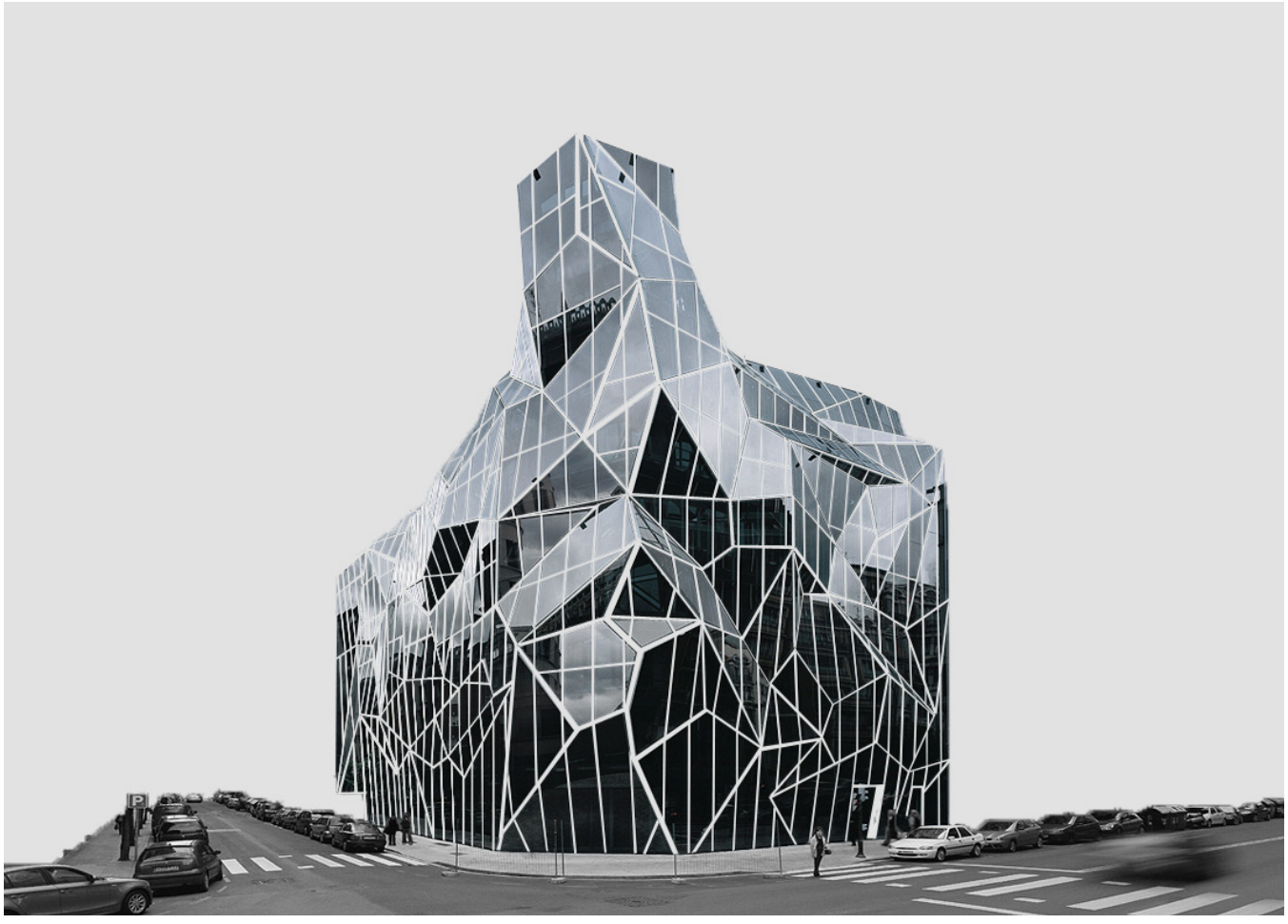
When viewing the Riddel Hall, one cannot help but be overtaken by the craftsmanship of the red masonry brick work. Every brick is laid so perfectly but ironically when viewing the building one sees a lot of red clay brick but does not feel that the building is expressing the idea of a red clay brick. To grasp what this means one must view the building with only its main material remaining. By using Photoshop's photo editing abilities it is possible to look at the Riddel Hall, and three other buildings, with all but its main material removed. In the case of the Riddel Hall, once all the materials other than the red clay brick are removed, you can begin to see that the emphasis of a relationship between the building and material is not at the forefront. In fact the red clay brick almost seems diminished in value compared to the shape of the form derived from the deletion of all but the main material. The Riddel Hall has begun to express the relationship between the building and the clay brick through its expression of masonry construction but lacks in expressing this relationship in all aspects of the design.

Material Studies: Material Emphasis Precedent Studies

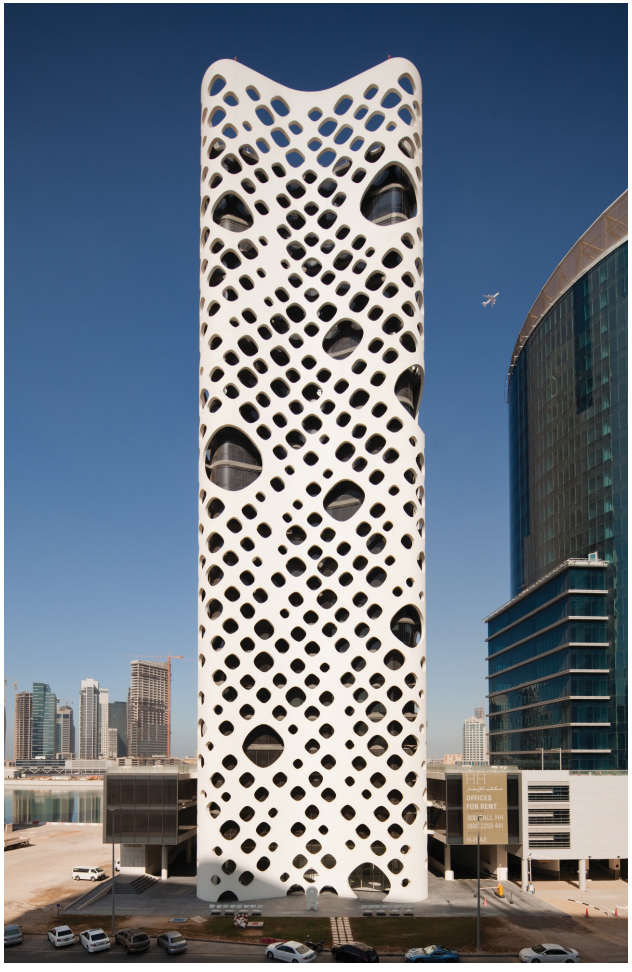
While viewing the wooden Huski Hotel in its normal state, it also seems that although one material is highlighted the emphasis of the design lies not on the relationship between this material and the building but on something else. Wood is used as the exterior finish and the hotel is a modern take on the old wooden ski chalets that used to dominate ski resorts. When the Huski Hotel is viewed through the editing capabilities of Photoshop and has all but the wood material removed it is yet again apparent that the woods relationship to the built building is not the focus of the design. Instead of the building helping to define what it means to be wood and the wood helping to define what it means to be a ski chalet, the design seems focused on placement of volumes within an overall composition.

Material Studies: Material Emphasis Precedent Studies

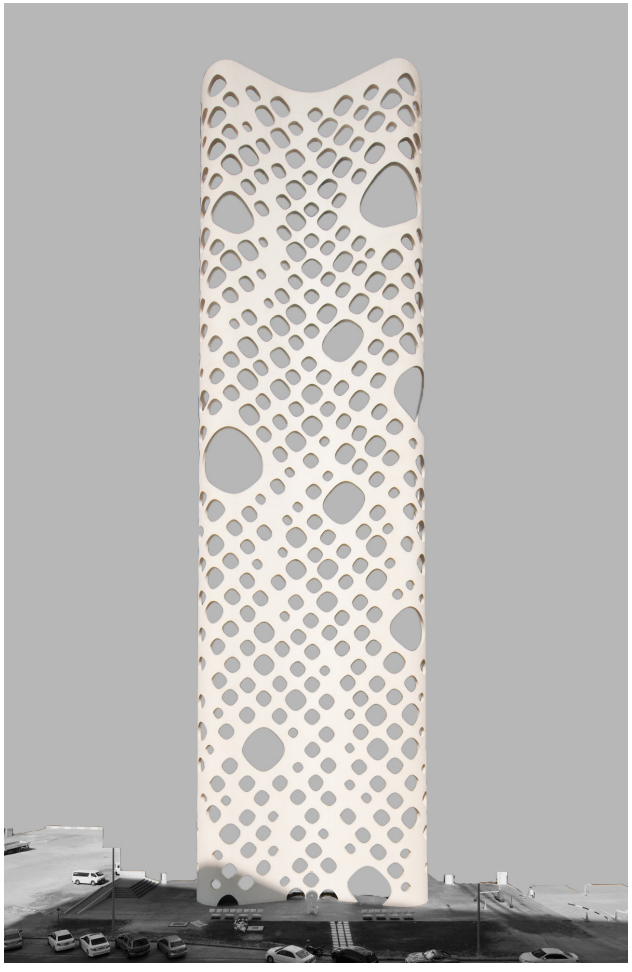
The Basque Health Headquarters is another example of a building with apparent emphasis on a material that begins to show a relationship between building and material but only scratches the surface of bringing this relationship to the forefront. Its many folding planes of glass create a odd jewel like exterior which reflects most of its surrounding upon it. The building has a lot of glass but reads as a design focused on its chaotic form. This in abundantly clear after the Photoshop treatment has deleted all but the glass of the building. Even with all its mullions eliminated the design of the Basque Health Headquarters is still largely focused on the form and not the material of glass and its relationship to with the building. A good example of a glass building that understands more in-depth a relationship between glass and building is the Apple Store in New York. It is an example of a glass structure which is more successful in further defining a relationship between the material of glass and a building although this relationship is not completely exhausted in the design process.



Material Studies: Material Emphasis Precedent Studies

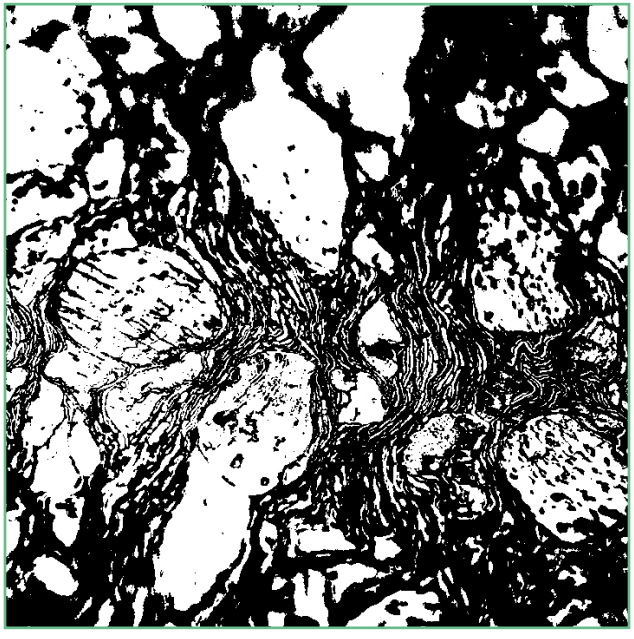


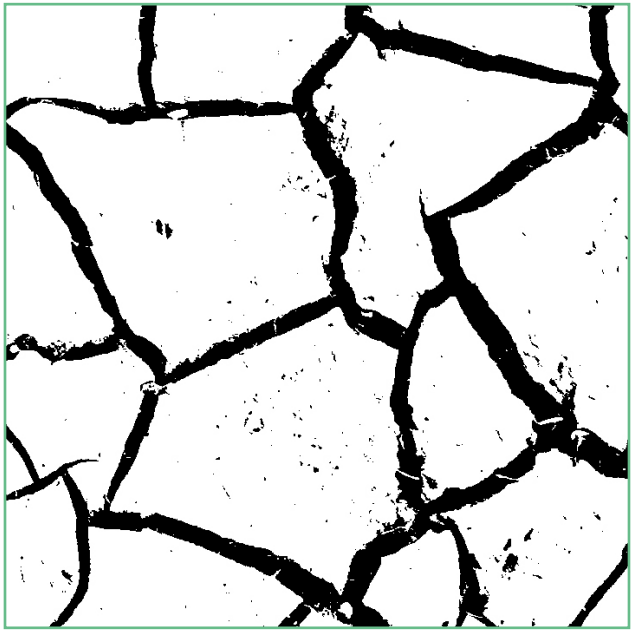
Another example of a relationship beginning to emerge between building and material can be seen in a very different structure type, a skyscraper. The O-14 Tower where an enormous amount of concrete was used to create its eighteen inch thick concrete shading skin the design emphasis is begins to explain what it means to be the material of concrete in a building. When viewing the concrete shading skin by itself it becomes apparent that the building begins to show the relationship between a building and that building being constructed of concrete. The building shows what it means to be concrete by the shape and pattern in the skin showing how concrete can be formed. The next step to would have been to create a symbiotic relationship as right now the building helps to define the material but the material does not help to define what it means to be that building, a skyscraper.

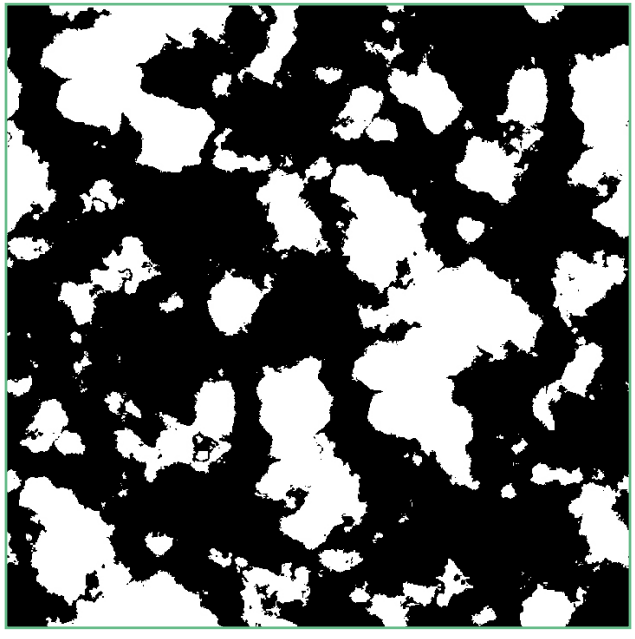


Material Studies: Material Aesthetic Motif Studies

The analysis of the mass and void relationship within the material can lead to the beginning of deriving a schematic design motif from the material. In cork the large cork pieces can become the masses while the in fill become the voids. By analyzing the mass and voids in the material one can begin to create a mass to void ratio for the building which will be designed. Also looking at the opposite version of the mass void relationship in the material can help as well. The new found mass to void ratios can be compared to typical mass to void ratios of different function buildings. By finding a building function that involves using similar mass to void ratios as the material you have chosen you can derive a building function from the material itself and become the basis for a relationship between building and material.

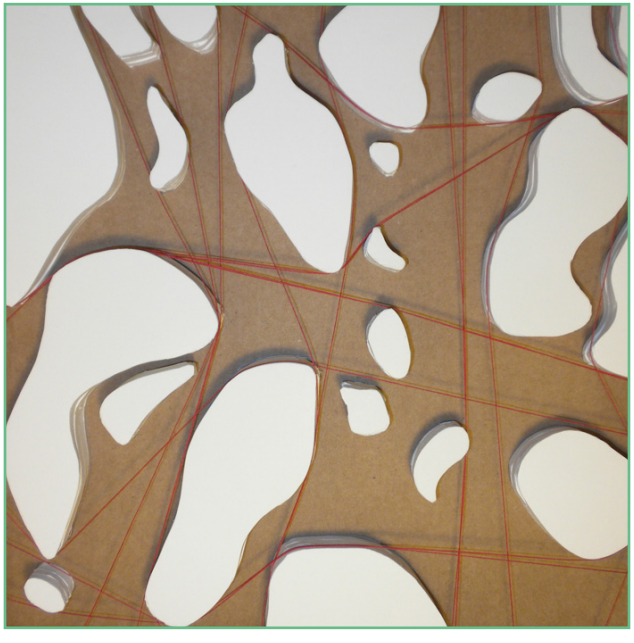






Material Studies: Material Aesthetic Motif Studies

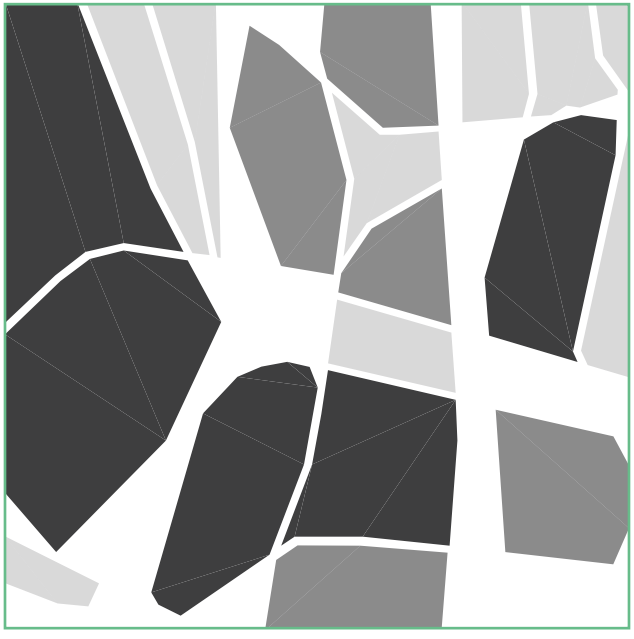
After a mass and void relationship analysis a further analysis of the material can be conducted by doing a circulation study. Using the positive and negative versions of the mass and void studies one can create optimal circulation paths through the material. By creating a grid which can be pushed and pulled around the masses left from both the positive and negative mass and void studies, a circulation pattern will be developed that has optimal paths between destinations within the building. In cork, the voids created by the removal of the in fill will push and pull points within this superficial grid placed over the material. This morphed grid can be extrapolated from the analysis of the circulation of the cork and implemented in the design of the building further enhancing the relationship between the building and the material it is built of.



Material Studies: Material Aesthetic Motif Studies

This new circulation pattern can lead to a new analysis. By traversing these circulation routes new volumes are created by the boundaries of the circulation paths. If these volumes are extruded one begins to see a relationship of spaces. Gathering spaces can be created in the voids that remain. Main circulation corridors can be seen in high volume circulation routes and secondary circulation in smaller circulation voids. The volumes themselves can be compared to functions as well, with certain volumes and proportions more preferable to certain functions than others. An example would be a smaller volume near a main circulation gathering area. A volume such as this leads well to being a bathroom facility.

Analyzing these volumes for function also brings in another analysis. This analysis is one of hierarchy. Volumes of certain sizes and in certain clusters can lead to inherent hierarchy systems. These ideas of hierarchy can be used to create areas of functional importance within the building. A cluster of large volumes can be seen to have high importance from a hierarchical perspective and thus your main functions would be placed in these volumes.



Material Studies: Material Aesthetic Motif Studies

Analysis of the materials chosen don't have to be restricted just to the building design either. Analysis of the materials can be implemented in all scopes of a design project from site to minor details. In the idea of site derived from material, one could analyze a material as typography lines. In wood the grain lines could easily become motifs for site design or site locating. Where grains are close together, steeper grades would exist. The typographical features of the site would follow the grain patterns of the wood chosen. The deriving of site from material could work in two ways. One would be to find a site which matches these typographical lines and the other would be to create typography on the site to match the typographical lines derived from the material. Minor details can also be work out from the analysis of the materials chosen. These minor details could range from staircase design to structural connections. If wood were analyzed for structural connections, the motif of branches and knots to the trunk could be used. A socket could be created into which the beam is pushed into place and a structural connection is created. Structural systems could also be derived from a material by looking at their molecular structure. It has been theorized that placing structural components in arrangements found in molecular could be incredibly strong compared to traditional structural systems (Schropfer, 2011).

Material Studies: Conclusions

When analyzing a material for aesthetic motifs, it may happen that certain analysis cannot derive a motif for design from the material (as shown in the hierarchy analysis earlier). This shows that certain motifs are more important fundamentally to certain materials while other motifs are not. The motifs that can be derived from that material are unique to that material and must be expressed in the relationship between that material and the building that is constructed of that material. As a result of these studies, one begins to realize that half of the equation is missing. Only focusing on aesthetic motifs in a relationship between building and material will not create a symbiotic relationship in which the building helps define the material and material helps define the building. Rather the design would just begin to show a relationship that only does the first or second half of what it means to have a symbiotic relationship between material and building much like the 4 buildings investigated earlier. The missing part that makes a relationship between building and material symbiotic is the essence motifs. Essence motifs in materials include but are not limited to: nature of the material, properties of the material, methods of use of the material, physical structure of the material, knowledge of the material, etc... . By expressing these essence and aesthetic motifs in the design, a symbiotic relationship between building and material can be nurtured. This is the thought that drives the next phase of the thesis, which is a demonstration of this idea that a building and material can exude a symbiotic relationship.

Building & Material Symbiotic Relationship Demonstrations

This section focuses on the creation of a symbiotic relationship between a material and a building where one party effects the other to create the design. For this relationship between material and building to be explored a demonstration of a final design in which the design in all its aspects is derived from a material has been done. The material chosen to investigate thru this demonstration is wood. By choosing wood and basing all design decisions on its relationship with the building a design can successfully present this symbiotic relationship to its occupants and the wood will help define the building to the occupants while the building also will help define wood to the occupants.

Building & Material Symbiotic Relationship Demonstrations:

To begin the process of creating a wooden building that has the character of a symbiotic relationship between building and material, one must first understand methods of construction for an explicitly wooden structure. Creating a building largely out of one material has many implications in the construction techniques that can be used to create such a building. The following precedent studies can be used as a guide to the methods and techniques that can be used to successfully create a building entirely out of wood.

Kizhi Pogost

Architect: Unknown

Year Built: Late 17th Century

Location: Lake Onega, Russia

Description:

The complex is comprised of 3 buildings of all wood construction. It basic structural unit is a round log from Scots Pine and about 30 cm in diameter and 3 to 5 meters long. Not a single nail was used in the construction of the structures. It is rumored to have be completely built using only a hammer and chisel. Legend has it that the builder, after finishing his work, threw his hammer and chisel into the lake. Although partly rumor this method of construction and craftsmanship was the optimal method of working the wood to create the aesthetic sought in the design.

Building & Material Symbiotic Relationship Demonstrations:

Heddal Stave Church

Architect: Sira Eilif

Year Built: Early 13th Century

Location: Heddal, Norway

Description:

A stave church is a medieval wooden Christian church building. It uses an all wood construction technique that uses posts and lintels and a mortise and tenon construction technique. The posts are driven into the ground to create a sturdy structure.


flickr.com/photos/michael_hanisch/

Building & Material Symbiotic Relationship Demonstrations:

Holy Spirit Church

Architect: Imre Makovecz

Year Built: 1987

Location: Paks, Hungary

Description:

Imre Makovecz was a believer in organic architecture. This church uses forms found within nature and within wood to create a motif for the design. The techniques of construction allow the wooden structure to be exposed in a way that mimics the natural forms of wood. The wooden structure uses mortise and tenon construction techniques.

Building & Material Symbiotic Relationship Demonstrations:

Yellow Treehouse

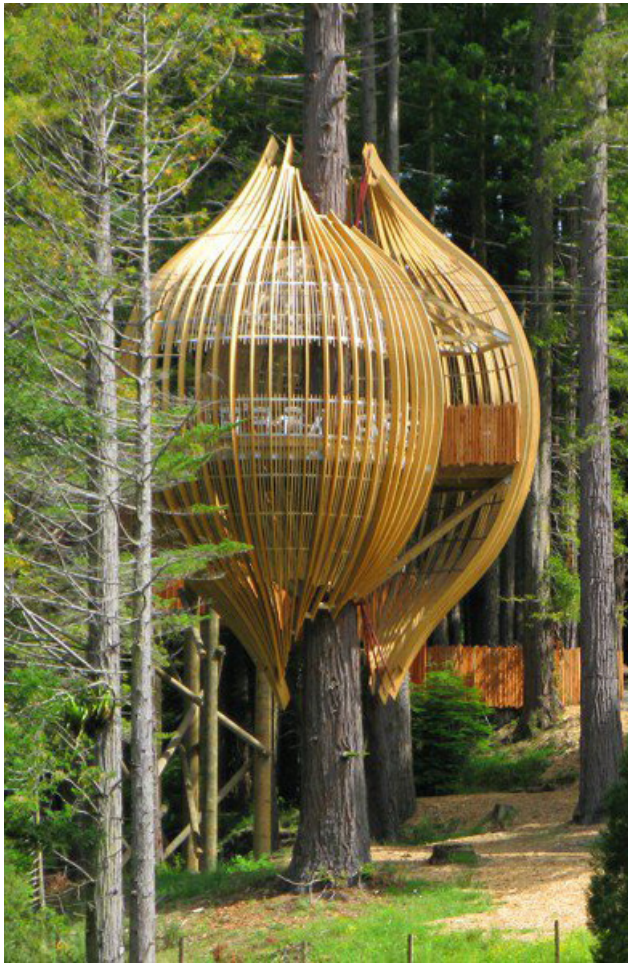
Architect: Peter Eising & Lucy Gauntlett

Year Built: 2009

Location: Auckland, New Zealand

Description:

The restaurant is a simple oval form wrapped organically around the tree's trunk. The verticality of the fins mimic the verticality of the redwoods and allow the building to naturally blend into it's setting, as though it were a natural growth. The structure gains its strength through many thin members spaced closely together. The numerous thin wooden members allow for a airy structure that is also very strong.



Building & Material Symbiotic Relationship Demonstrations:

While looking at the aspects of the material of wood, many motifs can come to the forefront. The motif chosen to be the main driving force behind this design was one based in the essence of wood. This essence motif is the idea of self-replication. Self-replication is an inherent property of wood in both its aesthetic qualities, such as the formation of grain patterns, and its natural lifecylce properties. Wood is a natural material that self-replicates itself to create more wood. To express this essence motif in a design a building must be able to demonstrate this reality of what it means to be wood. A building type that follows this idea of self-replication and could help explain this idea of wood is a sawmill. Historically sawmills were created of wood and symbolized the idea of self-replication. A sawmill would be built and repaired from lumber produced by its own blade and also would produce lumber to create more sawmills throughout the lands in which wood was being harvested. A sawmill is a self-replicating building as it recreates itself and also creates new wood structures. Buildings building buildings is the idea of self-replication and matches the idea of self-replication inherent in the material of wood. Thus a symbiotic relationship between wood and a sawmill can be achieved as this idea of self-replication will help wood define what it means to be a sawmill, and a sawmill will help define what it means to be the material of wood.

The diagram to the right attempts to understand the network and process of self-replication in both wood and the sawmill. The rings of grain represent the wood self-replicating over time from a central beginning point as the sawmill expands its network by creating more buildings from the original building.

Building & Material Symbiotic Relationship Demonstrations:

To begin the process of designing a sawmill that exhibits a symbiotic relationship between sawmill and the material of wood, one must first understand the function and mechanics of a wooden sawmill. The following precedents are original or recreations of historic old fashioned water driven sawmills that represent the type of sawmill historically created from the material of wood. These precedents do not have a design that tries to emphasize the relationship they have with the material they are built of but are useful in explaining the components required to make a sawmill work successfully. With the knowledge gained from analyzing these sawmills, an informed design can be created that is functional while also portraying the symbiotic relationship between wood and sawmill in the design solution.

Taylor Mill

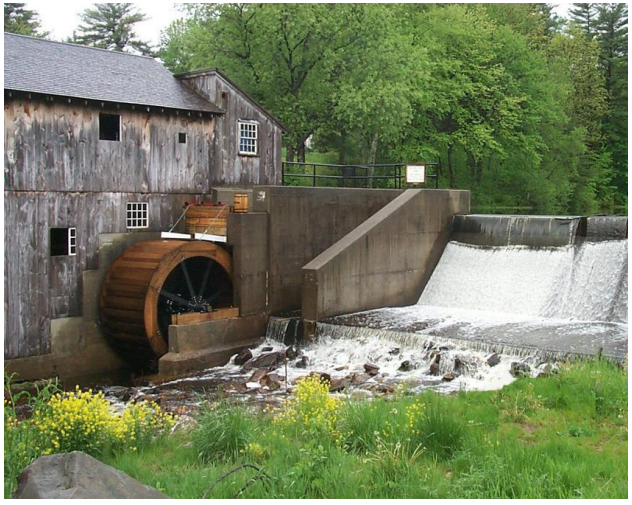
Architect: Robert Taylor

Year Built: 1799

Location: Derry, NH

Description:

The mill is an up and down mill, which is a mechanized version of a normal saw. A large water wheel powers the saw. The sawmill is historic while the dam has been rebuilt with modern concrete construction.



Building & Material Symbiotic Relationship Demonstrations:

Mill Creek

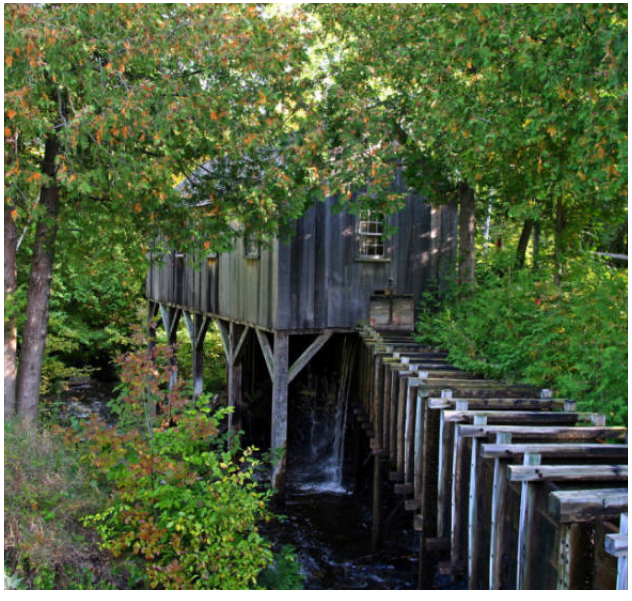
Architect: Michael Dousman

Year Built: 1984 (Rebuilt)

Location: Mackinaw City, MI

Description:

The original sawmill at Mill Creek operated from 1790 until 1839. The dam and creek were rebuilt in 1984 by analyzing wood on Mackinaw Island that was cut at the original sawmill. The mill uses a wooden dam to create a reservoir to power the gravity fed water wheel. The wood dam is constructed using a method which uses dunnage to hold down posts that run through the dam.



Building & Material Symbiotic Relationship Demonstrations:

Garland Mill

Architect: Eben Crocket Garland

Year Built: 1856

Location: Lancaster, NH

Description:

Uses a pulley and belt system which turns a circular saw. The mill has been a net energy producer since 1982. When not milling, excess power is generated which is sent back into the grid. This mills dam has become a source of both kinetic energy and electrical energy which has further helped its role as a building that produces a product.

Building & Material Symbiotic Relationship Demonstrations:

Kings Landing Sawmill

Architect: Unknown

Year Built: 1830

Location: Kings Landing Historical Settlement, Canada

Description:

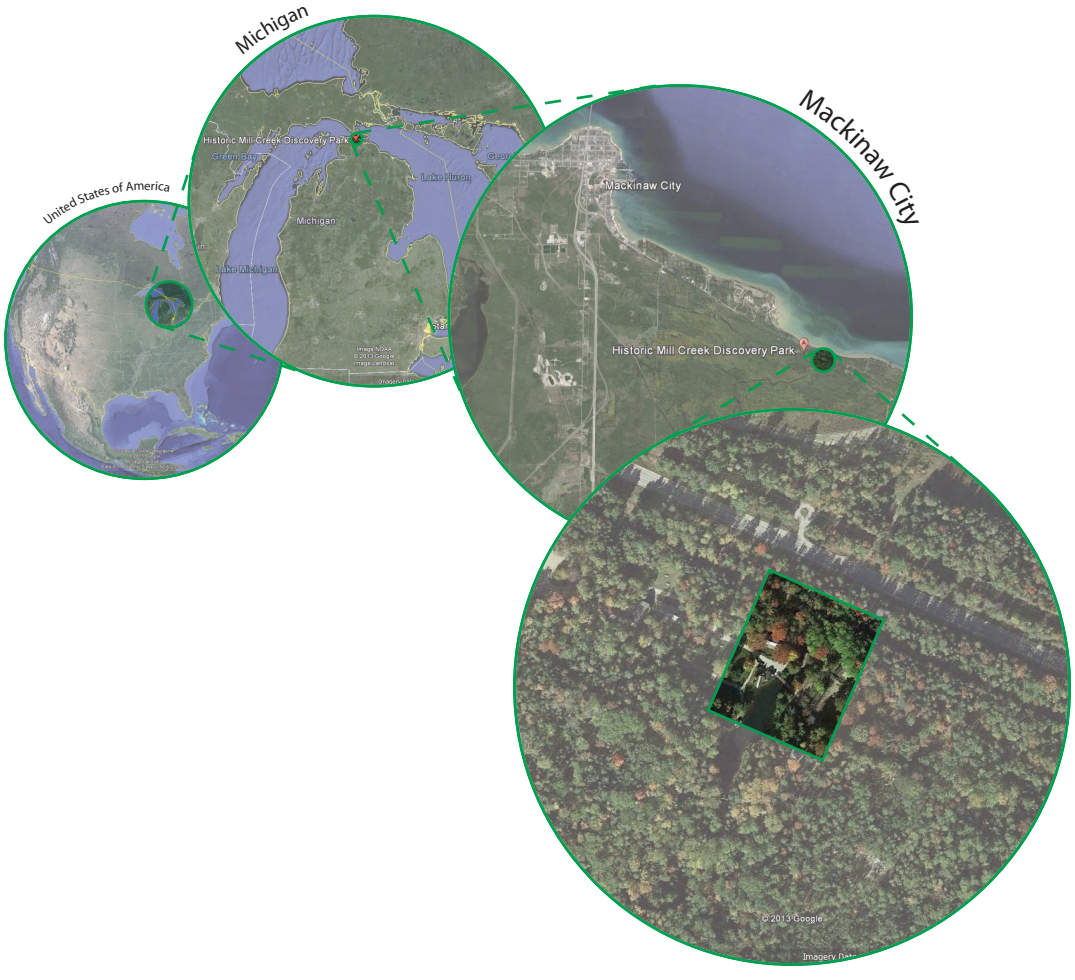
Part of a historic settlement that has be restored. The sawmill was one of a few buildings that did not have to be recreated. It uses an overshot water wheel as its means of powering the mechanics of the sawmill. Architectonically the water wheel is a focal point of this sawmill and highlights its importance as the power source for the sawmill. The overshot water wheel is used in preference over an undershot water wheel because it allows for a more even and regular flow of water and requires less water to turn as gravity helps turn the wheel.


Joel MacKenzie

Building & Material Symbiotic Relationship Demonstrations:

The final stage of this exploration of a symbiotic relationship between material and building results in the culmination of a design of a sawmill. The aspects of this sawmill strive to be focused on the idea of self-replication and convey this as the main relationship between wood and sawmill to the occupants of the building. This is done through construction techniques, building occupant interactions, site planning, the overall functionality of the sawmill, and by making the material of wood and the sawmill dependent on each other to be successful as a realistic sawmill. The other aspects of the design of the sawmill come from other essence and aesthetic motifs found in the material of wood and further help to emphasis the relationship between the sawmill and its relationship to the material it is made of and produces.

The site used for this design demonstration of a sawmill exhibiting a symbiotic relationship between building and the material of wood, was chosen because of its functionality aspects. The mill creek site near Mackinaw City, Michigan has historically been home to many sawmills over the years and has a small enough ravine to be the sight of a small scale wooden dam. It also is in an area used for harvesting trees for lumber and has both soft and hard wood types of trees available to create lumber from making it a sawmill that can have diverse lumber products.


Michigan
United States of America
Historic Mill Creek Discovery Park
Michigan
Lake Michigan
Mackinaw City
Mackinaw City
Historic Mill Creek Discovery Park
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Building & Material Symbiotic Relationship Demonstrations:

Building & Material Symbiotic Relationship Demonstrations:

The dam is constructed using stacked lumber that uses dunnage to hold post that run through the dam structure in place. The foundations for the wooden structure are laid as well as masonry walls which will hold the shafts of the sawmill mechanical system.

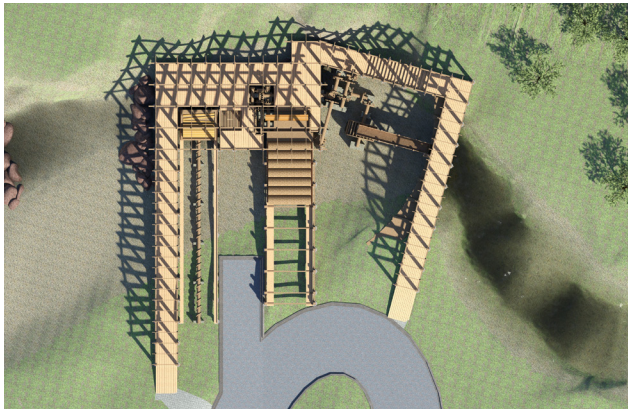
The sawmill mechanical system is constructed in a way that leads to high efficiency of lumber production which helps the building emphasize the idea of self-replication. Logging trucks can come in and drop-off logs into the ramp that leads down to the saw blade catch area. The mechanical system also brings the cut lumber back up towards the lumber truck to then take be taken off site to construct other building, or the lumber can be used to replace components of the sawmill further embellishing the idea of self-replication.

The wooden structure is built around the sawmill mechanical system. The structure uses hardwoods for the structure so these structural components are more durable. This helps the building show to the occupant what it means to be a hardwood as opposed to a softwood.

The skin of the structure is then attached to the wooden structure. The skin is constructed of softwood as its components are more easily replaceable then the structural components of the sawmill. This helps the building show to the occupant the difference between hardwood and softwood thru their different roles in the building. The skin is derived from the motif of wood grain patterns and helps the building describe what it means to be wood while also explaining what it means to be a sawmill because sawmills require open air spaces to ventilate the dust in the air.

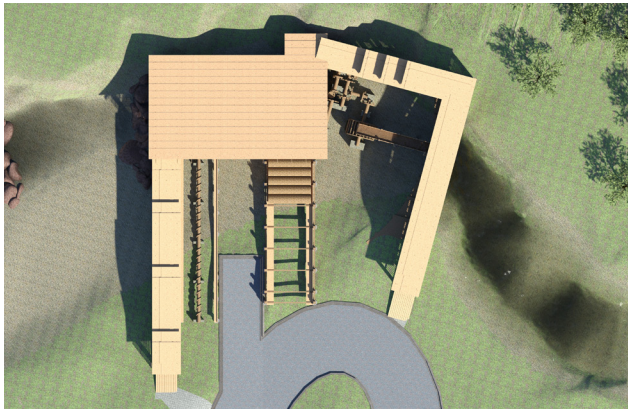
Building & Material Symbiotic Relationship Demonstrations:

The structural bays of the sawmill are built using lumber produced from the sawmill mechanical system. The size of the wooden structural bays is determined by the size of lumber that can be produced from the sawmill mechanical system in place, thus emphasizing the relationship between the material of wood and the building. The sawmill mechanical system is designed for 10-14 foot long logs ranging from 18-38 inches in diameter. This size accommodation was chosen as it is the optimal size to create lumber from and waster the least amount of wood.



The pathway thru the sawmill follows the process from start to finish of creating lumber. This helps explain the process to the occupants in a linear fashion and shows how the sawmill and material of wood interact at each stage of the process.

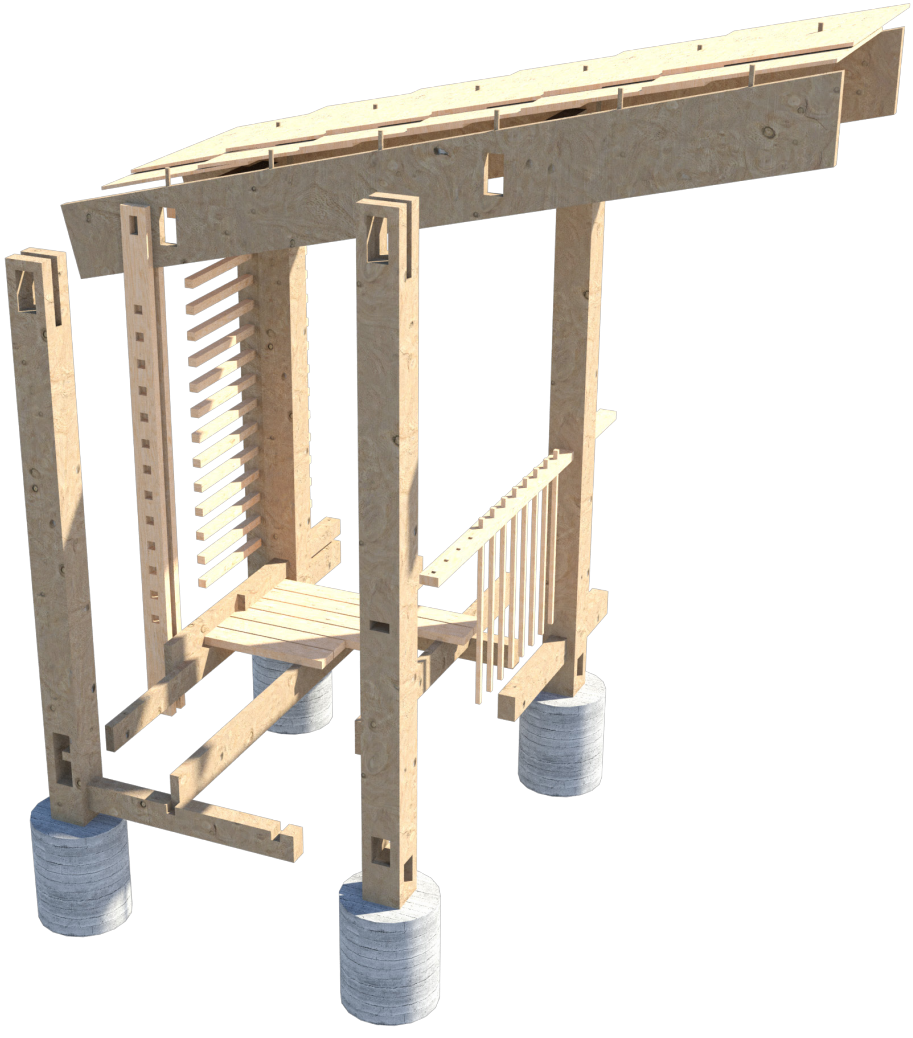
The skin is the final part of the construction process of the sawmill. The skin also follows the method used for the structure of the building by being built from lumber that can be produced from the sawmills mechanical system. As these components get replaced it further emphasizes the idea of a self-replicating building using a self-replicating material to construct itself.



The section of the sawmill explains how the sawmill uses gravity and falling water to power the mechanical system that produces lumber. The dam creates potential kinetic energy that is used when needed to run the saw blade and other mechanics. The mechanics have been designed to require minimal human effort which allows the building to express the idea that it is self-replicating.

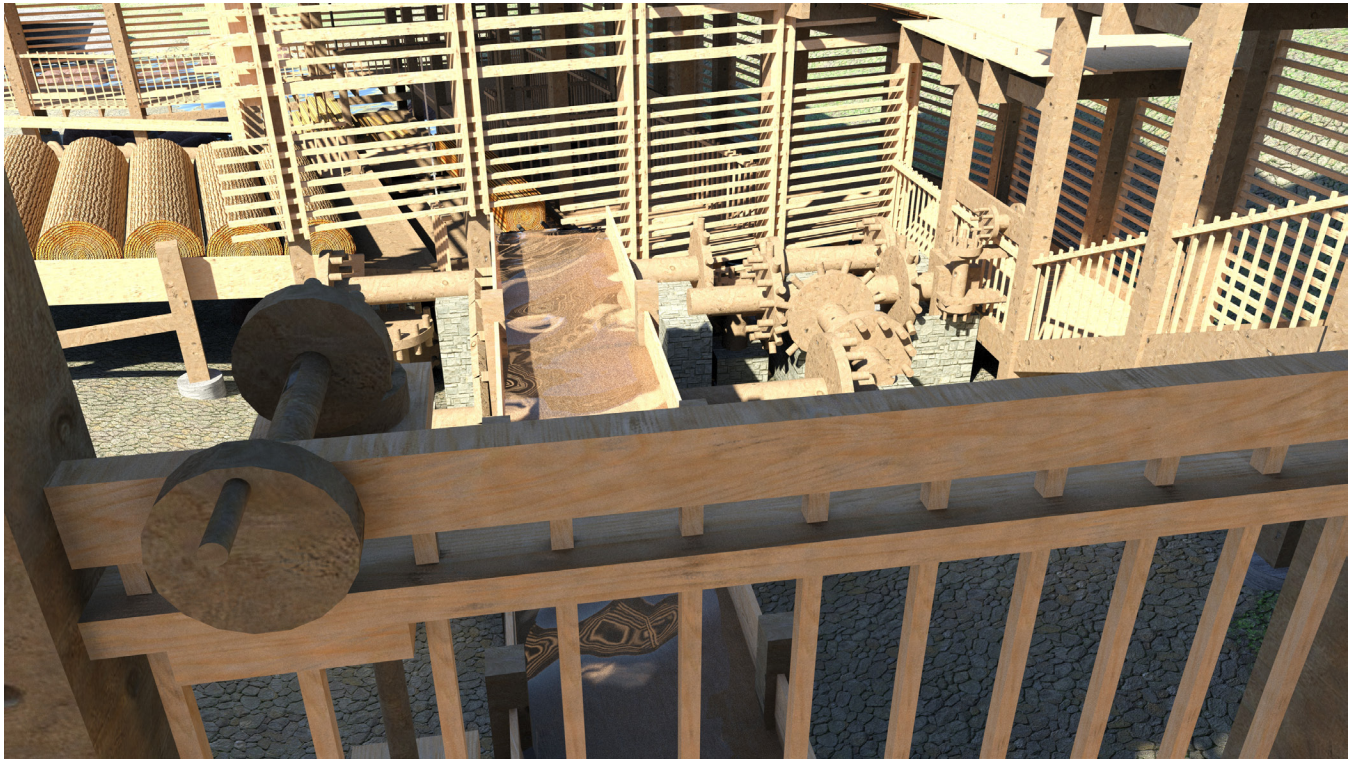
Building & Material Symbiotic Relationship Demonstrations:

Building & Material Symbiotic Relationship Demonstrations:



The mortise and tenon construction technique was used as the construction technique for this sawmill. The diagram to the left shows how the typical bay of the sawmill would be constructed. The mortise and tenon construction technique was chosen because it allows for an all wood constructed building. This technique also helps the building explain what it means to be wood because it emphasizes the properties of wood such as it high friction production. The mortise and tenon construction technique uses friction created by wood rubbing against wood to hold the components in place. The mortise and tenon construction technique was also chosen because it helps strengthen the symbiotic relationship being expressed between sawmill and the material of wood thru its ability to help show self-replication. The mortise and tenon construction technique allows for quick and easy replacement of components of the building as they age and further shows how the building self-replicates itself with a self-replicating material.

Building & Material Symbiotic Relationship Demonstrations:



To explain the symbiotic relationship between sawmill and the material of wood thru the idea of self-replication, the sawmill was designed to be interactive. The interactive components make the occupants/users of the space part of the process of creating lumber. As the occupants/users walk thru the building there are components which can be turned. These in-turn move gears of the sawmill mechanical system into place so that the next part of the process of creating lumber can begin. This allows the occupants/users to interact with the material of wood physically to create the product of lumber. This shows to the occupants/users how the building self-replicates itself with a self-replicating material.

Building & Material Symbiotic Relationship Demonstrations:

The mechanical system of the sawmill was designed for minimal human effort. The mechanical system is designed so that when a new log is needed in the saw blade frame a plate moves up and pushes the next log in line over the lip holding it back. The log then roles into the saw blade frame and can be fastened to cut dimensional lumber from it. By mechanizing most of the process of creating lumber, the sawmill helps emphasize the idea of a self-replicating building which in-turn emphasizes the this essence of self-replication found in wood.

Building & Material Symbiotic Relationship Demonstrations:

After the wood has been cut into lumber the lumber drops onto rollers which send the wood onto a platform on which the lumber is collected. This lumber can be used to replace components of the sawmill as needed. The components can be inserted easily where needed due to the mortise and tenon construction technique. This shows how the building can self-replicate itself and how the material of wood can replicate itself to continuing providing wood to construct more components of the sawmill. The lumber not used as replacement components in the sawmill can be brought up to the lumber trucks on the platform it was collected using a cartesian spiral driven by the water powered sawmill mechanics. This lumber can then be sent off to construct other buildings, further explaining the idea of self-replication thru buildings building buildings. All of these facets shown and designed in the design of this sawmill strive to show what it means for a material and building to partake in a symbiotic relationship and show this relationship to those who interact with the building. The building helps define the material it is built of, while the material helps define the building that has been constructed of that material.

Building & Material Symbiotic Relationship Demonstrations:

Final Conclusion

By reorganizing the design process and choosing a material as the first step of the design process and then analyzing that material for essence and aesthetic motifs one can successfully create a relationship between the material and building constructed of that material that takes on the form of a symbiotic relationship. The building and material will exhibit this symbiotic relationship in which the building helps define to the user/occupant what it means to be the material that the building is made of, while the material the building is constructed of helps define to the user/occupant what it means to be that building. As this relationship becomes prevalent in a design and all its facets, the design can begin to convey this idea of a symbiotic relationship between building and material such as in the sawmill design demonstration. This increases the understanding of the material and how one can work with it and brings the relationship between material and building to the forefront of the design process. This acknowledgment that a building and a material can partake in a symbiotic relationship can spur a new design approach in which we begin to understand and view materials differently than the way we may have originally understood them to exist. It can also lead to a new understanding of buildings and building types associated with the materials involved.