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Work in Process: Inhabiting Matter in Time

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WORK IN PROCESS:
INHABITING MATTER IN TIME

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ABSTRACT

The typical American house is conceived of and constructed as a permanent and singular object. This method of permanent design and construction is not conducive to sustainable resource and material protection. The permanent connections and material customizations used in construction disallow most C&D (construction and demolition) materials from being salvaged, reused or recycled once the house has reached its end-of-life. As a result, residential demolition in America produces for over 19 million tons of material waste each year (US EPA 6). Deconstruction offers a valid alternative to demolition but is not commonly practiced for two main reasons. First, deconstruction remains a more expensive alternative. Second, the perception of the house as a singular and permanent object undermines the reusability of its material constituents. The following thesis includes research of typical construction design and methodology, a proposed construction design and methodology, a precedent analysis of architectural projects designed for deconstruction, and a design case study testing the validity of the proposed construction design and methodology.

The research of typical construction design and methodology analyses those aspects that prohibit deconstruction as a viable method for dealing with the end-of-life of residential structures. The subsequent proposed construction design and methodology outlines a design hypothesis that would promote deconstruction over demolition. The precedent research analyzes past architectural projects that were designed with the intention of later being disassembled rather than demolished. The proposed construction design and methodology research is tested through the design process of the two case studies. These studies employ and develop design principles focused on creating a dynamic architectural design system that can adapt to changes in

the needs of its inhabitants. The design utilizes locally bought materials that can be reused or recycled completely after use.

INTRODUCTION

Buildings do not last forever. James Otis wrote, a “man’s house is his castle.” in 1761. The phrase has since become a commonly used expression meant to convey both a sense of permanence in the built form’s construction and a sense of security in the built form’s durability. However, certain false qualities are assumed when the house is perceived as a permanent object. Most prevalent among these qualities are durability and physical strength. As inherent properties of a castle, strength and durability are not accomplished through a castle’s design but through the borrowed properties of its constituent materials, namely stone. Stone is both durable and able to maintain physical and structural strength over time. However, the building materials used in modern construction are not as durable as stone. They are, conversely, chosen because of their temporary life spans. Typical American houses are built to last approximately thirty years (Jackson 1). Despite this fact, the perception that a house is, to some degree, a castle remains strong in the American psyche. The house is still intended to provide a desired security and sense of permanence. As a result, modern houses are built using methods of “permanent” construction, e.g., nails, screws, and adhesives. Building “permanent” constructions with impermanent materials expresses a false sense of durability. It follows that the aesthetic nature of the castle, perceived as durable and permanent, goes against the temporary nature of modern American housing.

The perception of a permanent structure also seems to against the temporary nature of the American resident. On average, Americans live in each house for 5.9 years before moving to a new house (Marclay 6). This trend of the constantly moving American began after World War II, when the US interstate system allowed city dwellers to move outwards from the city center in search of greener pastures and larger homes. This mobile trend has continued however, and has

become a large part of modern American life. The move has become a symbol of lifestyle change.

A bird's nest could offer a more appropriate metaphor for modern construction that would align with the temporariness of the modern American citizen. A nest is more intrinsically tied, as a signifier, to the temporality of its intended use. When the bird migrates south for the winter, the nest loses its use as a place of habitation. The twigs and moss of which the nest is constructed never truly transform into the singular object of the nest. These individual material members exist outside and independent of the nest.

A modern American house utilizes the same temporary use of short-term habitation. Material constituents are assembled to provide a temporary use for an inhabitant, namely, shelter. The materials with which the house is constructed are first extracted as raw materials. Once a material is extracted, it is processed into a form that can be more readily be used as a construction material. It is then combined with other materials to form a subassembly, or building component, e.g., window, door, etc. The material members and components are then assembled to accommodate human habitation.

When the materials are rearranged into a form that is no longer subjectively recognized as a place of habitation, the house ceases to exist. Unlike the nest, however, when the modern American house has reached its end-of-life, the material constituents do not retain their independence. Rather, the whole house is demolished. Though some efforts have been made in recent years to salvage and reuse or recycle building materials, the majority of demolition waste is sent to a landfill.

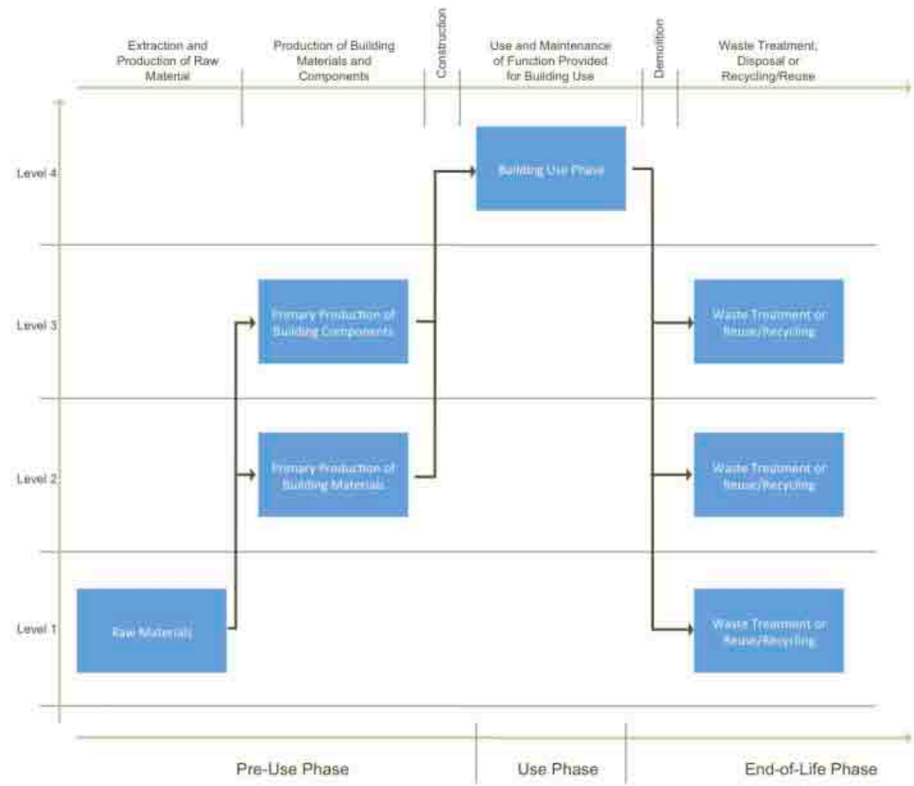


Figure 1: Material Lifecycle Phases

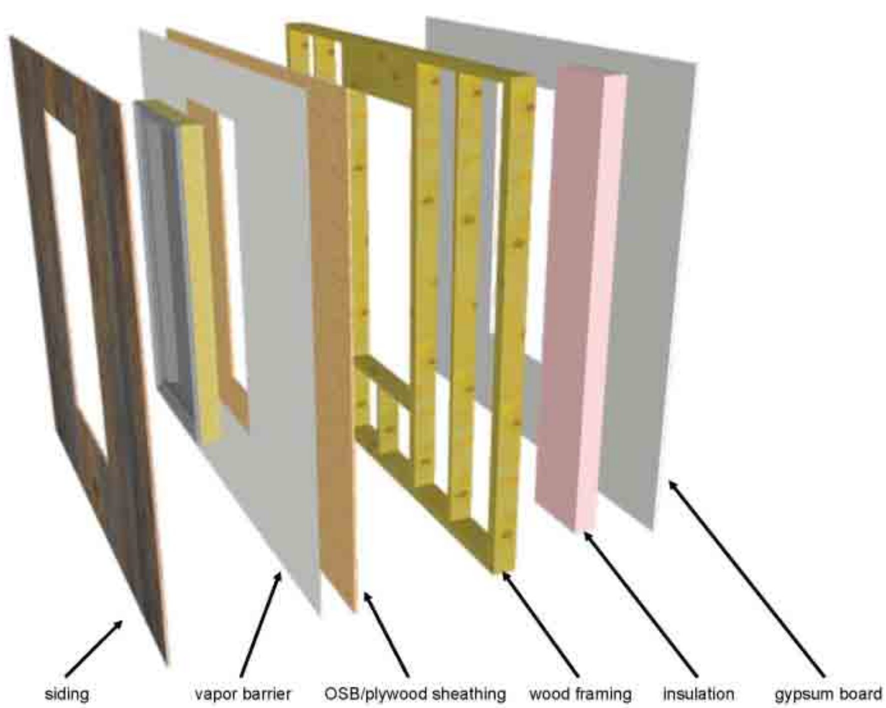
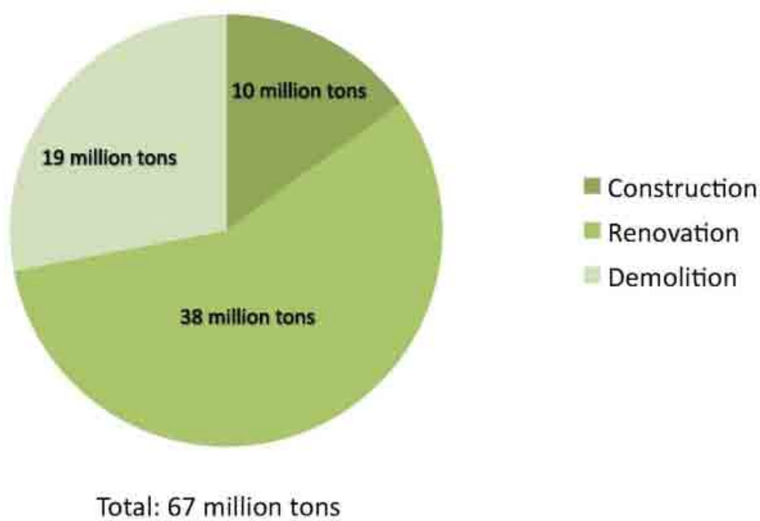


Figure 2: Typical Wall Section

According to the Environmental Protection Agency, the construction industry accounts for 60 percent of the total raw materials usage in the U.S. They estimate that building-related Construction and Demolition (C&D) produces 136 million tons of material waste per year, of which demolition and renovation account for over 92 percent. (US EPA 6) In North America, 25 to 45 percent of material waste is the result of C&D waste, yet only 20 to 30 percent of C&D waste is recycled. The remaining 70 to 80 percent is either incinerated, resulting in the emission of greenhouse gases, or sent to a landfill to decompose, the largest source of human-caused methane emissions. (BCLUD)

Table 1: Annual Material Waste Produced by American Construction, Renovation, and Demolition



As the average American residence lasts for 32 years (Jackson 2), an inconsistency exists between the current lifespan of the building materials with which we build and the intended lifespan of newly constructed residential projects. If an attempt to incorporate the temporary

nature of the material lifespan into the design and construction process of new residential construction is to be successful, two realities must be considered.

The first, the economic reality of a consumer-driven, capitalist society, values economic efficiency as the single greatest attribute in creating and maintaining the economic viability of industry. Economic efficiency is defined by the cost-effectiveness of a product. Cost-effectiveness is defined by the relationship between a product's cost in production and its market value. This economic reality typically outweighs any argument for environmental responsibility, especially, resource and material protection. Rather, any method that is not cost-effective is not considered, regardless of ecological benefits. In the book, *Cradle to Cradle*, William McDonough and Michael Braungart argue that, historically, economic efficiency and ecological responsibility have been at odds. The major reason is that "environmental goals are typically forced upon business by the [regulating authority] — or simply perceived as an added dimension outside crucial operating methods and goals — industrialists see environmental initiatives as inherently uneconomic." (McDonough 61) This economic prejudice towards environmental responsibility creates a roadblock for the development of ecologically responsible architecture. Environmentally responsible architecture values the protection of natural resources and materials. This economic roadblock prevents any argument for material and resource protection in architecture. Rather, it is dismissed as being 'inherently uneconomic'.

The second reality is the perception of the modern American house as a whole and permanent object. The built form is consequently perceived as a single entity independent of its material makeup. This perceived permanence facilitates the continued use of current, unsustainable construction methods, specifically the incapacity of "permanently" constructed buildings to be deconstructed and separated for recycling. This perceived permanence results in a

built form that is seen as a single entity independent of its material makeup. The traditional architectural design process serves to reinforce this unity of construction. The architectural form is generated through spatial arrangement that is only later realized through the use of materials. The materials and material connections are treated as secondary to the design of the overall form. Consequently, the material lifespan can only be thought of as an afterthought of the initial design of the house.

Until the resulting inconsistencies between the material lifespan, the lifespan of the built form and the dynamic nature of the inhabitant are resolved, the construction industry will continue to produce an unsustainable cycle of construction and demolition. The solution cannot be reached if buildings continue to be constructed using “permanent” methods. Therefore, a solution must be sought in the architectural design process. The following analysis of traditional construction practices, a proposed design and construction method, precedent analyses, and case studies are aimed at devising of an architectural design process that would account for eventual deconstruction. The intended result is a design process and construction method that would serve as a model for economically efficient and perceptually expressive resource and material protection. The initial design begins by incorporating the longevity of potential material members in relationship to the dynamic nature of the inhabitants’ needs. The resultant design concept is based on the method and expression of the built form’s potential for deconstruction. The goal of the subsequent architectural form is to create a system in which deconstruction is a more economically viable method than demolition. This new architectural form accepts its own temporary nature and relies on the nest rather than the castle as a primary ontological precedent.

TYPICAL PROCESS

Construction

Typically, newly constructed American residences are built to stand for thirty years, the lifespan of the average mortgage (Jackson 1). However, current methods of construction attempt to create permanent material connections. Consequently, post-use deconstruction becomes an arduous and economically inefficient alternative to demolition. Recycling C&D waste from demolition becomes difficult because the materials, which need to be separated for recycling, are screwed, nailed, glued, and welded together during construction. As the separation process increases in difficulty, excessive waste generation is produced from potentially recyclable materials. Also, many current residential projects are fastened to the site through "permanent" methods, e.g., a slab-on-grade concrete foundation. The subsequent removal process is again both arduous and economically inefficient.

Economic Factors

Modernism introduced the concept of replaceable parts with shorter life spans in an attempt to rethink the way in which humanity built and inhabited the architectural object. Modernism's attempt to design buildings with replaceable parts, claims David Leatherbarrow in his book, *On Weathering*, was inspired by the manufacturing process of cars with replaceable parts. The economic model of the automobile is accommodated by its accessible structural and mechanical system. The subsequent ease and economic efficiency in replacing parts promotes the replacement of smaller parts rather than the replacement of the whole. The design and nature of the car leant itself to this economic model as it is both mobile and accessible. However, traditionally constructed residential buildings are both static and inaccessible. The static nature of the traditional residential building contradicts flexibility inherent in the automotive design

method. As a result, demolition and new construction remains a more economically efficient model of dealing with a house that would otherwise require major renovations or maintenance.

The unintended result of conceiving of the building as a machine with replaceable parts was the devaluing of individual material members and components. Further, the inclusion of more manufactured parts meant the introduction of more connections. These connections had to be waterproofed, sealed, tightened for insulation, etc. leading to an increasing inability to disconnect those replaceable parts. These sealants made the parts less accessible and therefore less replaceable. Consequently, the material components became cheaper and less replaceable. The principle of designing less expensive, “replaceable” parts has continued because of the decreases in production costs. These newly mass produced products are designed for the efficient production of sellable goods. The best use of the materials became a secondary concern. The result of the mass production of building components, though “promis[ing] greater choice, has come in current practice to favor formulaic solutions” (Leatherbarrow 25). These “formulaic” solutions, however, are built on principles of construction efficiency. They subsequently fail to recognize the effect it has on decreasing deconstruction efficiency.

Perceptual Qualities

The most important perceptual aspect of the built form is the architectural detail or joint, i.e, the “joining of materials, elements, components and building parts in a functional and aesthetic manner.“(Frascari 31) The detail provides the basis upon which the whole of the built form is perceived. Marco Frascari argues in *The Tell-the-Tale Detail*, that a joint is a generative constructional and experiential aspect of the built form. It serves to attach “meanings to man-produced objects”(23). He asserts that the joint provides an ontological expression of the built

form's constructional reality. This ontological expression therefore informs human perception of the constructional reality of the built form without being representational.

Modern architects conceived of an architecture wholly different from that of their traditionalist predecessors: an architecture that acted not as an architectural form but as a machine. The resulting Modernist architecture, however, was machine-like only in a stylistic and representational manner. The ontological nature of the machine was never fully introduced into the built architectural works, i.e., the accessibility and replace-ability of the machine and its ability to be disassembled and reassembled without major destruction or wear to its parts. Consequently, Modern architecture merely utilized the aesthetic of machines but failed to mimic the actions of machines. The main reason behind this failure was the inattention to the ontological expression of the constructional joint.

In the final chapter of *Towards a New Architecture*, Le Corbusier argued that the industrial reality of the modern world demanded that architects and owners rethink the nature of the architectural form. He argued that he house be thought of as a tool rather than a construction. He envisioned the house as a machine "built on the same principles as the Ford car . . ." (264). The involvement of industry in the production and distribution of housing was at the center of his argument:

> Industry on the grand scale must occupy itself with building and establish the elements of the house on a mass-production basis.
>
> We must create the mass-production spirit.
>
> The spirit of constructing mass-production houses.
>
> The spirit of living in mass-production houses.
>
> The spirit of conceiving mass-production houses.

> If we eliminate from our hearts and minds all dead concepts in regard to the houses and the look at the question from a critical and objective point of view, we shall arrive at the "House-Machine," the mass-production house, healthy (and morally so too) and beautiful in the same way that the working tools and instruments which accompany our existence are beautiful."
>
> (Le Corbusier 227)

The current construction industry has assuredly achieved Le Corbusier's vision of the "replacing of natural materials by artificial ones, of heterogeneous and doubtful materials by homogenous and artificial ones . . . and by products of fixed composition"(232) i.e., standardized and manufactured materials. Unfortunately, Le Corbusier's "House-Machine" and later Modernist constructions relied heavily on a stylistic and representational expression of the "spirit of constructing mass-production houses" (232). Their designs overlooked the ontological expression of the joint. Specifically, they overlooked the value of the mechanical joint. The mechanical joint is not a static bond but a dynamic junction. The mechanical joint holds the ability to be dynamic, flexible, and most importantly, removable. Le Corbusier's designs did not act like machines, they were merely built on a similar understanding of construction. The Modern movement relied heavily on stylistic properties and not enough on ontological properties. As a result, the vision of the "House-Machine" served to perpetuate the perception of the house as a permanent object. Further, the "House-Machine" assisted in the creation of the current paradoxical state of the permanently perceived and constructed house of temporary materials, i.e., standardized and manufactured materials designed for a limited lifespan.

Conversely, the perception of the house as a machine may result in creating machine-like connections that allow for members and components to be easily removed or replaced. In this

case, the ontological expression and therefore accepted perception of the "House-Machine" may be more successful. However, the modern house continues to be constructed using intentionally permanent building methods. Subsequently, the already established perception of the house as a whole and complete object remains unaffected.

Habitation

The average American lives in each residence for around of 5.9 years (Marclay 6). The average house is constructed using "permanent" methods of connection, and is built to stand for approximately 32 years (Jackson 1). As a result of the inconsistency between temporary habitation and "permanent" construction techniques the modern American house requires constant adaptation to reinstate continuity. Current methods of adaptation include relocating to a more appropriate building, renovation to adjust for changes in habitation requirements, and demolition and new construction to restore the consistency between the constructed object and the inhabitant's altered needs. None of these methods, however, combat the perception of the house as a permanent object. Another common form of adaptable architecture is the creation of an inherent spatial flexibility. This spatial flexibility is non-specific to any predetermined use, which allows for the possibility of this space to be repurposed, e.g., a 10x10 room with one window and outlets on either wall can be used as an office, a bedroom, a den, etc. However, this inherent non-specificity reinforces the idea that the built form retains an amount of permanence, as its interior retains flexibility in its use without necessarily influencing the overall architectural form.

As established, this form of constant adaptation is the result of the impermanent nature of the materials used. The entropic nature of biological materials requires both perpetual maintenance and intermediate replacement. Some architects have suggested a reversion to the

use of more durably constructed houses using more durable materials. However, the constant cycle of obsolescence and renewal is not contrary to the temporariness with which modern Americans live. The architectural and construction industry may benefit more from building with an even more temporary lifespan as it would seem to align more consistently with the time span of habitation.

Economic Factors

The incongruity between a 5-year American habitation and permanently constructed modern houses demands constant renovations and adaptations of the "permanently" constructed house. Successive renovations, in turn, necessitate a constant economic investment stream. Consequently, modern houses are designed to achieve a level of spatial flexibility.

However, the flexibility of interior space without a corresponding flexibility of exterior façade does not accommodate growth of the number of inhabitants or major shifts in technological or cultural trends. The flexibility is limited to room type changes and interior spatial adjustments. Consequently, moving to a larger or smaller house with newer technologies and accommodating cultural considerations is currently a more economically efficient method of adjusting to the inhabitants' changing lifestyle. Over time, adjustments in the interior are not reflected on the exterior and result in a disconnected spatial shell. The disconnected spatial shell, therefore, retains progressively less value as a deconstruct-able assembly of materials and achieves, at least temporarily, its projected permanence. This projection of permanence reinforces a cycle of demolition and new construction and subsequent production of waste.

Perceptual Qualities

The perceived permanence with which the modern American house is constructed has strong correlations to a human need for a sense of security and stability. A necessary sense of

security is rooted in an apprehension towards the unknown possibilities of the future, while a sense of stability is necessary to quell the fear of humanity's own morality. In both cases, the architectural object serves to control the external environment, thereby providing both a secure enclosure and a perceived permanence.

In his article, *Building and the Terror of Time*, Karsten Harries contends that the human capacity for understanding the constantly changing state of human existence creates a desire for a perceived permanence. This perception of permanence acts to "link time and eternity"(IV) in an attempt to elude the reality of the constantly changing world. To that end, the architectural object provides a comfort when it is perceived as a whole and complete object. Through its sense of unity, the architectural object alludes to the human desire to "belong to being rather than to becoming,"(IV) in the Platonic sense.

Residential construction provides the desired perception of permanence through the utilization of "permanent" connection methods. These permanently perceived connections act as ontological markers of intransience and stability. The use of these ontologically permanent connections reasserts the paradoxical perception of the permanent castle constructed of impermanent materials. This presents a situation in which economic means and perceptual desires are at cross-purposes. While permanent construction and connection methods serve to project a durable and protective architectural object, the economic reality demands lower quality materials and a construction that needs to last only as long as its mortgage. For this situation to stabilize, the perceptual desires of inhabitants and the economic reality of the construction industry need to come to a resolution.

Demolition and Deconstruction

When a typical American house is constructed, the materials involved lose their individuality to the constructed form. When materials reach a site, they retain individuality from the built form. The 2x4s are strips of wood. Gypsum board is a thin flat panel of gypsum plaster pressed between two thick sheets of paper. Brick is an individual block of ceramic material. Yet, the more parts are nailed together and “finished”, the more the constructed form reaches a level of wholeness in which individual materials become parts, and lose their independence from to the constructed whole. The strips of wood become a stud frame; the thin flat panels of gypsum become interior wall surfaces; the ceramic blocks become exterior finishes. Once completed and placed next to each other, the three become a wall. Multiple walls are constructed at a distance from one another and at differing orientations to create enclosed space. A roof is constructed to connect the walls and begin to create a constructed whole, namely a house, which is perceived as a complete object. The individual members give up their individuality and the house becomes the dominant entity. Once the house reaches the end of its life, either by means of deterioration or loss of usefulness, it is dealt with as a whole object. The typical end-of-life removal method involves demolition.

Despite recent efforts to divert demolition waste from landfills, the American residential demolition industry still produces an average of 19 million tons of C&D material waste each year (US EPA 8). Based on the calculations of waste production provided by a recent NAHB study report, a typical 2000 SF home produced around 127.2 tons of C&D material waste during demolition. Of that, 96.5 tons (76%) was either salvageable or recyclable. (Dantata 8) Similar calculations from the EPA’s *Building Related Construction and Demolition Amounts* (9) determined that the amount of C&D waste generated during the demolition of a typical 2000 SF

residential building was around the same: 131.7 tons.[1] While there are many factors that contribute to the continuance of this condition, few can be dealt with at the architectural scale. Among these, two specific factors can be attributed to the design process: the incongruity between the material lifespan and the building lifespan and the permanent method of connecting material components.

On average, around one-third of the currently standing 124 million homes in America were built before 1960, while the remaining two-thirds are less than 50 years old. The same study that determined the ages of residences in current existence in the US also determined the potential lifespan for individual housing components used in the US market. The results conveyed a major incongruity between the lifespan of the building and the life spans of its constituent members. While the average house stands for 32 years, the foundations and footings have a potential lifespan of over 100 years, the framing and structure have an average potential lifespan of 45 years, and the systems and interior parts typically last only 17 years. (Jackson 2)

As a result of the incongruity between the lifespan of the house and the lifespan of the individual material components, many material components are demolished with the building before they have deteriorated to the point of uselessness. Those material components whose life spans is less than that of a house have to be replaced and thrown away while the building remains in use. This unsustainable system resultantly produces a large amount of material waste unnecessarily. Those materials that could have been salvaged were instead overlooked because they were permanently fastened to non-salvageable materials.

Economic Factors

The economic inefficiency of deconstruction is one of the major reasons that demolition is still a more commonly practiced method. Despite recent efforts to divert portions of that waste

Table 2: Life Expectancy of Major Residential Construction Materials and Components

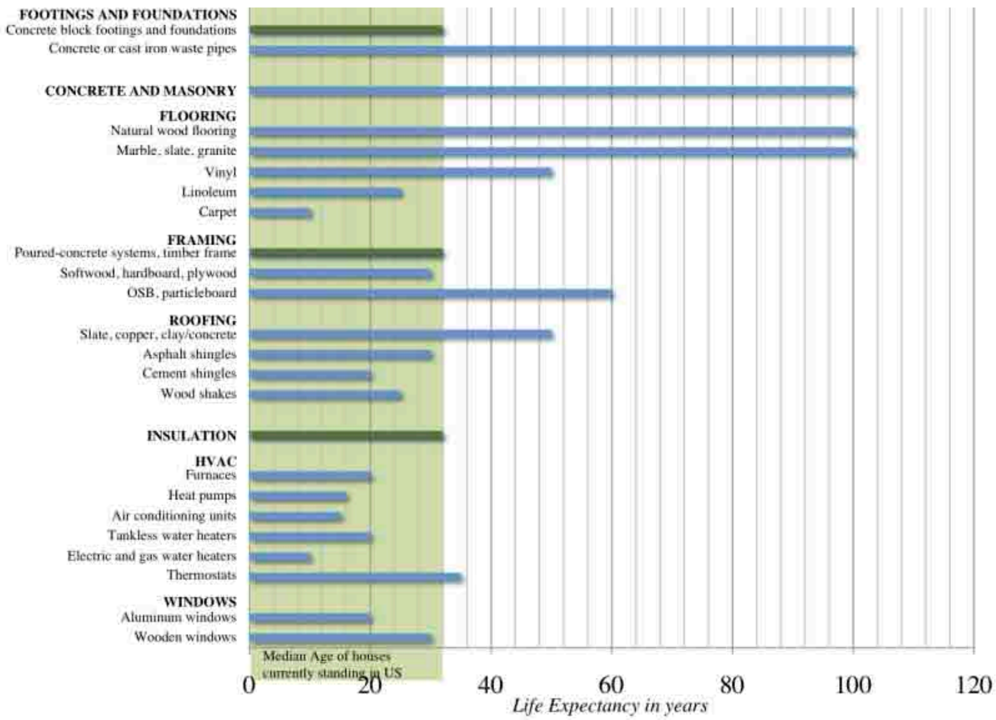
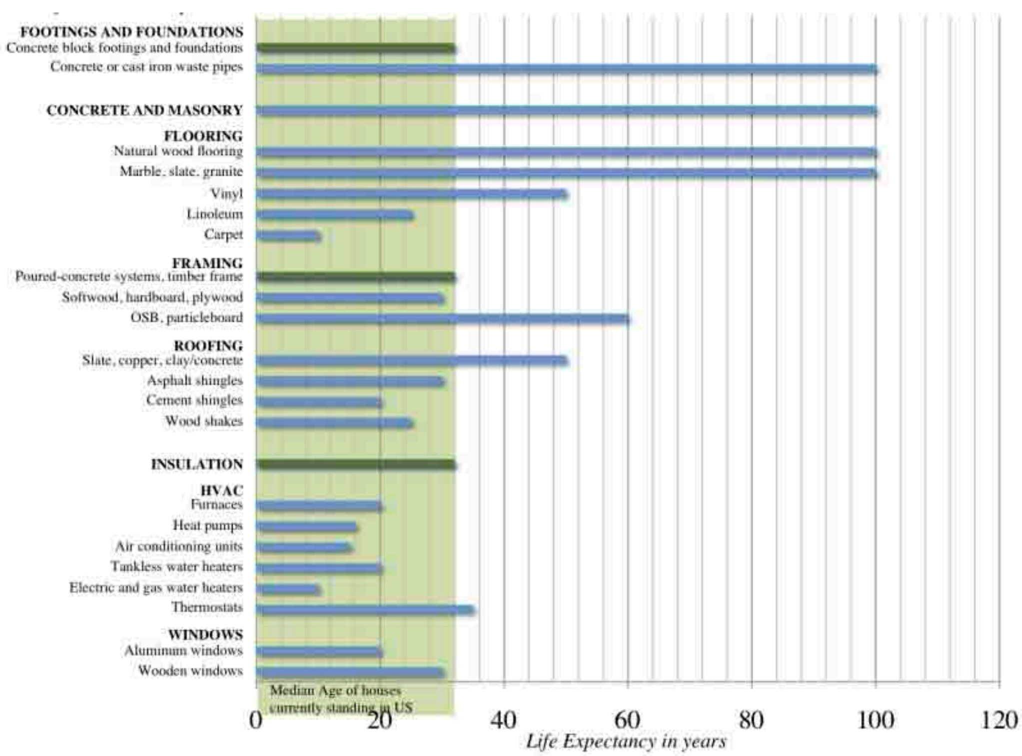


Table 3: Life Expectancy of Minor Residential Construction Materials and Components



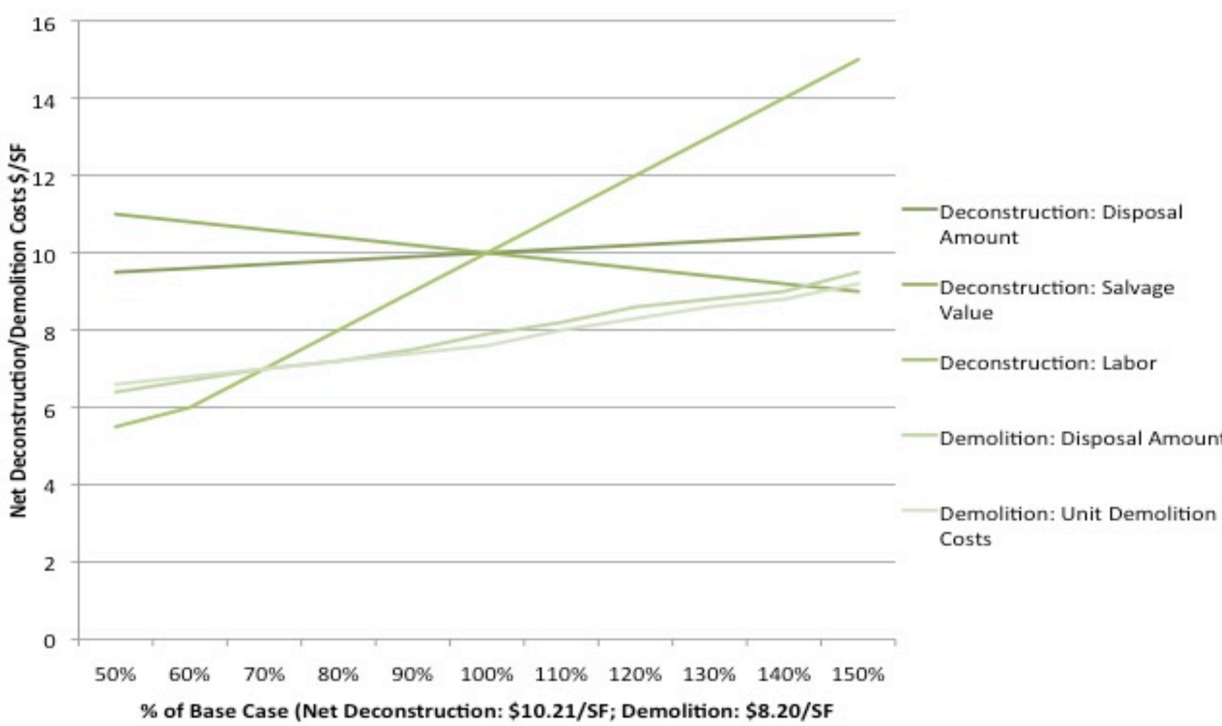
from landfills, sending all of the demolished materials to a landfill remains a cheaper, faster, easier, and therefore more cost effective method of demolition. Salvaging materials from demolition sites for reuse and recycling through forms of deconstruction often does not create enough revenue to balance the required cost of labor. Largely, this economic inefficiency is the product of a difficulty of removing salvageable materials, the result of which is more intensive labor and longer time frames.

Some American demolition companies have begun to divert a significant amount of residential C&D waste from landfills through a deconstruction process that entails taking apart the building components and separating them by material or type for reuse and recycling (Dantana 2). However, recent investigations of the deconstruction process have determined that, while it is ecologically beneficial due to the diversion of a large portion of waste from landfills, the method remains more expensive, more time consuming, and requires more specialized labor than typical demolition. One investigation determined that deconstruction of a 1000-2000 SF residential building would take a crew of 5-6 workers 10 to 15 days while "demolition of the same building may be completed in just one-fifth to one-third of the time" (Dantana 4). As a result, the deconstruction effort would cost 3 to 5 times more.

The results of the EPA's *Building Related Construction and Demolition Amounts* (B11-B12) determine the way in which deconstruction companies value the components of houses to be demolished is based on two main factors: the ease with which material products are removed, the largest cost, and the value of the reclaimed product, the largest gain. Ease of material product removal determines the length of time of a project and the amount of workers required. The

product of time and work is labor cost. The results of a subsequent investigation into deconstruction companies determined that "deconstruction labor is the most sensitive cost parameter." In the conclusion of this study, the researchers determined that a "decrease of about 20% in labor cost . . . [would] make net deconstruction costs equal to the base demolition costs."(Dantata 7). Accordingly, decreasing the difficulty of removal of the valuable components could have a dramatic influence of the economic viability of deconstruction. Increasing the economic viability of deconstruction would allow it to become a competitive alternative to demolition.

Table 4: Net Deconstruction and Demolition Costs per Square Foot



Perceptual Qualities

Of the 2,420,000 people that die each year in America, over 68% percent are buried (NFDA). Of the approximately 245,000 dwelling units houses demolished each year, more than

70 percent are sent to a landfill. (NAHB 1998) The correlation between the way Americans deal with the death of a building and the way Americans deal with the death of a loved one reveals information about the way modern Americans perceive people and architectural objects. Funerals are often held with an open casket for viewers to see the body as a whole entity before burial. Once in the ground, the casket and the body will eventually rot and decay. However, the perception we are left with is that the body is a whole and unaffected object, an unchanged entity. The decomposition is ignored; once the body is placed in the ground, it is no longer visible. What happens to the body after death is hidden.

Considering the correlation between the corpse and the demolished building, it can be argued that the American method of placing a demolished building in a landfill is meant to remove the whole object to reassert the idea that it "belong[s] to being rather than to becoming" (Harries IV). It is a way of dealing with the inconsistency of the permanently perceived architectural objet of impermanent materials. The reality of the impermanent material and what happens to it after the death of the building is hidden.

Recycling has been presented as an alternative to material waste being sent to a landfill, but recycling alone does not solve the perceptual problem. It may, conversely, serve to reinforce an ill-conceived perception of permanence. Recycling offers an alternative to waste that once again supports the idea of permanence. The symbol itself expresses a sense of completeness. Three environmentally benign ribbons circle in a constant and unbroken loop. The three ribbons are meant to represent the three aspects of environmentally responsible living: reduction, reuse, and recycling. However, the triangular orientation asserts that the system is a closed loop in which no outside energy is required and no waste is produced. The actual recycling process has a beginning and an end, requires outside energy, produces waste, and not all things that can be

recycled can be remade for the same use. William McDonough, author of *Cradle to Cradle*, refers to this process more appropriately as "downcycling". The perceptual nature of "recycling" assumes that materials can simply be sent to a factor to be repurposed without additional energy or resource use. This perception, however, is not true to form. "Recycling" implies simply a post-use process that is not involved in the material's initial extraction, production or use. The perceptual nature of "downcycling", a valid alternative, requires that building materials be treated differently in initial extraction, production, and use. Each step of the material's lifespan is a part of the downcycling process.

The downcycling process involves breaking down processed materials into raw materials to be used as a replacement of virgin materials in the production of new materials or components. However, certain properties of the downcycled material, typically strength and durability, are lost as a result of the process. Consequently, a material can only go through the process of downcycling a limited number of times. That number is determined by "the technical properties of the recycled material"(Hanssen331), "the energy embodied in the resource, its chemical composition and its organization"(Fraanje 22). Though that recycling limit is relative, all materials, regardless of their initial strength and resilience, will eventually break down.

To include post-consumer recycled materials in construction is not enough. The reality is that architectural and contracting entities determine the uses for virgin materials and many times without consideration for its post-use treatment, i.e., recycling or reuse. Many products that may be recyclable can actually cause "environmental impacts which sometimes can exceed the environmental benefits"(Blegini 319). Secondarily, many of those materials that could be recycled and reused without unbalanced environmental impact, do not retain the strength or durability to withstand the process. One reason for this situation lies in the production of

materials or components that actually “block other applications in the future,”(Fraanje 23) e.g., lumber with inherent structural capacity to be made into studs, beams, and other structural members is instead broken down into pulp for paper production. This disallows the pulp, once used, to be reused or recycled to its full capacity.

Due to the recycling process, many of these secondary products cannot do what their material predecessors could. In being downcycled, they lose strength and durability. Therefore, secondary products require additional virgin material. An important issue is that when materials not designed to be recycled are recycled, the secondary products have a shorter lifespan and are of a lower quality. (McDonough 59)

The secondary material is an afterthought of waste production. The design of the primary item does not take into account the possibility of a secondary material. Therefore, the secondary product is a second-rate product with a lesser value.

Conclusion

Attempting to simply recycle more of the material waste produced from renovation and demolition cannot solve the ecologically negative affect of material waste production. A more holistic method requires involving material stewardship as an initiative from the onset of the design and construction process. The permanent connections and material customizations used in the initial construction process disallow most C&D materials from being salvaged and reused or recycled. Typical American construction methods are not likely to change if alternatives do not offer a more economically viable method. Secondly, the perception of the house as a whole and complete object perpetuates an unsustainable cycle of demolition and new construction. The expression of perceived permanence goes against the reality that many of the material parts can be reused or recycled. An alternative design and construction method may not be one that is

more durable. In fact, an alternative construction may be even less permanent than traditional constructions. This alternative must begin with a change in the perception of the house; it must begin with a reevaluation of the value of the individual material and the value of the house as a whole; it must begin by looking first at the end of a building's life.

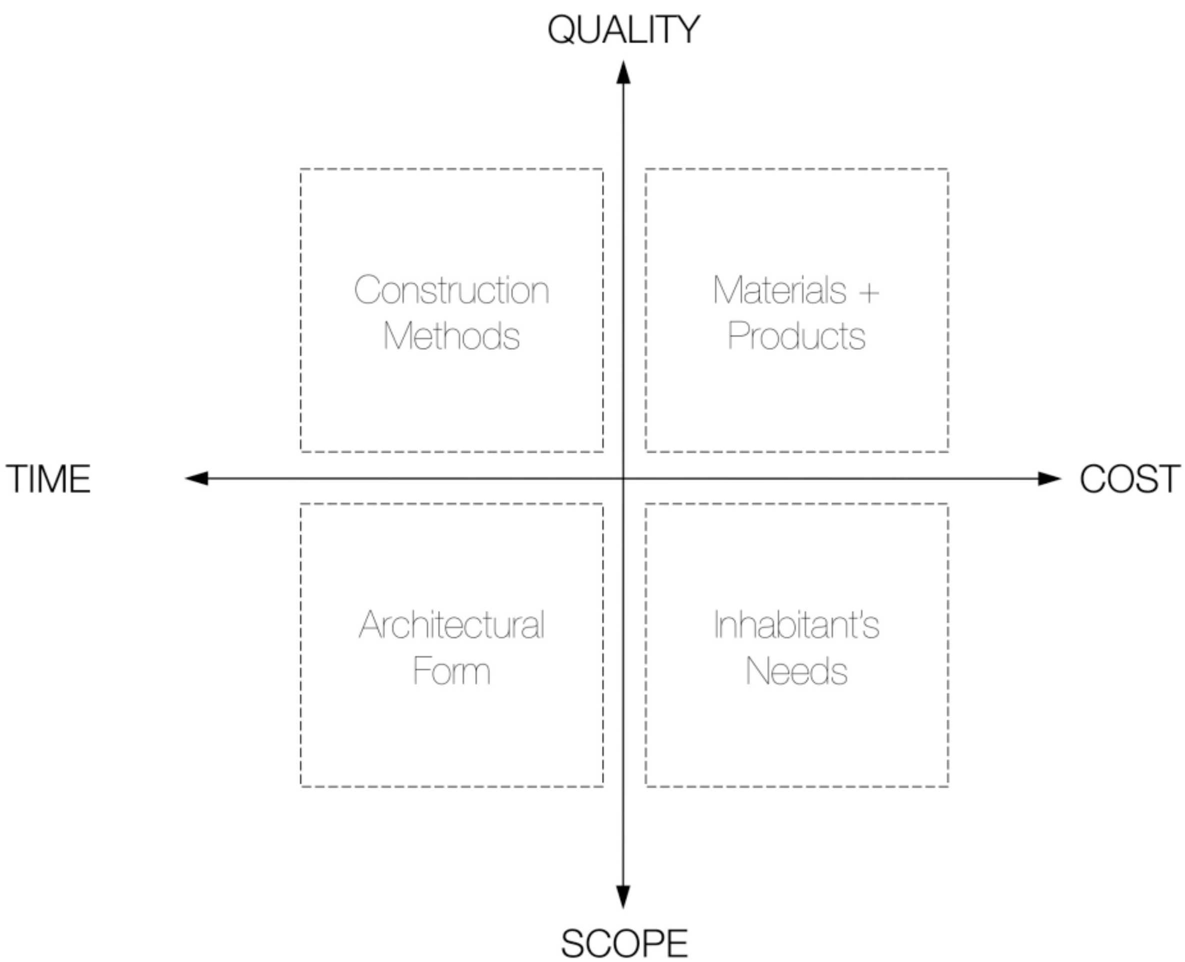


Figure 3: Schematic Design Concerns for a Typical Architectural Design and Production Method

It should not be the problem of those who recycle to come up with more creative ways to recycle material components. It is a holistic design and construction issue that will require rethinking the way in which new material components are designed and used. The key is the

design process. In order to create a working model for material stewardship in residential architecture, the temporary nature of the built form should be accepted and should become the primary form-giving aspect of the design.

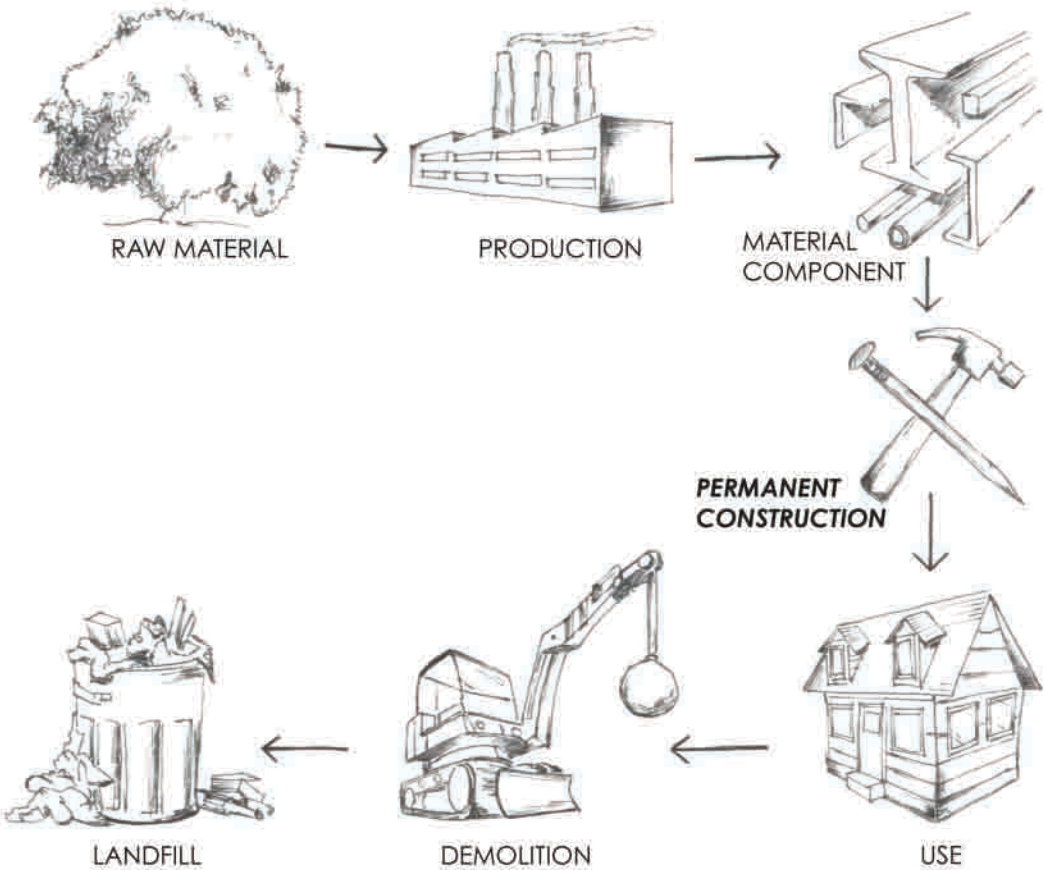


Figure 4: Typical Construction Material Lifecycle

PROPOSED PROCESS

The inconsistency that exists between a thirty-year construction and a five-year inhabitant does not necessitate a reversion to a more durable house. Rather, it would be better to design an even less temporary construction. However, for this system to work in a sustainable manner, the built form must begin by taking a position on the fate of the materials used in order to decrease material waste produced during renovation and demolition.

When deconstruction and the secondary use of individual building materials become a primary concern of the design process, efficiency of disassembly rather than use creates the basis for the construction and material connection methods. The basis for a new method of design is based on principles and positions taken on the treatment of building systems, structure, materials, and spatial and formal design.

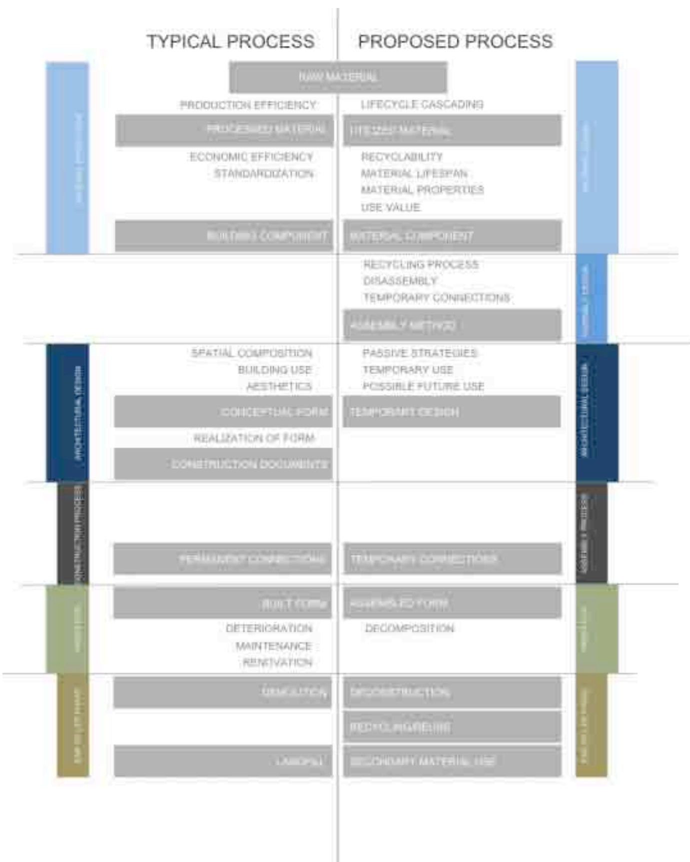


Figure 5: Typical v. Proposed Design, Construction, and Building Lifecycle

The basic principle behind each of the parts of this new method of design is the separation and accessibility of parts compacted enough to be easily removed. For building systems, e.g., electrical, mechanical, plumbing, accessibility is accomplished firstly by separating the building systems into layers. Second, the layering must facilitate access to components and assemblies. Lastly, the utilities and systems must be disentangled from the building's structural system. Disentanglement provides an ability for removal without damaging the structural stability of the structure. This principle is taken almost directly from machine-manufacturing principles.

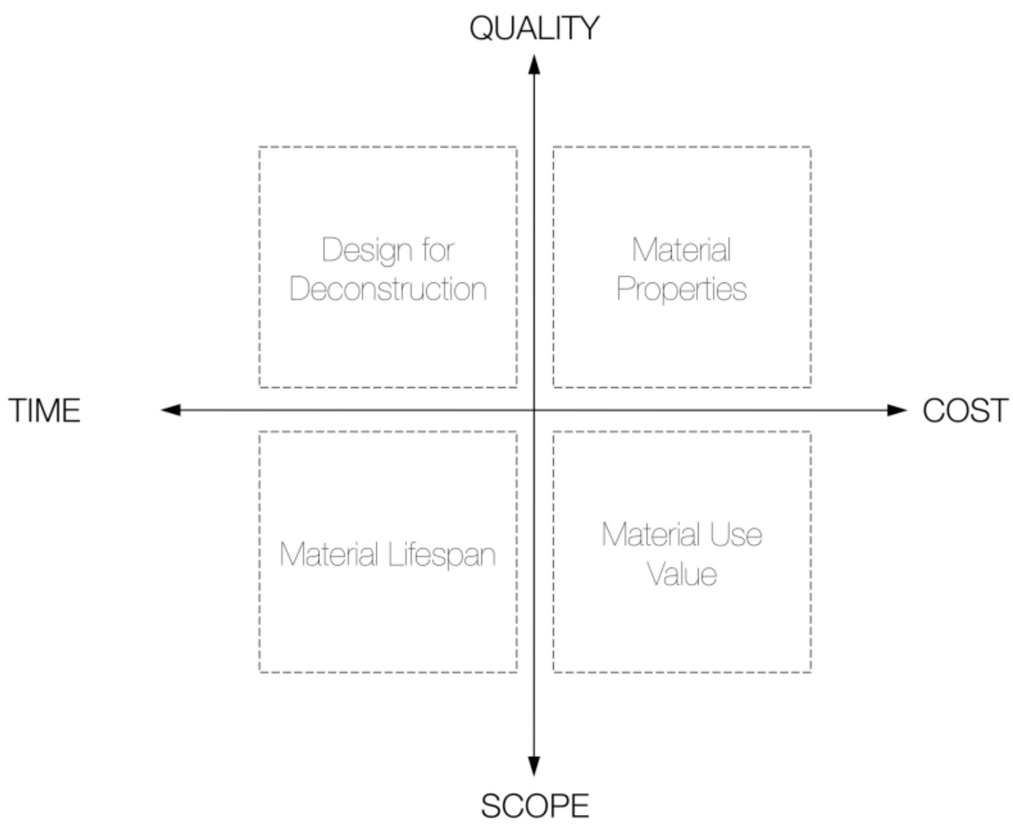


Figure 6: Schematic Design Concerns for the proposed Architectural Design and Production Method

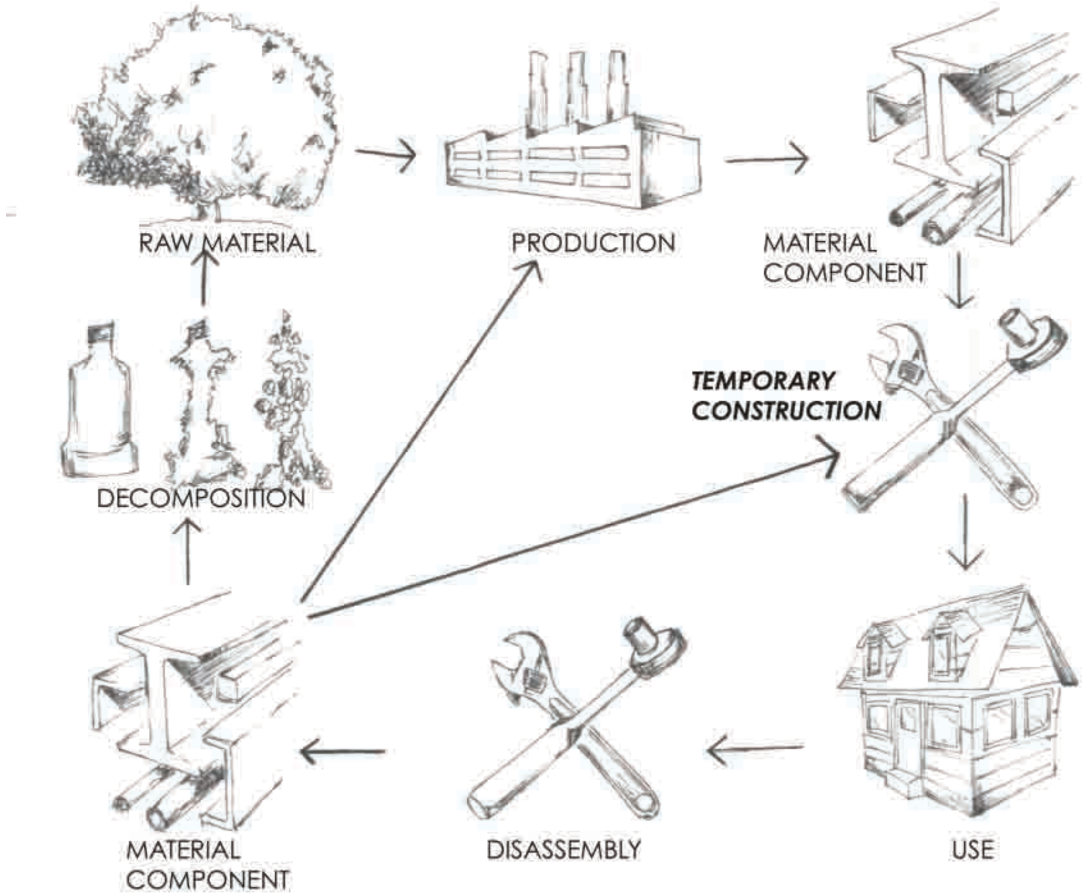


Figure 7: Proposed Construction Material Lifecycle

The main goal of the structural system is to make the disassembly method and order clear and simple. Clarity and simplicity is provided in a structural system that minimizes its number of components and fasteners. Secondly, in an attempt to create temporary connections, the material joints must employ mechanical fasteners in lieu of sealants and adhesives. These mechanical joints must also strive to simplify connections, making them understandable and expressive. Also, the connections should be visible and accessible.

The goal of the materials used is to provide both an ease in deconstruction, meaning that the scale of material should be appropriate to human scale. Post-use value is provided by using

materials economically worth recovering or that can be reused or recycled completely without large amounts of additional resources. Economic value is also increased by decreasing the amount of differing materials allowing an increase of the economic gain for each material. This mindset would also preclude the use of composite materials.

Lastly, spatial configuration and formal design must strive to provide openness for accessibility and spatial flexibility. Openness and spatial flexibility are allowed mostly through maximizing clarity and simplicity and minimizing formal complexity.

For this methodology of a design for deconstruction to become a successful architectural model, these principles must inform the construction methods, functional systems, and, most importantly, the architectural design and aesthetic expression of the constructed form. The following proposed method is an investigation of taking an architectural position based on these principles for deconstruction. The main goal is the production of architectural principles that create a flexible, adaptable, and deconstruction-ready architecture.

Recycling and Reusability

Temporary habitation is one of the primary goals of traditional architectural design and construction. Consequently, habitation takes precedence over the end-of-life concerns of the building. For most projects, the eventual demise of the built form is not considered during the design process. As a result, the materials utilized to create the built form are connected by permanent methods, e.g., adhesives, welds, screws etc. Typically, this mentality leads to the construction of built forms that must either be demolished or renovated at the end-of-life. As established, this frequently results in the production of substantial material waste.

However, if the secondary material use and recycling processes are considered during the initial design phases, the resultant way in which the building is deconstructed could determine

the way in which the building is constructed. When deconstruction becomes a primary concern in the design process, traditional design and construction methods should be reassessed as they are aimed at achieving a more permanent connection of materials. A new mentality becomes necessary that considers both the assembly and disassembly of material connections. The proposed design process begins by determining the materials, not the form or layout of the new construction. Secondarily, as the value of any post-use of materials becomes an important aspect of the design process, materials with differing life spans could be grouped and aligned with their primary uses. The goal of grouping parts or systems is to allow those parts to be disassembled and properly reused or recycled. In her book, *Smart Materials,* Michelle Addington argues that to determine a material for a project, it is first necessary to determine material properties and values. This investigation includes determining "how a material performs"(26) and "why one material is differentiated from another"(26). Only then should the architectural classification of "what a material is and where is it used"(26) be considered. Through this classification process, a building material can be utilized "according to its physical behavior, " and ". . . according to its phenomological behavior."(29)

By grouping the material parts by intended use, the lifespan of those individual material elements achieve an independence from the lifespan of the assembled whole. The material elements then achieve a transience and autonomy that undermines the permanence of the building as a static form. A resultant expression of impermanence creates the potential for a dynamic form that shifts and changes in response to the lifespan and use of its material components. A level of modest permanence is achieved by those material elements with longer life spans as they are designed for longer single uses. These longer lifespan materials constantly accept new material elements that serve to adapt to the changing needs of the inhabitants.

Accordingly, the joint becomes essential in connecting those parts of the built form with different life spans as they will be deconstructed and recycled at different times. To reintroduce continuity between the material lifespan and the temporary habitation, both material and formal connections must be reconceived into forms that more readily lend and express flexibility and adaptation over the lifespan of the building. The material joint must become the mechanical joint, able to be unfastened and refastened to accept new material members.

The first step in creating a successful model for residential design that reintroduces this continuity is a reinvestigation of the decision making process of design. Traditionally, the four main factors considered in the initial decision making process of an architectural project are quality, scope, time, and cost. However, an architectural design model that considers disassembly and material stewardship as high priorities should additionally consider the factors affecting the choice and use of material components within the built form; four major factors in determining where and how materials should be used are recyclability, material lifespan, material properties, and intended use.

Economic Factors

As established in the typical method demolition and deconstruction analysis, “deconstruction labor is the most sensitive cost parameter,”(Dantata 7) influencing the economic viability of deconstruction, the most important design parameter must be accessibility and ease of deconstruction. By accommodating for an accessibility and ease in deconstruction, the time of deconstruction and consequently, the necessary labor involved in deconstruction decreases, resulting in lesser labor costs.

Table 5: Demolition v. Deconstruction Cost for Typical Process

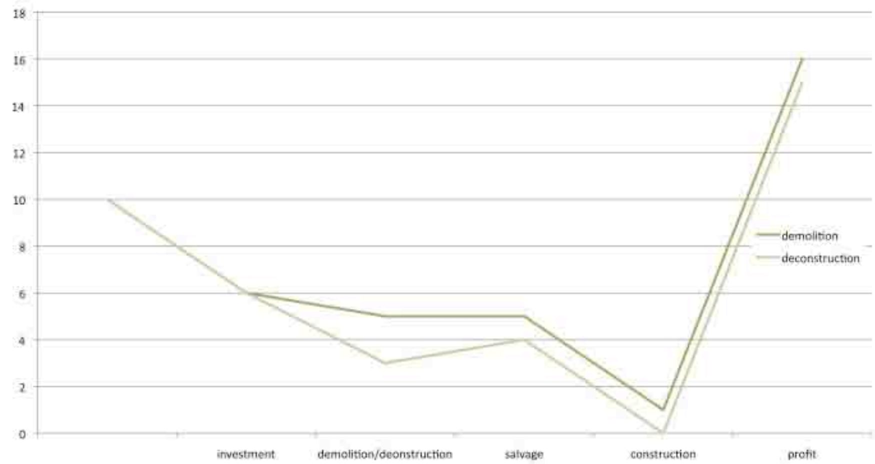
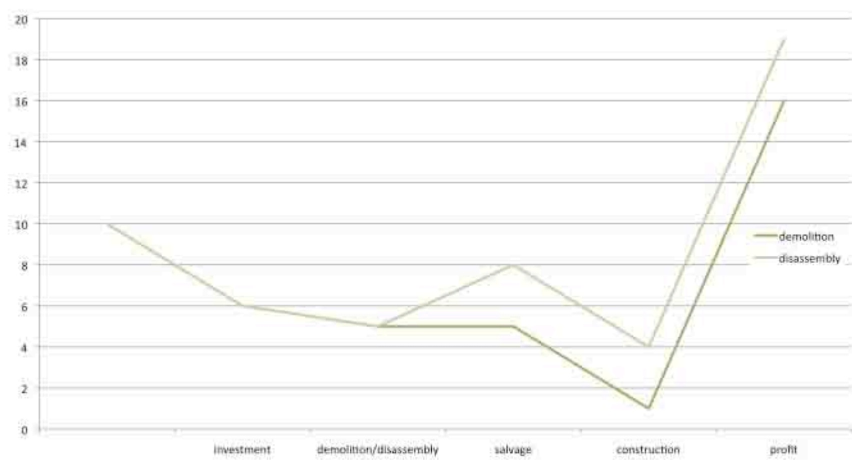


Table 6: Demolition v. Deconstruction Cost for Proposed Process



Design accommodation for accessibility and ease in deconstruction begins by determining the scale of accessibility for deconstructing parts of the building, i.e., the parts should be grouped in order to create an effective system for eventual disassembly. This system

separates the building into a series of parts that can be taken apart by differing levels of laborers and tools. The smallest scale material must be able to be removed or replaced by an individual with limited tools or knowledge of the system. As the scale increases, so does the number of necessary workers, tools and knowledge of the system. Yet, at all scales, the number of workers and tools should be decreased in order to reach the full potential of the building system's flexibility, adaptation, and ease in disassembly. For certain parts of the construction, the professional contractor, due to both liability and necessary skill, becomes responsible for installation. These less accessible members are also more permanent and have increased life spans. Increased life spans, in accordance with increased flexibility in use allows these more permanent members to retain an amount of economic and use value on the site, must remain open to accepting both reused and new assemblies of those less permanent members. This method of designing for deconstruction reduces the cost of labor for the deconstruction process and allows for more whole parts to be salvaged, increasing the economic gain produced by salvaging and recycling. Also, designing in layers of life spans rather than a whole building single use lifespan allows this process to compete economically with the traditional methods of demolition.

The resulting system is separated into scale parts, or layers, based on the intended disassembly method. Assumedly, the disassembly method would begin with inhabitants and workers. It would only later require more advanced tools and machinery. The smallest and most accessible scale is the envelope. This layer is made of parts that can be unattached and removed by and individual inhabitant with minimal effort. It is assumed that the envelope may even change seasonally. The next layer is the platform and shelter, more commonly the floor and the roof. These layers would require a minimum of two people and some hand held tools for

disassembly. These layers would assumedly be accessed only in larger renovation projects. The following layer would contain the structural system requiring skilled workers willing to accept certain liabilities involved. The worker would also require a more extensive knowledge of the structural system, including lateral forces, potential loads, etc. The least temporary and least accessible system is the site work. This layer mediates between the inconsistencies of the ground conditions and the more regulated and universal nature of the structural system.

Each of these layers utilizes materials that do not require extensive customization or modification. Unmodified and standardized material parts reasonably ensure that the economic value of the individual material may be regained more fully after the material is removed. The increased salvageability of these members creates a greater economic incentive for choosing deconstruction over demolition. By retaining a sense of wholeness, the material members also require less labor cost and necessary energy to be reused or recycled. For those materials that cannot be reused, they should be at least separated enough that they can be wholly recycled.

Perceptual Qualities

A house that can be disassembled will more likely be disassembled if it appears as if it can be disassembled. The expression of the temporary connection and a retained individuality of material is required for the success of this method. The nest, as the antithesis of the castle, provides an adequate analogy for expression. The nest remains in two perceptions simultaneously: that of the whole and that of its constituent members. Though the nest is recognizable as a whole, its temporary connections and loose organizational structure allow individual material members to retain an independence outside of the perception of the whole, e.g., the rim of the nest is perceived an equal amount as the twigs and moss of which it s made.

The impermanence of the built form creates a situation wherein the value of the transient or independent material retains both its economic value and the value of its implied use independent of its place within the assembled whole. The whole then becomes the expression of the utilization of materials to provide a need for the inhabitant. It is an aesthetic of necessity; it utilizes a basic principle: "form follows necessity". The form giving properties are bestowed upon the interaction between different parts, their intended uses and the limitations of the site. This calls into question the definition of the material member. Traditionally, material members are assembled to create a whole form that then delineates certain spatial qualities. However, if the material members are positioned based on their inherent experiential and use properties rather than added as an afterthought to an already determined form, the importance of, for example, the wall assembly is no longer its ability to be utilized in various circumstances. Its value lies in the inherent properties of its materials and their relationship to the intended use on site and the potential secondary use.

Frascari argues that the "putting together of spaces and materials in a meaningful manner," (Frascari 36) determines, to a large degree, the perception of the built form. Further, he determined that how two parts are put together reveals the "meeting of the mental construing and of he actual construction" (26), simply put, the understanding of how a construction is held together is affirmed by the visual revelation of the construction joint. The value of the revelation of the temporary joint, therefore, provides the perceptual point at which the inhabitant affirms the temporary nature of the architectural form. Creating a system of disassembly that is accessible is not enough to ensure that the perception of the building as an impermanent shell will affect the mindset of the inhabitant. The accessibility must be designed in such a way as to be expressive of

the constructional technique and an understanding of the "future perception in relationship to the architectural object," (Frascari 30), or the revelation of the temporary joint.

Temporary Habitation

Traditional residential construction is designed with a certain amount of intended spatial flexibility. The rooms or delineated spaces of the house are many times given a non-specificity in order to allow the structure to retain value despite the changing necessities of its users, e.g., neither bedrooms nor offices are intentionally designed as specific to an intended use allowing a potential for interchangeable use based on the inhabitants' needs. This intentional flexibility is the result of an inability to actively adapt to the changing needs of the inhabitants due to the static nature of the typical American house.

A dynamic architecture, however, would be designed of temporary parts that retain specificity to certain experiences and uses. This changing form actively engages in the changing needs of its inhabitants. Adaptation is achieved through disassembly and reassembly. The actively customizable system begins to then articulate and reflect, though form, the rate and change of the evolving nature of the inhabitant. Secondarily, more temporary members may also respond to certain regional or environmental aspects at differing times of year. This may require an orientation that does not align with the orientation of the site or the expression of its intended uses. Therefore, the resultant and constantly fluctuating form becomes dependent upon the interplay between two controlling factors: the environmental conditions and the changing needs of the inhabitants. This precludes a universal form. This would instead be the result of a regional system that would then respond to the specific characteristics of the site, such as orientation and context.

As a result of this method of form generation through response rather than through intentional and static form, the architect loses a large amount of authorship over the resultant form. The overall form instead becomes a response to the context and the inhabitant's needs. The disconnection of material members in accordance with this inherent active flexibility, therefore allows for the individual material members to retain an independence from the whole. This once again, reasserts the intended expression of the house as a nest, or a series of parts.

To allow for accessibility for the inhabitant, the layers are pulled apart into their individual uses. The wall ceases to be a tightly packed all-in-one entity; the layers are split into a thermal barrier, a waterproofing membrane, a structural component, a plumbing system and an electrical system. This allows for different layers to be removed and replaced at different times. The building components of the proposed method utilize materials for their inherent properties. The material properties and life spans determine the material's use. The materials are then split up both into intended use and lifespan. If the lifespan and the use can be linked, the materials can be separated into systems, e.g., thermal barrier, waterproofing membrane, etc. These systems can be separated into components on a human scale that can then be moved and removed to account for changes in the inhabitant's needs and climatic seasonal shifts. By classifying the systems based on specific interior uses or experiences, the facades of those sections would reflect the interior use and so reintroduce a continuity between the interior habitation and the exterior aesthetic expression.

Economic Factors

To see the house as an investment is to understand that any alterations made to customize the house to the specific needs of the inhabitants must be weighed against the potential market value of the whole, therefore determining the amount of profit or loss. Decreasing the cost of

renovation through the use of a more flexible structural and customizable system could solve this economic issue. A more flexible structure and a temporary façade may result in an increased salvageability of whole materials, as they would have to be designed to be adjusted and readjusted without major adjustments. The individual members could then retain their economic value as non-customized material parts. This design would also simplify the deconstruction process as the process would be more easily expressed and direct. The result is an adaptable system that could decrease waste produced by renovation and decrease labor costs of both renovation and deconstruction.

Perceptual Qualities

As a result of the typical American design and construction process, the built form is viewed as a whole and complete object. However, the proposed method values the disparate life spans of the individual materials as a major factor in deciding the placement and longevity of independent members, the resultant form no longer achieves finality upon construction. Instead, the built form remains in a constant perceptual cycle of assembly, disassembly, and reassembly. The value of the form therefore is decreased; the form is instead a secondary result of the orientation of the reassembled parts and their relationship to both each other and the site.

Traditional residential architecture regards building components as material assemblies that are typically designed for a universal purpose, e.g., window, door, wall assembly. Each of these material assemblies is then placed within the built form and serves in some way to either delineate space or provide it with certain properties, e.g., a fixed window lets in light and provides a visual connection with the exterior. However, if the material components were envisioned as joints rather than parts or assemblies, the delineation of space would become secondary.

Although traditionally, the "joint" is thought of as the connection between material and material components, Frascari argues that the material joint is only one type; the joint, or detail, is rather more broadly understood as the "mediate or immediate expressions of the structure and the use of the buildings." (Frascari 24) Therefore joints can express themselves not only materially but also compositionally. As compositional elements, they become experiential rather than material. Frascari classifies these joints as 'formal joints'. The formal joint serves as a spatial rather than a material connection, e.g., the "connection between an interior and exterior space" as "in the case of a porch." (Frascari 24)

Construction

The main goal of the proposed method is to create ease and provide expression for deconstruction. Consequently, the construction goals of the project are merely a reflection of the goals for deconstruction. Material selection is a result of an analysis of inherent material properties, material recyclability, and the material's post-use market value. The majority of materials should be local materials, thereby modestly securing both that old materials can be resold and new materials of similar dimensions and properties can be found. The connection system would then be customized to a degree to account for the lack of customization of the envelope materials. Customization, however would make it harder to reuse. These connection members would more likely have to be recycled, allowing them to be shipped from a manufacturer rather than found locally.

PRECEDENT ANALYSIS

St. Peter's Basilica in Rome was designed and constructed to last forever. Its massive scale and use of heavy, durable materials, namely concrete and marble, expresses a sense of permanence and durability. It was designed to make a statement about the power and eternal nature of the Catholic Church. Unfortunately for the Catholic Church, concrete will crumble and marble will crack. "No building stands forever, eventually everyone falls under the influence of the elements, and this end is known from the beginning" (Leatherbarrow 24). The built form by nature is temporary. Raw materials are repurposed into material members that are then assembled for a certain use. Over time, all materials, degrade and wear which results in the inevitable destruction of the architectural form. Yet, most architectural projects continue to be designed as permanent products that ignore the eventuality of their material demise. They instead assert a built form that presents itself as a whole and complete object. This intentionally permanent design and construction method results in an architectural form that is both whole and assumedly permanent, i.e., the constituent parts are affixed to both each other and the site as if the building is going to stand forever on that site. Ironically, the assumed permanence of material connections creates a condition in which it becomes more viable to demolish the building completely. Demolition undermines its assumed permanence, whereas renovation or the reuse of parts of the constructed form for later use would conversely allow at least part of the form to retain a more permanent existence. Through this assertion of completeness, these built forms retain a wholeness that does not readily adapt to change in program, situation or form. Instead, the form as a final product either exists or does not exist in a specific state of being.

The antithesis of the built form as final product is the built form as a temporary assembly. The temporary built form comes from a design and construction method that realizes its own temporariness and accepts that its form remains not in a static state of being but rather in a

dynamic state of becoming. As a result, the building is conceived of in parts rather than as a whole. Ironically, through an acceptance of its own temporariness, these parts of the built form retain a partial permanence through their potential to be reused on site or repurposed and utilized elsewhere.

A traditional building is made up of different materials that are composed in such a manner that the building is perceived as a seamless whole. This perception is reinforced through the intentional permanence of material connections, e.g., welds, nails, adhesive, etc. Therefore, the main function of the resultant whole, the delineation of space, takes precedence over the reality that the materials are individual components. The individual spaces are then perceived as the individual components that make up the whole of the built form.

However, the objective of disassembly requires that a classification of building parts be extended to include both those spaces into which the building is subdivided and also those constituent material elements into which the built form will later be disassembled. As the spatial composition of the assembled form is temporary, the classification of these components may then be defined through some means outside of the traditional wall, floor, or roof definitions. This classification may consequently reveal some meaning or aspect outside of the traditional perception of walls, floors, and roofs, e.g., the disassembly method itself or the specific use of individual material components.

As the proposed method falls into this category, the following analysis focuses on those past architectural projects designed for eventual disassembly or adaptability. The analysis focuses on the successes and failures of these projects in allowing the forethought of disassembly to influence the design and construction of the project. Secondarily, the analysis will attempt to

determine the strategies behind the project's relationship to context, organization and scale of its parts and connections, and the perceptual qualities of the architectural form.

Although there are many archetypal built forms that may fall into this category, e.g., tent, trailer, etc., the analysis focuses on three buildings that utilize the assembled form method in building types that are typically built using typical design and construction methods. Among these, three buildings stand out as atypical to their building type in differing historical contexts: Ise Shrine, an historic Japanese monument, Nakagin Capsule Tower, a Modernist residential tower in an urban area of Tokyo, and the Loblolly House, a recent single residence project aimed at sustainable construction.

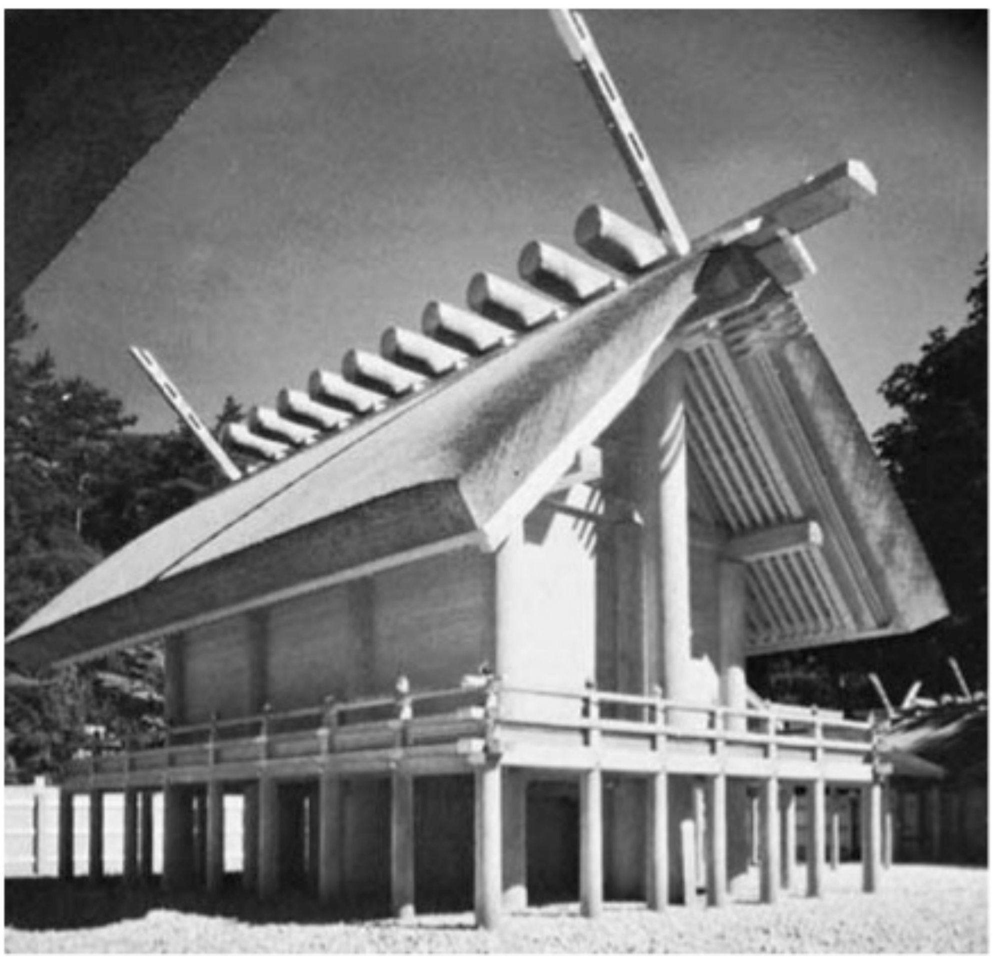


Figure 8: Ise Shrine

Ise Shrine

The Ise Shrine is disassembled and reassembled every twenty years in a ceremonial practice known as *Shikinen Sengu* (Watanabe 29). This cyclical process has taken place 59 times over a period slightly longer than 1000 years (Tange 52). It can be argued that the process itself actually retains more cultural and spiritual value than does the completed form. The cultural value of Ise Shrine is associated with the temporal and impermanent existence of the built form. In accordance with traditional Japanese philosophy, the building preserves an "attitude of willing adaptation to an absorption in nature . . ."(Tange 18).

Parts: Members

As Ise Shrine is built with the specific intention of perpetual disassembly and reassembly, the nature of which is in fact more important ceremonially than the intermediate lifespan of the built form, the parts are designed and classified not only for their use within the timeframe of the built form but also for their order in the process of disassembly. The primary structure is the only part of the built form that touches the ground. Raising the remainder of the built form off the ground allows the disassembly to take place without major disruption to the site itself. The remaining two parts, the secondary structure and the envelope, are less independent from each other. The disassembly process begins with the removal of the envelope and continues to disassembly of the secondary structure. This process takes place first with the roof assembly, then the walls, and lastly the flooring. Though the disassembly method may seem similar to other projects, Ise Shrine is unique in that its individual parts are structurally interdependent. As Kenzo Tange described after visiting the site:

> At first sight, the posts and beams seem to support the weight of the roofs, but in fact there are small gaps between the posts and beams and they do not touch directly. The

> weight of the roofs is therefore borne by the board walls [envelope]. Only when after a number of years the boards have been contracted, posts and beams touch, and the posts start sharing the burden of the roofs with the walls.
>
> -from *Ise: Prototype of Japanese Architecture* p. 46

This constructional interdependence, through its shift in structural support over time, realizes and conveys the passage of time, as does the cycle of disassembly and reassembly that occurs every twenty years.

Connections

Though the disassembly method may seem similar to the Loblolly House and Nakagin Capsule Tower in that the primary structure remains an independent construction allowing the secondary parts to be disassembled and removed, Ise Shrine is quite unique in that its individual parts are connected by primary joints, i.e., members are designed to fit each other without an adjoining member, whereas the parts of both the Loblolly and the Nakagin Capsule Tower are connected by means of a secondary member. This primary connection of members reveals an interdependence of parts that allows an ease of disassembly and removal as there are a lesser number of parts and necessary tools.

The major success of the Ise Shrine is its use of Japanese joinery techniques. The structural members are equipped with their necessary connection in situ. This structural system can then be assembled without the use of secondary connection members. The subsequent disassembly process requires less tools. This method of encoding the structural member with the connection information creates an efficient disassembly system. It also minimizes the number of members and simplifies the disassembly process.

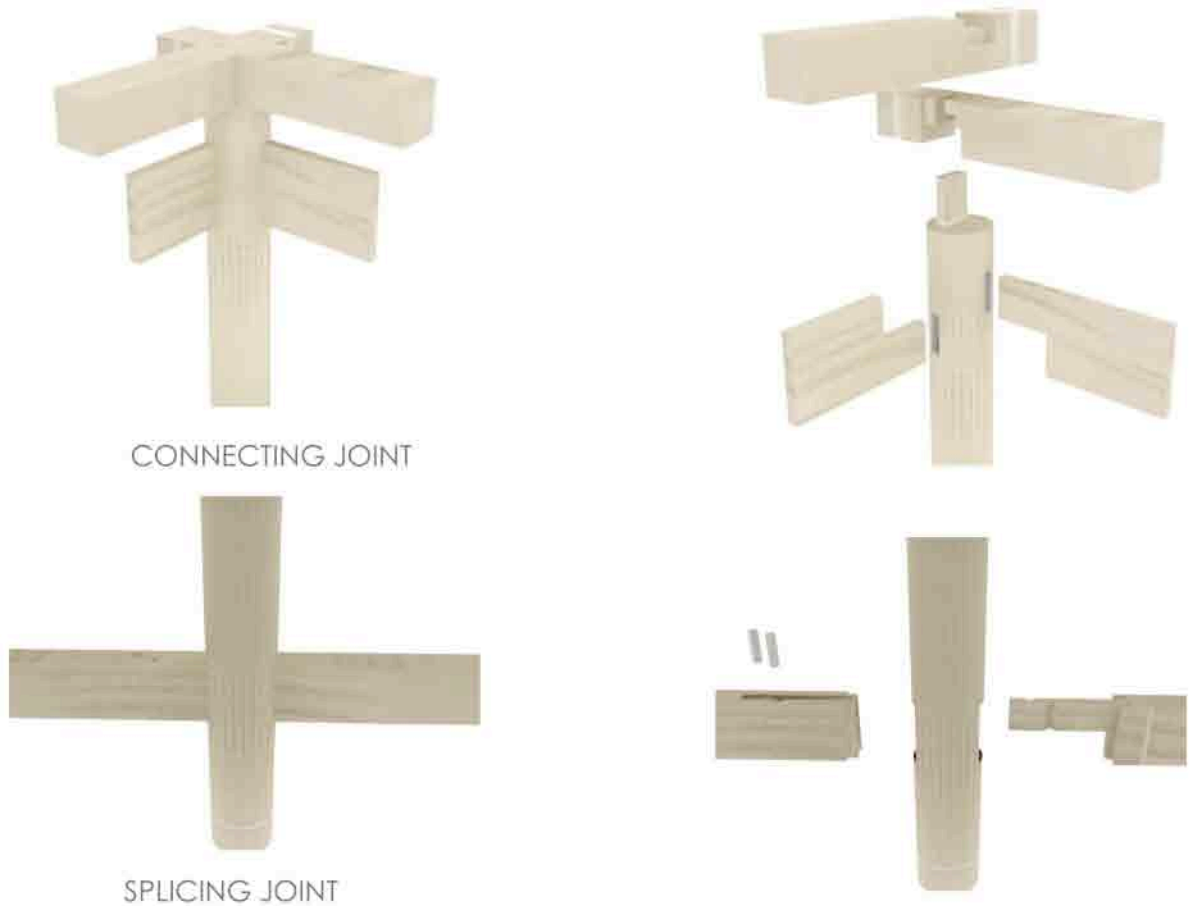


Figure 9: Ise Parts and Connections

Nakagin Capsule Tower

The Nakagin Capsule Tower was designed by architect Kisho Kurokawa and built in 1972 in an urban area of Tokyo. It exemplifies an alternate function of the urban residential tower as an organic entity. It was designed to adapt and change in response to possible future changes in technology and urban culture. The building contained replaceable residential units that were fastened to a more permanent core. The 8'x12'x7' modules, or capsules, were intended to be 'unplugged' and replaced, after a 25-year lifespan, by newer capsules. However, the capsules were never replaced and the building's residents voted to demolish the structure in 2007. The demolition continued despite pleas from Kisho Kurosawa to utilize the building's

Figure 10: Nakagin Capsule Tower

flexible nature and replace the original capsules with newer updated residential units. (Ito 52-54). The building's unfortunate but ultimately inevitable demolition brings into question the validity of the design. As it was never utilized for its intended purpose, the failure of the design is the focus of the subsequent forthcoming analysis.

Parts: Modules

Traditional Japanese architecture expresses the value that a single form can never reach monumental perfection. The architect's belief is that the architectural form's four basic components: man, nature, structure and form, are themselves relative and in constant flux. Therefore, the harmony created between them through the built form must be "coordinated so

that the reciprocal relations between them are always capable of change. Flexibility is one of the most fundamental characteristics of Japanese creative work"(Blaser 7). In the case of the Nakagin Capsule Tower, architect Kisho Kurokawa attempted to generate flexibility through the implementation of temporary modules that could be removed and replaced every twenty-five years to accommodate population growth and changes in culture and technology. These temporary components, or fully integrated "living capsules", served as the private living space for residents. The modules were attached to a main vertical structure that included the transfer of services and the circulation of residents. The main structure was envisaged as an outlet into which the temporary modules could be "plugged". The architect intended that, after a twenty-five year lifespan, the living capsules would be "unplugged" and replaced with new capsules to accommodate the growing and changing culture of Tokyo.

Connections

The temporary connections used in the Nakagin Capsule Tower were composed of standardized parts that could be later replaced without the need for custom parts. In relying on standardized parts, Kisho Kurokawa maintained his building would be adaptable for future generations. The notion of utilizing standardized parts with the intentional ability to later replace those parts is typically a method utilized by automobile manufacturers. Car manufacturers attempt to design in order to maintain the usability of a car despite the shorter life spans and occasional failures of its constituents. Though Kurokawa utilized a similar design philosophy, his intention was based on the notion of adaptability to change in living conditions and population growth over the course of the resilient core's lifespan. Through the use of standardized connections, Kurokawa was attempting to ensure that later generations would choose to replace

the modules rather than demolish the building. The process would be more viable and accessible granted that the universal parts were still being manufactured.

Conversely, the closed nature of this system disallowed any change or adaptation that did not adhere to its standardization, thereby decreasing the flexibility of the system and paradoxically making it less able to adapt to future conditions. Though the reasons for the building’s eventual demolition were not strictly limited to this lack of flexibility, the strength of the concept was not enough to influence the outcome.

The major aspect of the Nakagin Capsule Tower was its conceptualization of the individual living space as a separate and removable object. The disconnection of the living capsules from the more resilient and durable core structure allowed the building to retain a use value after the modules had been removed or replaced. However, the largest failure of the actual disconnection of the module from the core was the form’s lack of visual expression of the ability of disengagement. The temporary connection was hidden, allowing the building to retain a comprehensiveness common to typically constructed structures. In retaining a perceptual completeness, the method of flexibility was hidden. The differentiation of form and material were the only outward expression of the residential units’ detachment capabilities. Without prior knowledge of the system, its nature was not visually explanatory.

Secondly, the living capsule, or module, retained the qualities of a whole and complete object. Hence, the module was treated in the same manner as a permanently perceived object, it either exists or does not exist. The module’s interior pieces did not allow the same flexibility and interchangeability inherent in the larger system. The renovation of the building would have required whole replacement modules, not simply replacements for those parts that required substitution.

Also, the deterioration of the core structure was one of the main reasons the building was demolished (Solomon). The project was perhaps too ambitious in its scale. The large, more permanent core still relies on the perceived permanence utilized in typical design and construction. This part, as the module, did not retain the flexibility of the whole and was therefore subject to the fate of permanently perceived objects. In essence, the building was made of only two parts, the structural core and the living capsule. Both retained a wholeness that disallowed the intended flexibility of the design to permeate their use and end-of-life treatment.

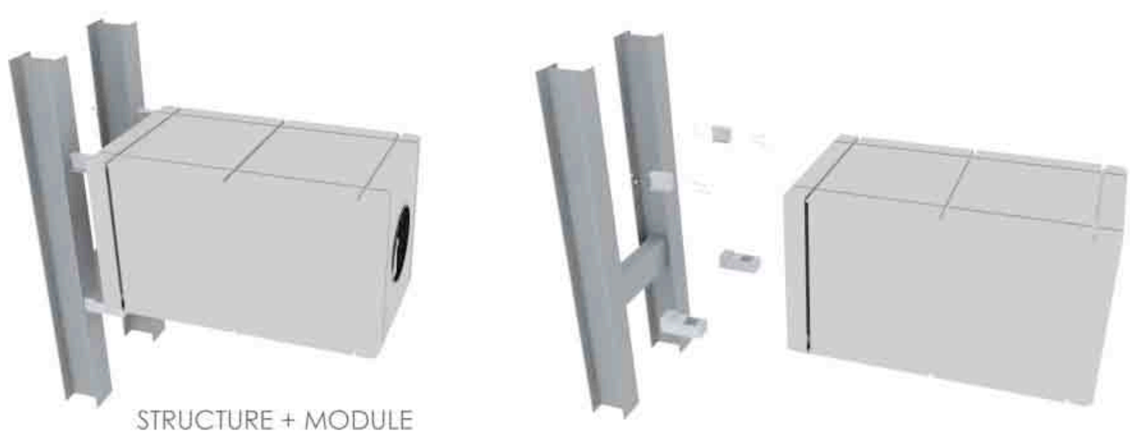


Figure 11: Nakagin Casule Tower Parts and Connections

<u>Loblolly Residence</u>

Among recent residential architecture projects, Kieran Timberlake's Loblolly House attempts to explore the possible environmental and sustainable benefits of designing and building in prefabricated panels and sub-modules. Among these proposed benefits is the concept of accepting, to a degree, the building's eventual disassembly. Once the building had served its purpose, the house would be disassembled and removed without permanent damage to the site or extensive material or resource waste caused by demolition (Kieran, Timberlake 141-142). This method of designing with eventual disassembly in mind allows for the building to take on a new

level of ecological responsibility wherein the architect becomes responsible for not only the house's construction and initial occupation but also for its demolition and removal.

Figure 12: Loblolly Residence

Parts: Panels

The Loblolly House is made up of prefabricated, panelized parts whose assembly method was designed based on the form's future method of disassembly. Each part was prefabricated off-site and sectioned into panels or blocks that could be removed efficiently and transported for possible reuse or recycling. The goal was to create an efficient system for disassembly and recycling. The panels are classified based on both their use value and the schedule of assembly and disassembly. The outermost layer, the environmental envelope, was designed to protect the interior spaces from rain, dirt and other environmental particulates and was designed to be removed first along with the thermal envelope. The panels, or "wall cartridges", that make up the thermal envelope are fully integrated sections that serve mainly to enclose and insulate the

interior space. The floor cartridges, which are similar to the wall cartridges in that they are fully integrated panels, serve the dual purpose of providing services, including radiant heating, microducts, and electrical conduits, and the structural floor for interior living space. The block services, which include finished bathrooms and mechanical service rooms, were built off-site as completed modules with *in situ* services that are then "plugged-in" once on site. With the exception of the environmental envelope, each of these systems is attached on-site to the scaffold structure, which stands independent of the rest of the assembled form. The independence of the structural scaffolding allows the individual panels to be removed systematically and efficiently without damaging the structural integrity of the whole, the goal being to provide a system of disassembly that is a more advantageous system than demolition. By creating a method of disassembly that competes in ease and economic viability with demolition, Kieran Timberlake, as designers, have reasonably ensured the end-of-life choices for the built form.

Connections

Though the structural scaffolding system utilized in the Loblolly House is similar to the Nakagin Capsule Tower connection system in that it is made up of already manufactured elements, the intention of the Loblolly system was not based on the notion of future adaptability, but rather future disassembly and removal. The architectural advantages of the system chosen lie in its "ease of use and speed of assembly"(Kieran 67), and, consequently, speed of *dis*assembly. Secondly, the use of these standardized parts that are available only through a specific manufacturer ensures the creation of a closed-loop system of reuse and recycling of parts, as certain members can be sold back to the manufacturer, creating economic incentive to maintain the closed system.

The major flaw of the Loblolly House lies in its perceptive qualities. Although the scaffolding system is revealed in part throughout the house, the overall form still retains a wholeness that overpowers the perception of the individual members. The resultant whole therefore does not balance the expression of the whole and the part. This aesthetic balance is required to reach the perceptual quality of the nest. Consequently, the Loblolly residence is similar to the Nakagin Capsule Tower in the lack of its expression of its inherent flexibility, though to a less severe degree.

The Loblolly Residence suffers from a second perceptual issue that negates its flexible nature. The panelized members are the base constituent element of the system. These panels are fully-integrated and made up of a number of differing material elements that are connected using typical permanent methods. As a result, the accessibility of the systems is limited thereby decreasing the amount of system flexibility.

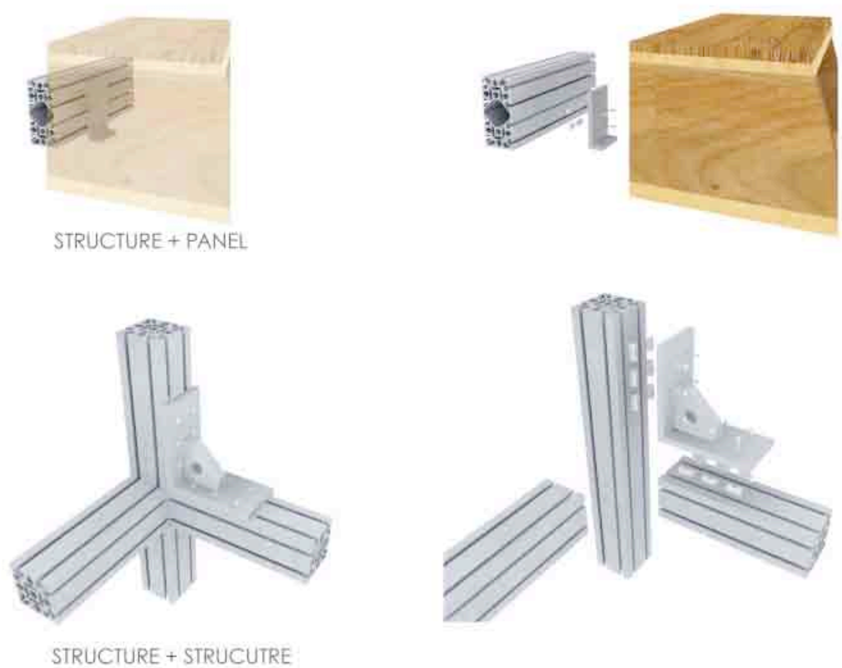


Figure 13: Loblolly Residence Parts and Connections

Similarities: A New Building Typology

Though the Ise Shrine, Nakagin Capsule Tower, and Lobolly Residence differ in location, scale, uses, and style, they share certain similarities in design and construction. These similarities are specific to the influence of an intentional disassembly method introduced during the initial design phases. These similarities reveal certain mutual perspectives on the method and process of disassembly, specifically, the built form's division of components based on the order and extent of intended disassembly. The three resultant building elements, site connection, structure, and envelope, and the connections between them provide the means by which the disassembly process becomes a viable method of the built form's end-of-life.

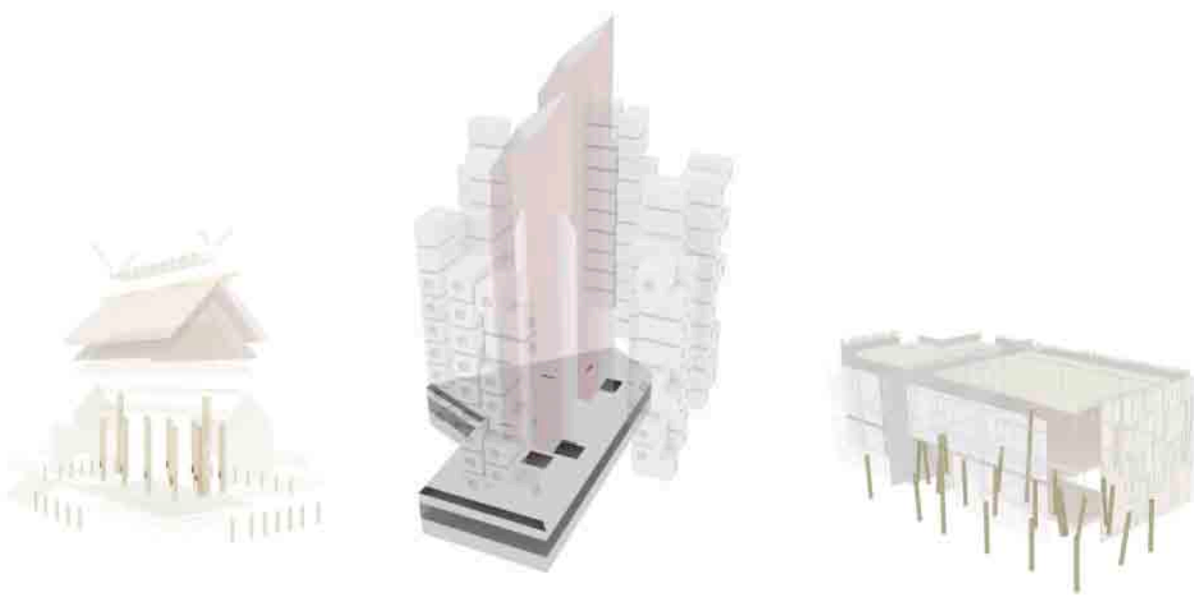


Figure 14: Ground Connection - Ise Shrine, Nakagin Capsule Tower, and Loblolly Residence

Ground Connection

The ground connection members mediate between the irregularity of the ground conditions and the more standardized structural systems. This site-specific member creates a separation between the site and the structure. For both the Nakagin Tower and the Loblolly

House, the site connection is built as a permanent addition to the site. The site connection member in these cases becomes an eventual site condition when the built form is removed. The process of the removal of the Ise Shrine from the site during the disassembly process is more complete; the only piece left on site is not structural but merely a means of demarcation. In order to create a more regular form to which the structure can attach, the site connection lifts the base of he structure off the ground and creates a tabula rasa.

The tabula rasa, "scraped tablet", in each of the three projects acts as a flat plane upon which the structure sits. The standardized nature of the structure requires this blankness of pallet to eliminate the relative incongruities of the site. This is the point at which the form transforms from site specific to universal. The shift is necessary to retain the regularity of the structural members.

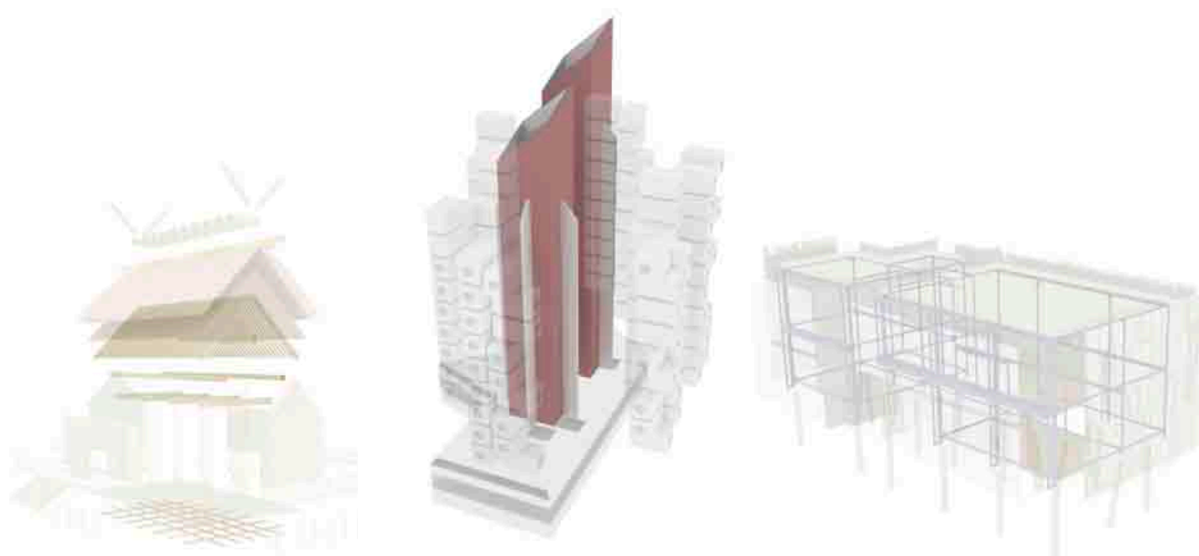


Figure 15: Structure - Ise Shrine, Nakagin Capsule Tower, and Loblolly Residence

Structure

In order to facilitate the mostly non-structural envelope systems of the Ise Shrine, the Nakagin Capsule Tower and the Loblolly Residence, the structure provides stability for the

envelope allowing it to be removed without damaging the structural integrity of the whole. This independent stability allows the envelope to retain an independence from other building parts. The structure must be able to be disassembled into its constituent parts efficiently without decreasing the remaining form's structural stability. This extent of disassembly is considered only in the Loblolly House and Ise Shrine; the Nakagin Capsule Tower contends that the structure should remain a permanent part of the built form.

The second use of the structure is to provide a regulated system to which the envelope can attach itself. This is mainly true for the Nakagin Tower and Loblolly House which both utilize a standardized structural system that creates a more regulated form of attaching the envelope to the building. Ise Shrine still provides a structure to which the envelope attaches, but the hand-made quality of its joints disallows the level of standardization provided by manufactured joints.

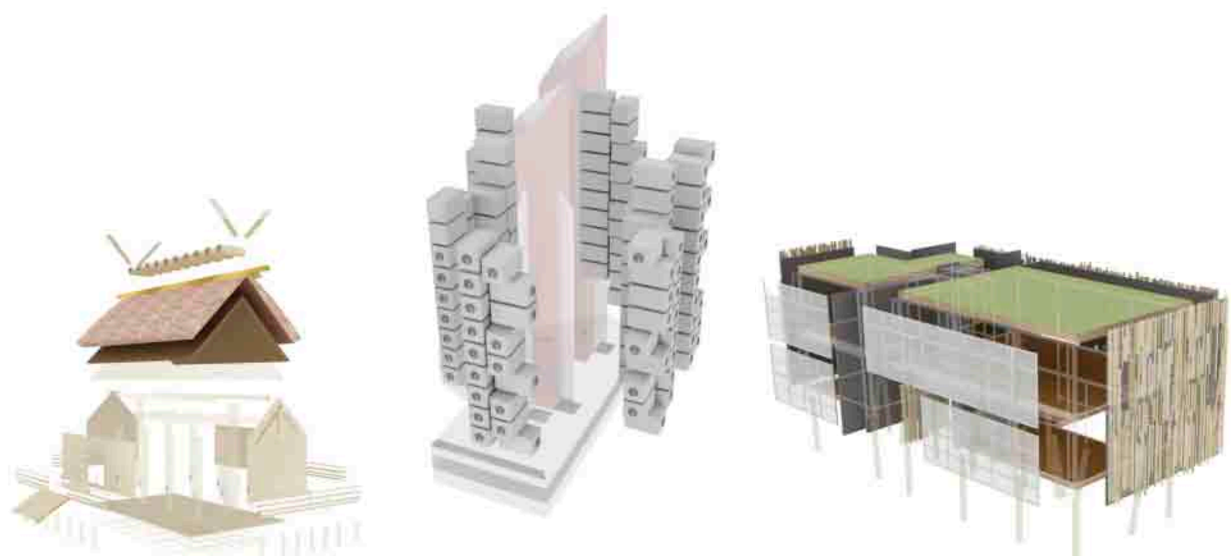


Figure 16: Envelope - Ise Shrine, Nakagin Capsule Tower, and Loblolly House

Envelope

Typical construction begins with a foundation and moves upwards and outwards to the skin of the building. It follows that disassembly would most logically begin from the outside and work inward. As the first element to be removed in the disassembly process, the building envelope typically retains little to no structural value as the building must retain its own structural integrity throughout the disassembly process. The envelope instead acts as a covering only. In the case of the Loblolly Residence and Nakagin Capsule Tower, the envelope also houses the building systems.

Perceptual Qualities

Architectural projects designed to be later disassembled rather than demolished differentiate themselves from traditional architecture through their realization of the temporary nature of the built form. An expression of an inherently designed disassembly method may offer an aesthetic revelation of this temporary nature.

In *An Architecture of Reality*, Michael Benedikt argues that certain architectural works contain “moments of realness” in which the “world becomes singularly meaningful . . . without being ‘symbolical.” Within these moments, which he refers to as “direct esthetic experiences”, the inhabitant experiences the reality of the built form free of either reference or allusion, thereby making the experience real or authentic. He defines the realness of experience through four primary components: presence, significance, materiality, and emptiness, all of which work together to create an authentic experience. This innate authenticity can then exist only in the built form that “bring[s] to light a genuine history—human or natural—of its site and the circumstances of its construction”(Benedikt 40). It can be argued that each of the buildings analyzed above contains a component of realness.

However, the fundamental understanding of a building, according to Benedikt, is that it must be a “primary object,’ *necessarily permanent*”(12). This permanence, claims Benedikt, is necessary to elude the perception that architecture is merely “a medium of communication” (12) and therefore unable to contain moments of realness. The temporary natures of the previously analyzed precedents are, by design, at odds with this necessary condition. The perception of architecture as a *necessarily impermanent* object, therefore undermines the ability of Benedikt’s components to create moments of realness in the built form. Consequently, if a building is designed for disassembly it evades Benedikt’s notion of a perception of permanence, thus, it must seek a new type of realness if it is to retain value and elude the inauthentic condition of representation. A redefinition of a sense of realness for the impermanent object must realize the reality of its impermanence. Subsequently, it seems more probable that a realness of impermanence will reveal not only the *history* of the site or the circumstances of its construction and the *future* of the site and the circumstances of its *de*construction. This revelation of deconstruction and necessary temporariness creates experiential moments not of a physical reality but of a temporal reality. A temporal reality understands, accepts, and expresses the temporary nature of the built form. It becomes necessary, then, to redefine Benedikt’s components of reality to adjust to this new perception. Through this perception of a temporal reality, the architectural form is given new perceptual qualities. These perceptual qualities allow the structure to combat those necessarily permanent qualities of typical constructions.

Historical Significance

Ise Shrine has been disassembled and rebuilt 59 times over a period slightly longer than 1000 years (Tange 52). Paradoxically, the temporality of the form, being rebuilt every twenty years, allows it a longevity that provides the basis for its historical significance. The true nature

of its “historical significance over and above its formal timelessness,”(Benedikt 40) is the process of rebuilding itself. The construction of the form then expresses its temporal realness through an articulation of temporary connections. Articulation presents the reality of its cyclical deconstruction. Benedikt presents the component of significance as a “fundamental seriousness . . . and a sense of magnitude independent of [the built form’s] actual size” (Benedikt 38). If this seriousness and magnitude is meant to express a significance to those who use the building, then a temporal significance must create a seriousness and magnitude that is based on the passage of time. However, to elude mere representation, this seriousness cannot be symbolic of the passage of time, but rather must be ontological in nature. However, as Benedikt’s definition of significance is differentiated from symbolism by regarding those buildings as being “significant to someone, rather than, or in addition to, being symbolic of something.”(38) Ise Shrine, through its cyclical process of disassembly and reassembly provides an historical significance to those who can relate the rebuilding process to moments in their own lives.

This relationship of ceremony to individual allows the building to retain its significance through the passage of time. Further, the connection of ceremony links generations, creating a greater and more widespread cultural significance. The resulting connection and magnitude is less comparable to the historic significance of an architectural form and more closely related to the magnitude and cultural connection created by a cyclically celebrated event. In many cultures, cyclically celebrated events center around an act or ritual. In the Judeo-Christian tradition, for example, communion involves the act of drinking wine and eating unleavened bread, symbolic of the Passover consecrated by Jesus and his disciples before his crucifixion. The act is meant as a symbolic link between members of the same faith uniting them in parallel relationships with a deity, namely, Jesus. The Ise Shrine utilizes a similar technique of ritual meant to link

contemporaries of differing age groups in their cultural heritage. Where this differs, however, is that the ritual of disassembling and reassembling Ise Shrine is not symbolic but ontological in nature.

Cultural Presence

The true presence of the Nakagin Capsule Tower could only have been realized through the displacement of viewing the building's formal transformations over time. Although that transformation never came to pass, it does not invalidate the idea nor does it detract from the relevance that the expression of the potential for disassembly and reassembly provided a cultural presence and attitude towards a willingness to change. Benedikt defines presence as a perceptually implied "assertiveness" and "attentiveness to our presence." However, when dealing with the expression of the temporal reality, assertiveness is best shown through an acceptance and pronouncement of the temporariness of the built form. The expressed differentiation of the living capsules from the core structure in the Nakagin Capsule Tower begins to assert an architectural will to adapt. The resulting architectural form would then reflect the changing urban environment in which it is placed. It is attentive less to the current presence of the inhabitants and urban dwellers and more to the evolutionary nature of culture.

Temporary Materiality

Materiality, for Benedikt, is a major component of an authentic moment that ties the inhabitant to the reality of the material substance. This is accomplished through an "appreciation of the natural origin of its substance and the manufacturing or forming processes that the latter has evidently undergone."(44) However, architecture that articulates a sense of *temporal* reality must be aware of its own temporariness. An expression of temporary nature of the form is its revelation of the independence of its constituent materials. The reality that those materials are

merely travelling through the site, being used only for a short time. A revelation of the independent material members creates the perception of the temporariness of the form itself. The Loblolly House achieves this level of material expression through its material connections. The structure is held together with intermediate members that can be taken apart with a wrench. This joint is revealed throughout the house. Secondly, the intermediate members also hold the panels in place with this expressed reality of eventual disassembly. However, a complete revelation of independence would go even further to reveal the independence of each material member. The Loblolly Residence reveals only the separation and independence of the constituent prefabricated panels. Each panel, however, must be later dismantled into its constituent material elements in order to be properly recycled. This secondary step of material separation and recycling is not revealed. Therefore, the true appreciation of the secondary use is not communicated.

Towards an Emptiness

"Emptiness may resound without sound, may be filled by its potential to be filled, and make open what is complete."(Benedikt 50) Each of these projects studied provide a system for disassembly that was developed and perfected in order to accommodate change. Yet, the unwillingness of each of these systems to accept parts that are not customized to fit that specific system forces change to adhere itself to the closed system set in place. For the Nakagin Capsule Tower, the replaceable nature of the capsules limits new development and growth to completed parts that can be "plugged in" to the established outlet, the core structure, by a specified plug. What remains unaccounted for is the adaptability of the system itself. The Loblolly Residence utilizes a closed system of building that requires any renovation to adhere to the system of assembly and disassembly set in place. The strength of this system lies in the control of demolition and material waste, but it remains a whole and complete system whose material

usage, though consisting of parts that may have varying life spans, is inherently tied to a singular use for the building. Once that use is complete, the individual parts do not retain any individual value. Consequently, the built form remains either complete, and therefore unable to create emptiness, or removed wholly from the site, also making the perception of emptiness an impossibility. Ise Shrine retains its historical significance through the process of its complete disassembly and reassembly, though the resultant form then suffers from the same issues as the Loblolly House. None of these buildings succeeds in creating a temporal emptiness. This goal can be achieved only when a system provides openness in connection and use.

In a 1983 address to the New York Architectural League, Vittorio Gregotti argued that the first tectonic act was not the primitive hut, but the moment “man placed a stone on the ground to recognize a site in the midst of an unknown universe, in order to take account of it and modify it.”(Frampton 98) Therefore, it is through the marking of ground that man begins to investigate and derive meaning from a site. The completed structure does not allow for the emptiness of meaning achieved by the obscurity that exists at the moment the site becomes marked as a site but not for an intended or specific use. The obscurity and ambiguity of this moment must be retained in that part of the built form intended to be left on the site for the longest period. For the traditional architectural form, this will inevitably be the foundation. However, the traditional foundation still derives a specific and intended use. As the built form degrades over time, that which is left must both mark the site and become a site condition, thereby providing the demarcation of a non-specific use and retaining the obscurity that allows the perception of the inhabitant to fill the site with his/her own meaning and intended use. By expressing obscurity, i.e., that which is not immediately definitive or direct in purpose or intended use, the remaining form creates an openness and emptiness into which the future

inhabitant, builder, designer places inserts a new perception, a personal and subjective meaning that can be ascribed only through a human desire to complete that which is lacking, to define that which is not yet defined.

CASE STUDIES

Case studies are typically used as a research strategy that involve an in-depth, longitudinal examination of an instance or event. This traditionally involves the collection and analysis of data, and a corresponding report. However, in the instance of a proposal for a design process, it seems more logical to go though the motions of the design process for a new project. The design process attempts to utilize the principles developed in the critique, proposal, and precedent analysis. The following design acts as a case study to determine the validity of the assertions of the proposed method.

Rethinking the nature of context and content in light of an accepted and expressed impermanence, the architectural form serves in the same sense as a nest. A nest serves as a temporary assembly of parts to mediate between the content, or those things which are necessary for habitation, and the context, or the external/given environment. The relationship between these two forces, the will to survive and the natural condition, determines the type of architectural mediation necessary. Therefore, the following designs are based on the intersection of environmental conditions and human habitation.

Conceptual Design

The initial design of the project began from the concept of expressing the impermanence of the built form in two main ways. First, the revelation of the mechanical joint is necessary to create a perceptual connection to the ontological understanding of the temporary nature of the resultant architectural form. This resultant architectural form emerges from the specific needs of the inhabitant to mediate between the environment and temporary living space.

Designing for disassembly demands that the form-giving concept of the built form be determined by some factor of its ability or capacity for disassembly. The aesthetic expression of disassembly in the design attempted to retain the individuality of distinct material members,

which both allows the material to be reused without alteration and reasserts the analogy of the nest. Both aesthetically and ontologically, the design attempted to maintain both the individuality of the constituent members and the built form as a whole object.

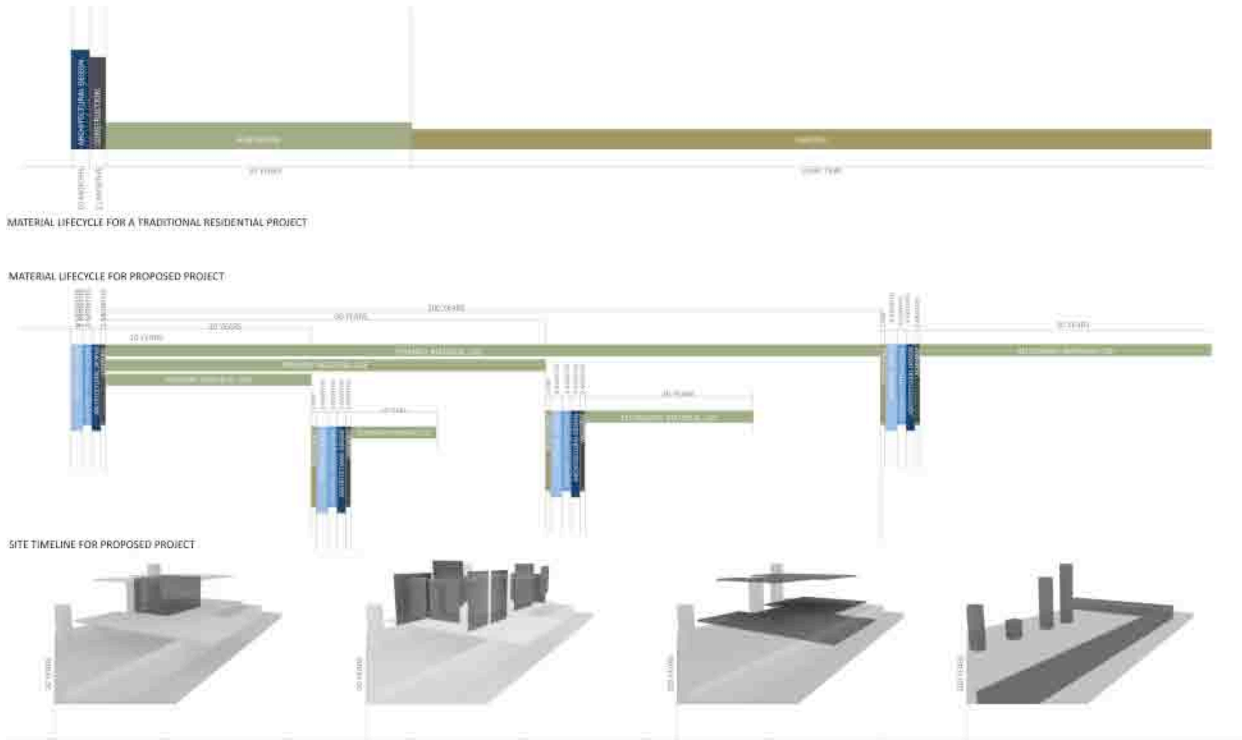


Figure 17: Schematic Design for Separation of Members

Overview

The designs have explored the intersections of environmental conditions and human habitation as a way to determine the necessary components for a relative location. Secondly, the designs are analyzed to determine how they would function with a system of temporary components responsive to both the needs of the inhabitant and the given climatic conditions. The resolution of conflicts caused by inconsistencies and critical similarities of external environment and human habitation is climate-dependant. The relative climate serves as the main force behind deciding the nature and condition of the architectural form as the conflicts and resolutions

between the exterior environment and the needs of habitation may differ depending on the environmental conditions. Therefore, it seems unlikely that a universal system could be created that allows for optimum resolution in all cases. However, as habitation needs are somewhat universal and environmental conditions can be quantified, it seems more likely that a regional system could be developed that is flexible enough to account for a smaller range of inconsistencies within a specific region. Therefore, the project will apply the concept to two juxtaposing climatic conditions: New Orleans and New York.

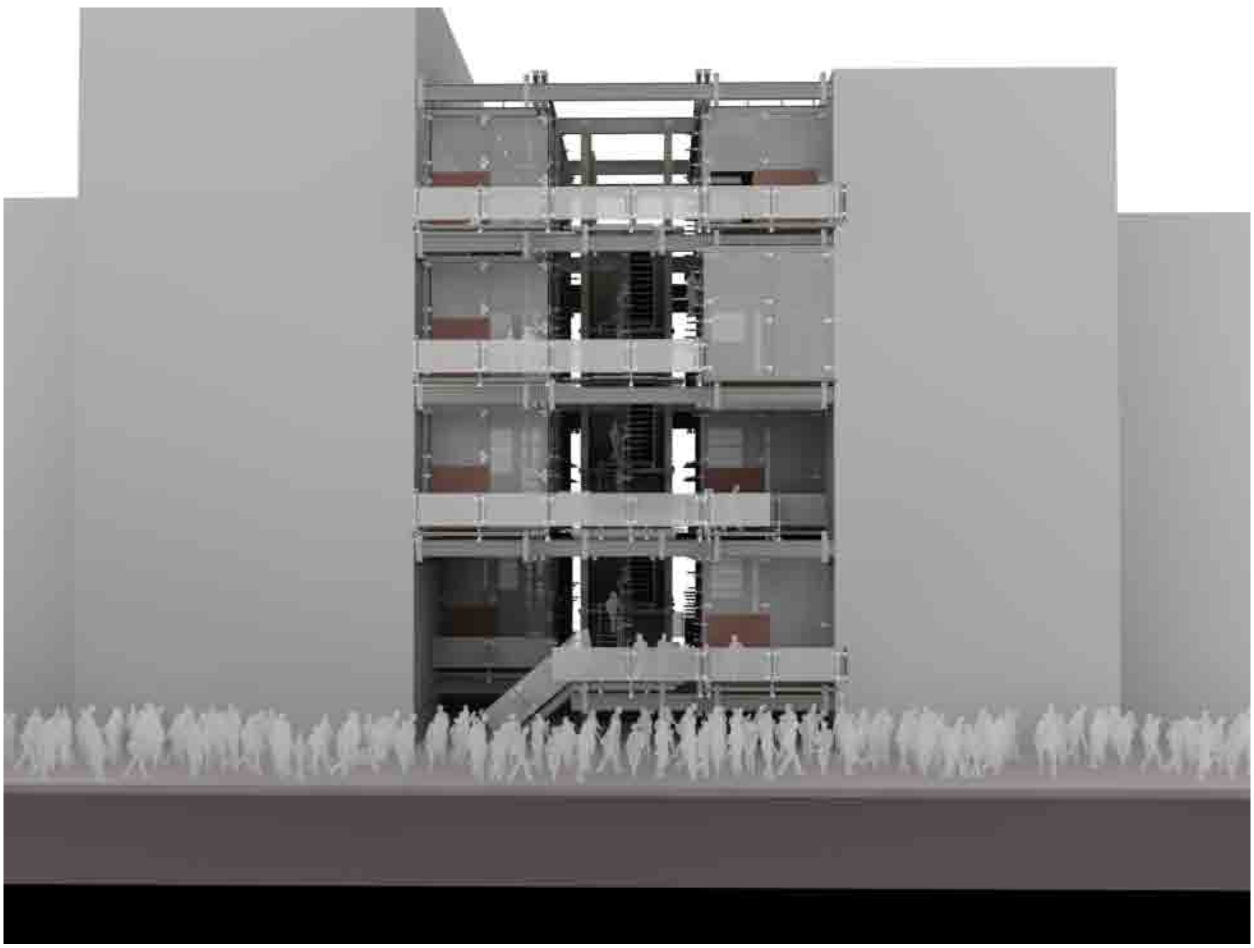


Figure 18: New York Design

Figure 19: New Orleans Design

The goal of the two case studies was to determine the result of applying the concept of temporary habitation that values its material constituents and their post-occupancy uses more highly than the architectural form, to similar urban settings with differing climatic conditions. The resulting design process is based on the intersection of the inhabitant's needs, the climatic conditions, and four goals based on the concept of designing for disassembly:

1. The parts, after use can be utilized again without any adaptation and for various applications.
2. The remaining structure can be reused without demolition or large scale renovation for multiple uses after its initial use.
3. The materials can be recycled completely.
4. The building, as much as possible, will utilize passive strategies in order to lower dependence on non-renewable resources.

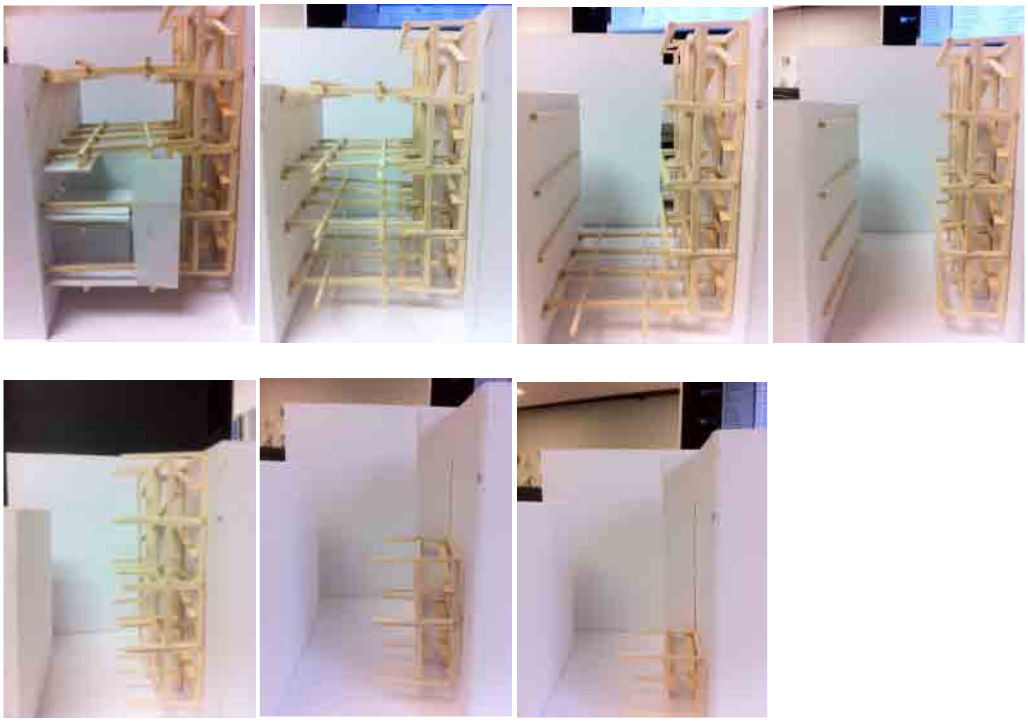


Figure 20: Schematic Disassembly Method Models

Site Analysis

As the main practical concern of the design is the mediation between the inhabitants' needs and the climatic conditions, the site analysis remained limited to the main environmental factors that influence human habitation: daylight, rain, temperature, and humidity. Subsequent to the investigation of climatic conditions was the availability, scale, dimension, and inherent properties of local standardized materials. Local materials were chosen as the concept for the design impinges on the idea that the façade would shift and change over time. Consequently, material would change and be replaced over time requiring the purchasing of new materials of an already determined scale and dimension. Secondly, this provides a local market for the resale of those materials after use. By providing a material market for those temporarily used materials, the owner retains a resale value of the material rather than the house, reinforcing the intended acceptance of the temporary use of materials.

Figure 21: New Orleans Site Analysis

Figure 22: New York Site Analysis

Climate-Based Design

The main divergence of the two case studies was based on the differentiation of climatic conditions. The project based in New Orleans focused on cooling space and decreasing humidity to account for human habitation. The thermal envelope, intended to keep the interior space cool, was designed in two parts. The tight, interior envelope kept heat from entering the mechanically cooled space, while the loose, exterior envelope kept heat from solar radiation away from the living space. The interior envelope required materials with high insulation values that could create a tight seal around the interior space. The exterior envelope required highly reflective materials that were pushed away from the tighter envelope to decrease solar gain on the south and west sides of the structure.

Decreasing humidity and increasing air circulation in a humid climate are typically conflicting systems. The air that is brought though the structure contains copious amounts of water. However, using a desiccant filter in place of a typical window screen pulls moisture out of the air as it enters the conditioned space.

The main concern of the New York project is thermal insulation to keep heat in during the colder months of the year. The resultant form differs from the unit design of the New Orleans project by reversing the thermal envelope. The envelope connection joints of the New Orleans project extend outward to hold reflective materials away from the structure decreasing solar gain. The envelope connection joints of the New York project are faced inward to hold in place materials with high thermal capacity on the south and west facades. The space created these materials and the translucent waterproofing envelope produces a green house effect to provide warmth for the inhabitants.

Creating a waterproofing membrane worked similarly in both systems. This membrane had to be developed for a system of mechanical joints in lieu of permanent connection types and typical waterproofing membranes. This issue was solved through the use of neoprene gasket placed between the separated and individual materials of the envelope and the interior structural system.

Parts and Connections

The two designs for the case studies were based on a system of separation similar to the multi-layered system discovered in the precedent analysis. By separating the ground connection, structure and envelope, the system provides a more explicit order to the eventual deconstruction process. This order works at two scales. First, the separation of the ground connection and structure of the building from the individual structure and envelope of the inhabitants' living spaces allows for individual units to be disassembled and removed without affecting the stability of the larger construction.

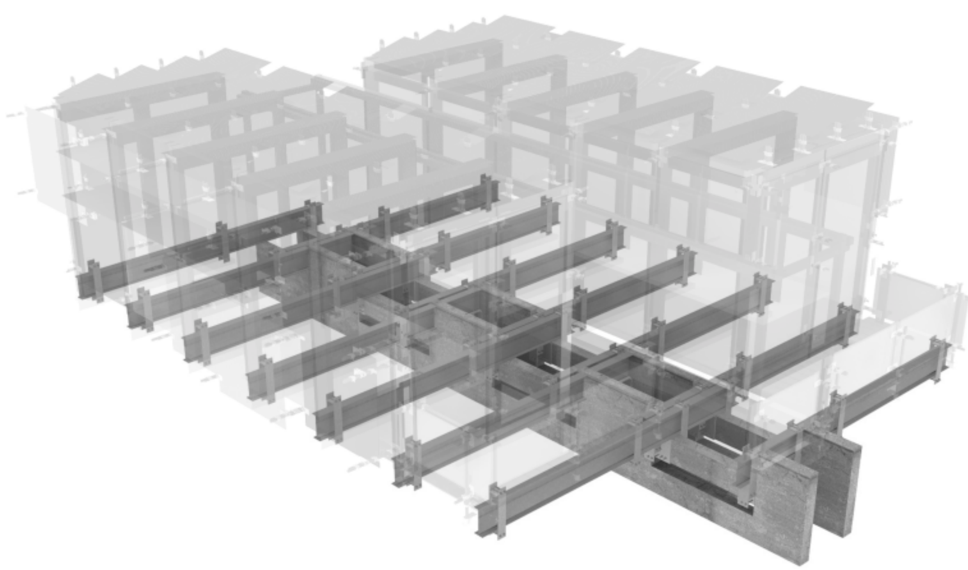


Figure 23: New Orleans - Ground Connection

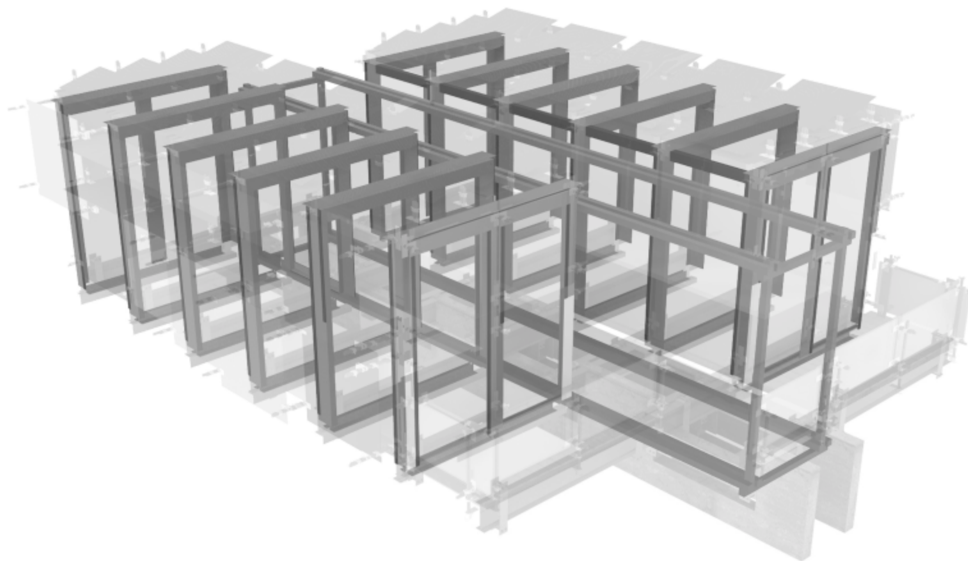


Figure 24: New Orleans - Structure

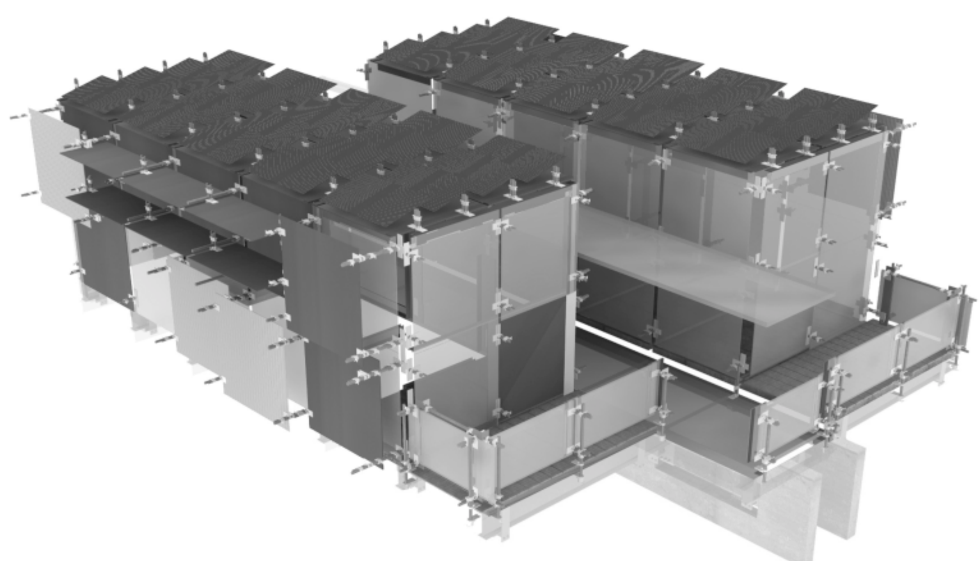


Figure 25: New Orleans - Envelope

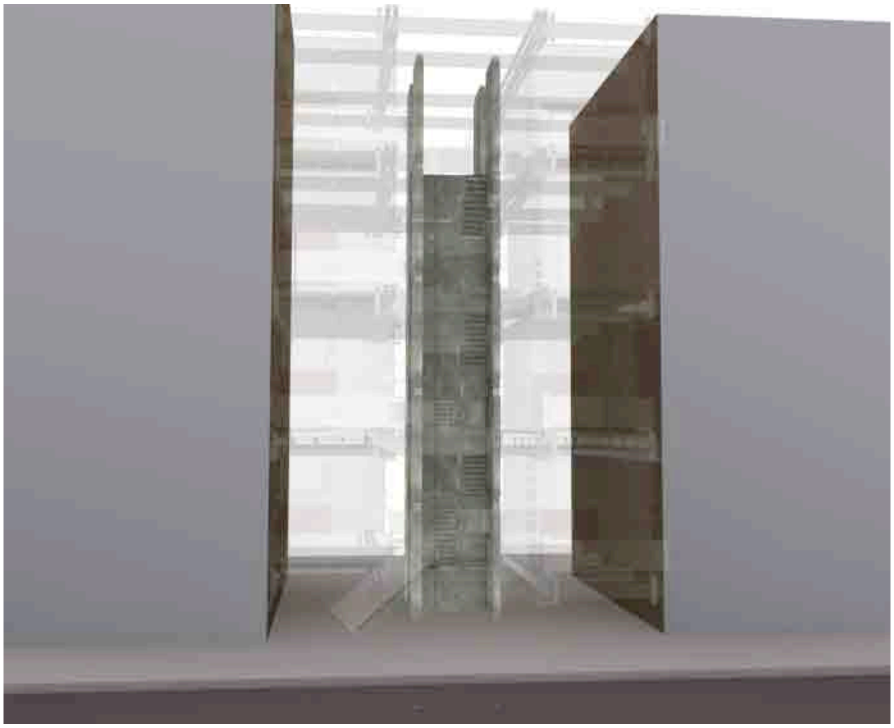


Figure 26: New York - Ground Connection

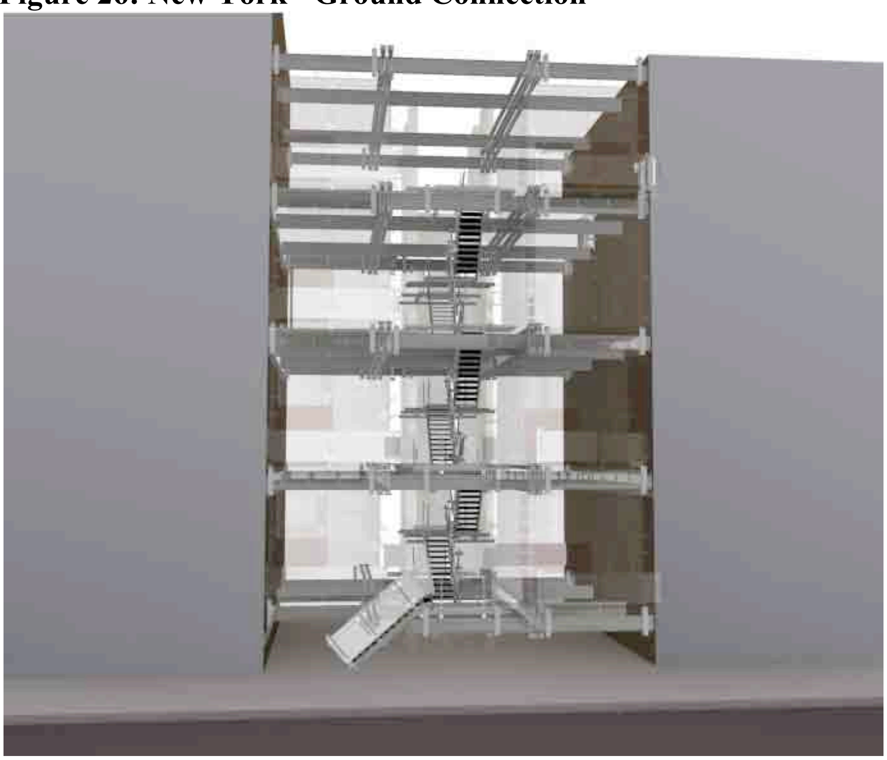


Figure 27: New York – Structure

Figure 28: New York – Envelope

On the smaller scale of the individual residential units, the separation of structure from envelope allows the envelope to be either manipulated or removed without disrupting the structural stability of the unit.

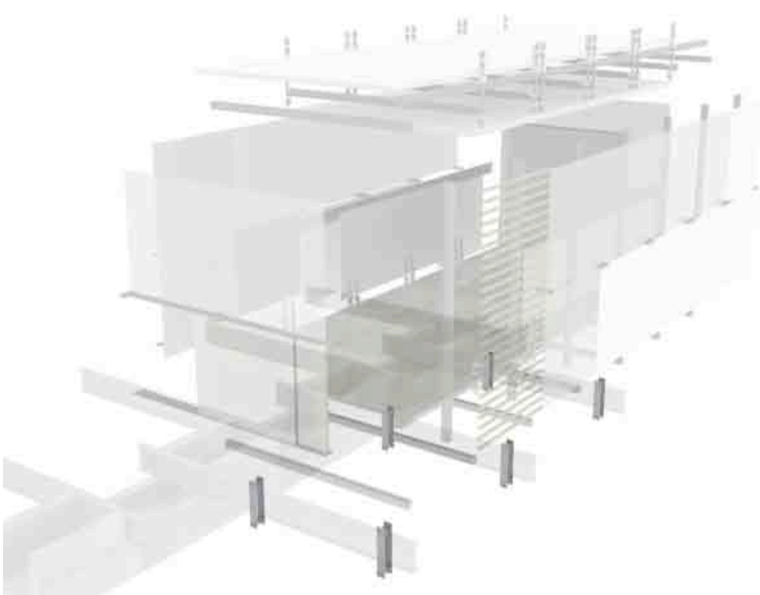


Figure 29: Individual Residential Unit - Connection to larger structure

Figure 30: Individual Residential Unit - Structure

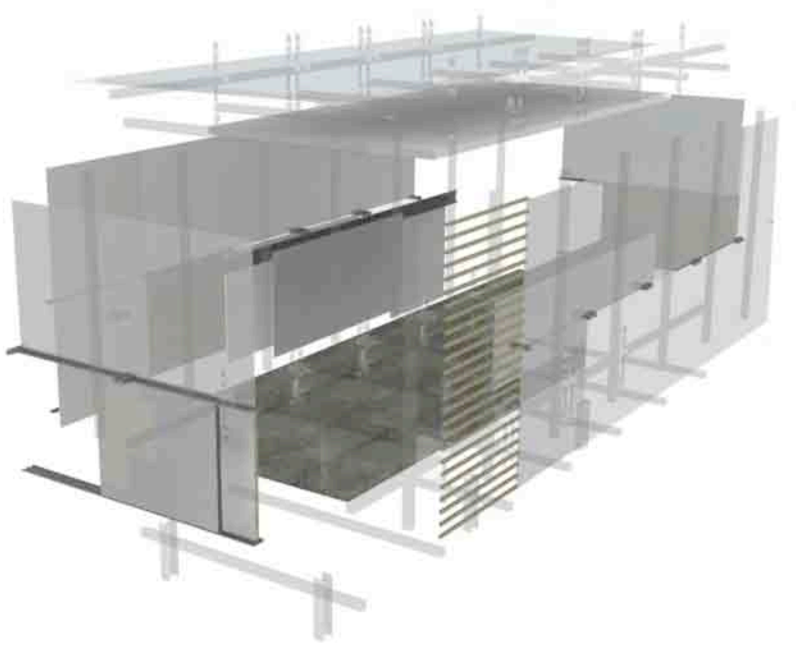


Figure 31: Individual Residential Unit – Envelope

The individual residential units utilize a structural design inspired by the structural connection of the Ise Shrine in which the connection method is a part of the manufactured

member. This eliminates the need for a secondary member and allows the parts to be easily disassembled and reassembled. These structural members are among the few custom fabricated members of the design. These steel tube members are made of steel and are designed to be recycled rather than reused after use. Therefore, these members provide the penetration through which the mechanical joints are fastened.

The mechanical joints can be unfastened and refastened to accept different envelope materials. This allows the material parts of the envelope to retain their economic value post-use.

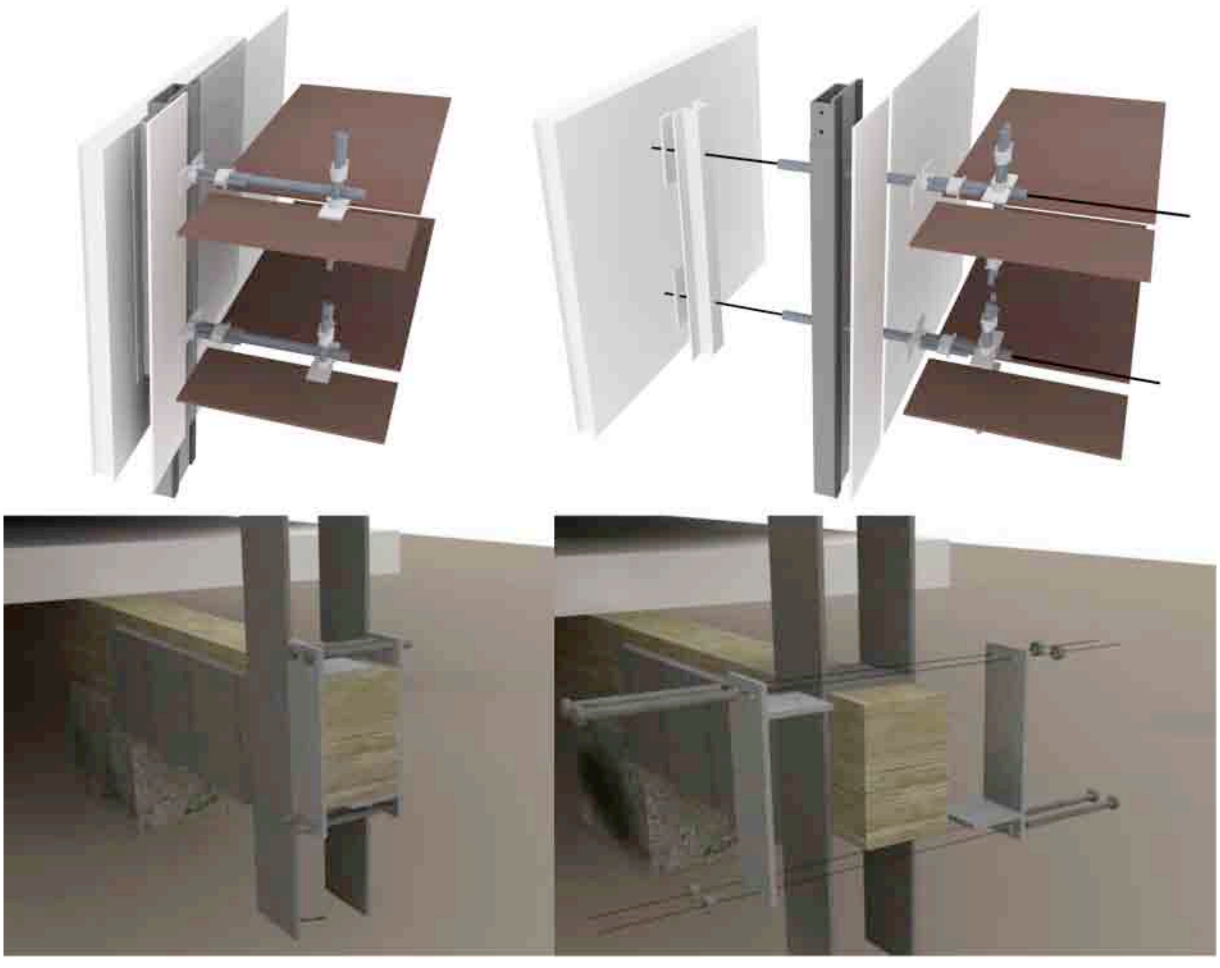


Figure 32: Conceptual Mechanical Joint

Figure 33: Detail of Railing and Porch Assembly

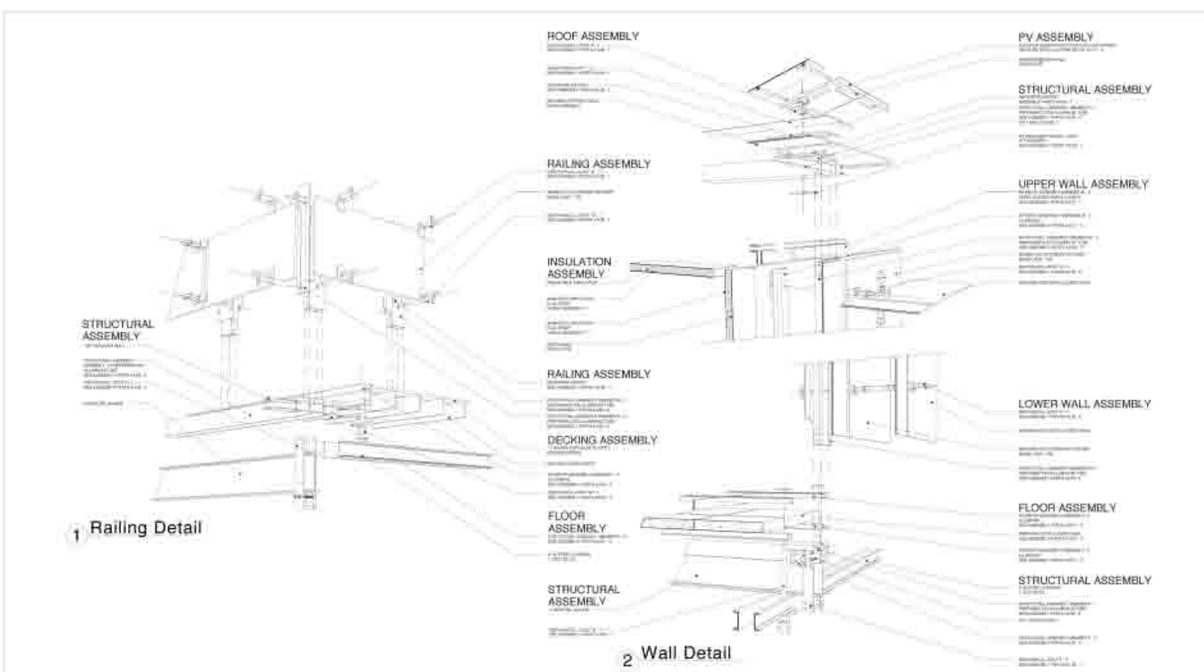


Figure 34: Assembly/Disassembly Drawings for a Typical Residential Unit

Aesthetic Principles

The major aesthetic principle of both case studies followed a simple principle: form follows necessity. The forms of the buildings are a direct reflection of the relationship between the inhabitant and the climatic environment. This form changes and shifts over time as the needs of the inhabitants change and the climatic conditions shift. Second, this understanding of the temporary nature of the architectural form is made clear in the revelation of the mechanical joint. The mechanical joint is a reusable connection that can accept new material parts. The clamp-like connection method of the mechanical joint is placed on the sides of the individual material, holding it in place without altering its size, shape or integrity. The unaltered materials can then be easily removed and reused. This treatment of the materials makes a statement both about the impermanence of the architectural form and the reusability of its material parts. The treatment of the envelope material also allows the architectural form to relate perceptually to the nest. The nest alternates between two perceptual understandings. It is both a whole object designed out of necessity and a group of material parts that retain their individuality.

The resultant whole attempts to include aspects of each of the four qualities of temporal architectural reality discussed in the precedent analysis. Historical significance in the Ise Shrine is created through the connection of individual to ceremony. The basis of this connection is the intersection of the cyclical reoccurrence of an event and the linear progression of an individual's life. The cyclical reoccurrence serves to sew together those similar events in an individual's life, allowing the structure to reassert significance to the individual at differing times in the linear progression of life. The designs for New York and New Orleans are not designed to be wholly assembled and disassembled at specific intervals. Rather, they are in a constant state of deconstruction and renovation that relates directly to the changing nature of the inhabitants.

Therefore, the form is significant to those inhabitants whose constantly fluctuating lives are reflected in the constantly fluctuating architectural form. When a couple has a child, the form is expanded to accommodate for the extra inhabitant. When an inhabitant dies, the unit can be disassembled and removed to commemorate the loss. The architectural form becomes significant to the inhabitants by actively responding to their changing needs.

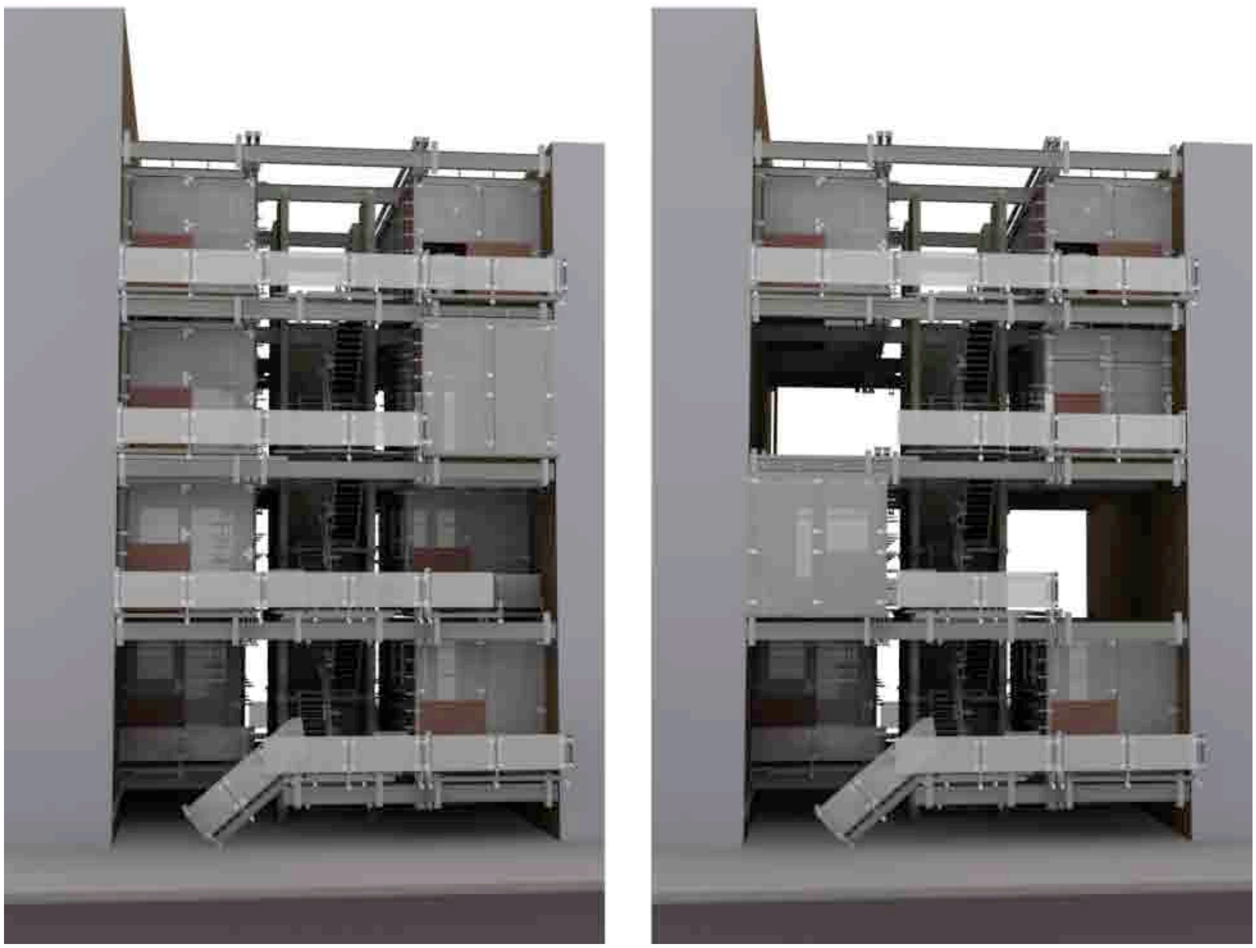


Figure 35: New York Case Study's adaptation over time

The cultural presence of the Nakagin Capsule Tower asserts an acceptance of the temporary nature of the architectural form by disconnecting the living modules and the core structure. However, a major fault of the Nakagin Capsule Tower was its inability to fully express this condition because the joint connecting the two parts was hidden. The design for the case

studies was turned inside-out to avoid this condition. The exterior facades display the mechanical joint as an ontological announcement of an acceptance of the architectural form's temporary existence.

The temporary materiality of the Loblolly Residence is revealed in the separation of the prefabricated panels. The intended effect is the realization of the temporary nature of the use of the material parts. This revelation is meant to reinforce the conception of that the materials can be removed and their current location is their final location. However, the panels of the Loblolly Residence are fully integrated with insulation, mechanical, electrical, and plumbing systems in situ. The case study designs take this one step further by separating the systems into layers and revealing the independent nature of each material part. Effectually, the severe separation of systems and individual material parts reveals the reusability of the each part and the intended flexibility of the temporary façade to accommodate differing climatic conditions.

Emptiness is obtained through the perpetual incompleteness of the architectural form. Although it has a limit, a size that it cannot extend past, it remains a constantly changing form. This incompleteness is at the heart of the design's potential success. Like a nest, it is made up of parts. Neither increasing nor decreasing the number of material parts destroys the perception of the spatial qualities of the nest. Similarly, the case study designs are not dependent upon a certain number of material parts, complete form, consistent scale or proportion to retain their perceptual qualities as inhabited spaces.

CONCLUSION

A design for deconstruction and a more sustainable future requires both a shift in building construction techniques and architectural design methods. Until the temporary nature of the architectural form becomes a primary and form-giving design principle, inhabitants, builders, and architects will continue to desire a perceived permanence, and that perception will continue to influence the design and use of the architectural form.

The case studies revealed two important factors of the influence of the conception of the nest as both an aesthetic and constructional model on the architectural design process. First, the hierarchy of decision-making in an architectural design process does not have to be essentially reversed as initially proposed. The issue of material reusability and recycling does need to be at the forefront of the actual design, but it does not necessarily have to be the initial conceptual principle. The main difference is that the architectural form cannot be considered as static. The design of typical constructions begins with form. This form remains static throughout the intended lifespan of the building. Renovations, component and material replacements, structural reinforcement, and all other changes are meant to happen inside the shell of the originally conceived form. The form eventually degrades as a result of the inevitable decomposition of its material constituents. As it is constructed and was conceived of as a singular form or object, it is typically demolished as a singular object.

The conceptual basis of a dynamic form requires a non-form related conceptual basis. The form must instead become a frame. The frame retains its value longer than the form. In many renovations, the envelope materials are removed while the frame is reused. Its ability to be reused by attaching different materials allows flexibility and resultantly, the durability of use.

Some recent constructions, as a result of a sustainable movement in architecture, have been built with more disassembly-ready construction methods. On the surface, these works seem

to be in line with recent trends aimed at eventual deconstruction and recycling as an alternative to demolition. Kieran Timberlake's Loblolly House is among recent architectural projects built in this fashion. The Loblolly House is constructed of prefabricated "subassemblies" (Kieran 52) that are designed as wholly integrated panels. In their recent book, *Refabricating Architecture*, the architects refer to the system of designing in subassemblies as analogous to the manufacturing methods of modern cars. The car is still being seen as the basis for the design and manufacturing of progressive architectural projects. The Loblolly Residence is still based on LeCorbusier's argument that residential construction methods should be based on the manufacturing and assembly methods of the automobile.

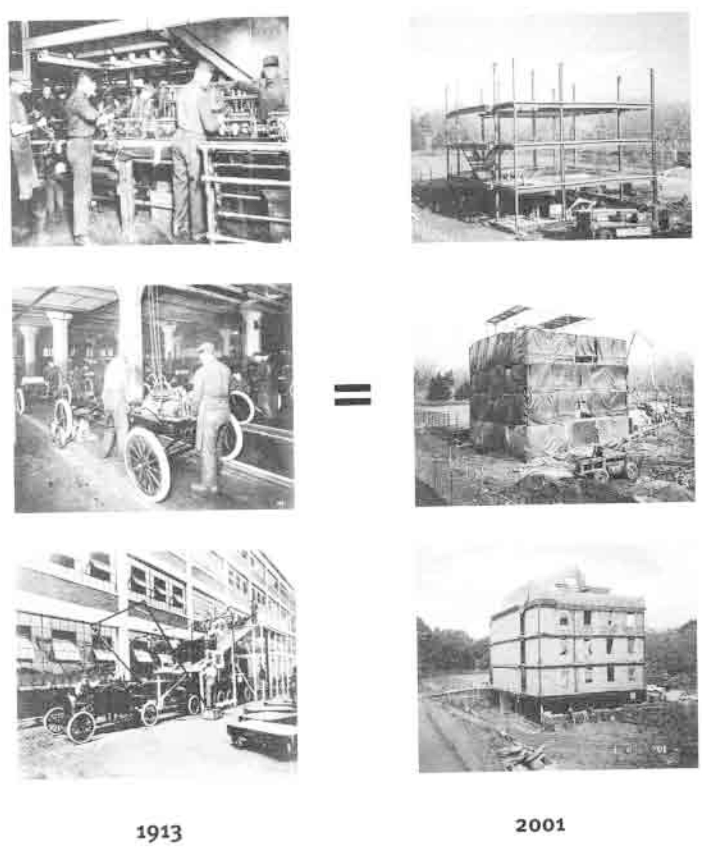


Figure 36: Ford Assembly Method and Typical Construction Method
From Kieran Timberlake's *Refabricating Architecture*

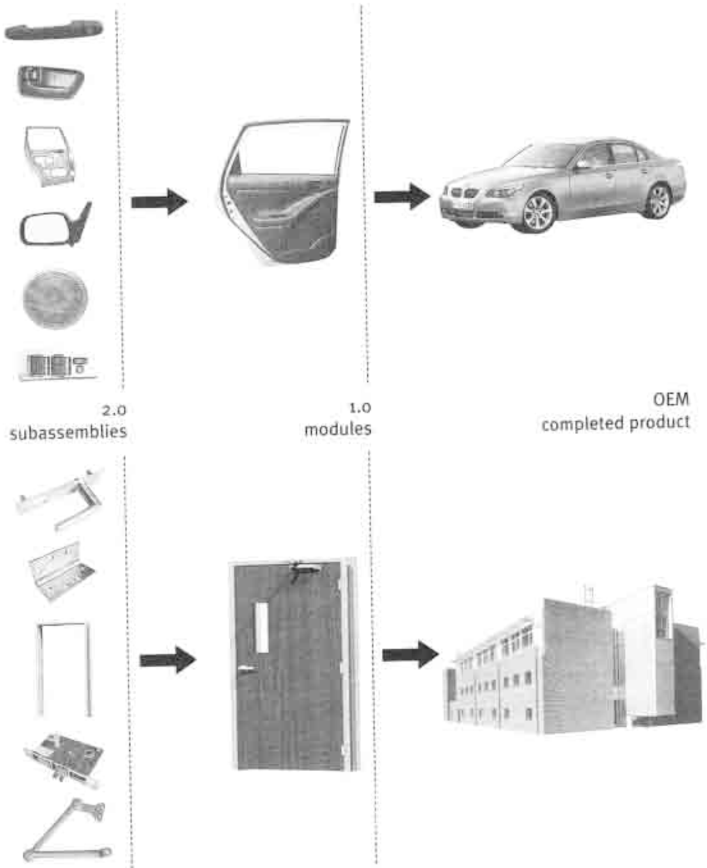


Figure 37: Kieran Timberlake's Example of the Assembly Method of a modern car and a modern building
from Kieran Timberlake's *Refabricating Architecture*

Also, this conception of the architectural form as a dynamic object provides it with the true machine-like quality that Le Corbusier sought. Le Corbusier's "House-Machine" was based on the aesthetic and assembly method of the car. Kieren Timberlake's Loblolly Residence was based on the assembly method of the modern car. However, the car still expresses a façade of finality and completeness. The outer shell of the car hides the mechanisms and the joints. The modern car and, consequently, the modern house are pre-packaged as complete objects. This conception still does not reveal the nature of the built construction as a temporary assembly of

material parts. The conception of the house as a "machine for living" is a legitimate conception of the aesthetic and assembly of the modern American house, but the car is the wrong machine.

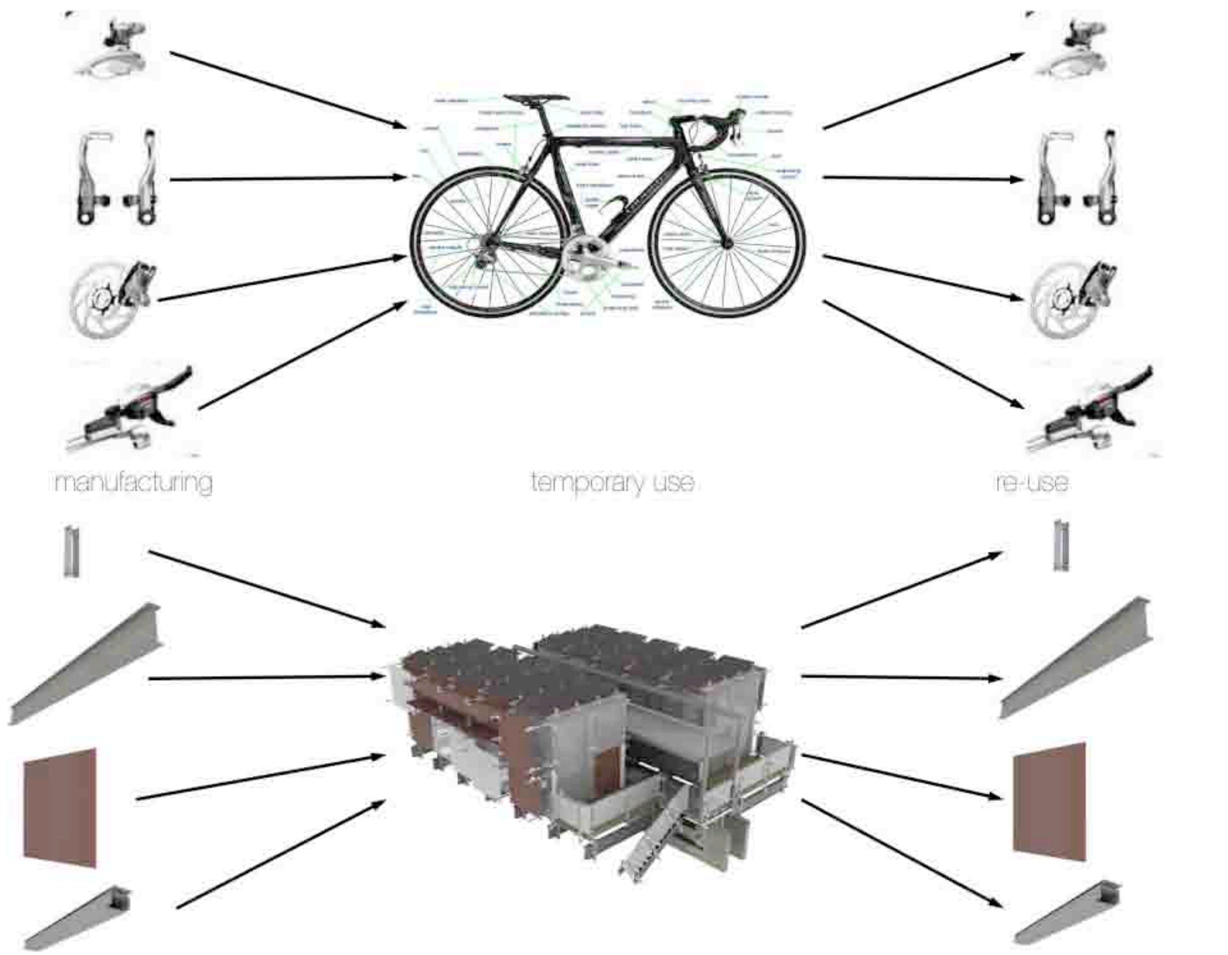


Figure 38: Assembly and Disassembly Method of a modern bicycle and the Proposed Assembly and Disassembly Method

The dynamic "House-Machine" is a bicycle. The bicycle does not have the automobile's sense of pre-packaged completion. It relies on the aesthetic of its mechanisms. Its mechanical joints are simple, accessible and direct. There is a direct ontological connection between its aesthetic expression and its intended use. If the car and the Modern construction utilized the principle that "form follows function", then the bicycle and the dynamic form utilize a more

direct principle: form follows necessity. The bicycle is merely a combination of parts formed in a very specific way to facilitate a human necessity. The house should follow this same principle. The house should be a direct reflection of the human necessity for mediation between the external environment and the inhabitant's need.

The conception of a permanent and singular form as a method of architectural design is not conducive to sustainable resource and material protection. Unless a new and dynamic architectural form replaces this conception, sustainability will not work.

If design evolution does not compel change, then tomorrow is our temporary address.

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VITA

James Legeai was born in 1985 in Baton Rouge, Louisiana. He spent the majority of his youth in Orlando, Florida, where his father worked as a paint salesman and his mother worked as a school nurse and later administrator before retiring for health reasons. He has one older sister, a younger brother and a younger sister.

After graduating high school, he attended Florida State University for two years pursuing a degree in art history before transferring to the architecture program at Florida A&M University. He acquired his Bachelor of Science in architecture in the spring of 2009, enrolling in Louisiana State University's Master of Architecture program beginning in the subsequent fall semester. He had become interested in ecologically responsible architecture during his undergraduate degree and decided to investigate material and resource conservation and recycling efforts for his master's thesis.

He believes that ecological responsibility in architecture will only become an effective model when it becomes a basis for architectural design principles. Without becoming an indelibly linked aspect of architectural design, ecological responsibility will not create a long-lasting effect on architectural practice.