The Building That Learns to Fish: Architecture, Peak Oil, and the Need for Adaptability

THE BUILDING THAT LEARNS TO FISH

ARCHITECTURE, PEAK OIL, AND THE NEED FOR ADAPTABILITY

A Thesis Presented

by

JUSTIN MICHAEL PELLAND

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Approved as to style and content by:

_____

Sigrid Miller-Pollin, Chair

_____

Alexander Schreyer, Member

_____

Kathleen Lugosch, Member

_____

Kathleen Lugosch
Graduate Program Director
Architecture+Design Program
Department of Art, Architecture,
and Art History

_____

William T. Oedel
Chair, Department of Art, Architecture,
and Art History

ABSTRACT

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MAY 2012

JUSTIN MICHAEL PELLAND, B.A., UNIVERSITY OF MASSACHUSETTS AMHERST

M.ARCH, UNIVERSITY OF MASSACHUSETTS AMHERST

Directed by: Kathleen Lugosch

Oil is a finite resource; This much has been established as fact and is commonly agreed upon. We will, some day, find our supplies depleted. The question that remains hotly debated, however, is when this will happen and what impacts it will have on our modern lives. Estimates and forecasts abound, but still no one can answer these questions definitively. As fossil fuels, the energy behind virtually every aspect of our lives, become scarce, our patterns of growth will face a reckoning. We will be forced to adapt and adjust; either shifting our energy demand to more renewable sources, or reducing it by significant amounts. Although there are a plethora of what-if scenarios when predicting the effects of an end to oil, it's easy to recognize that the peak oil crisis will significantly impact our lives. It will change how we live them and, by extension, where and how we construct our buildings. So what does this mean for buildings - one of the country's largest consumers of energy? This thesis proposes that a theory of adaptability, when applied properly to the design and construction process, can begin to equip our building to handle the range of possible outcomes that an energy-poor future poses.

This thesis also aims to address, in the broadest of terms, how our current approach to design could lead to significant issues in a post-oil, energy hungry world. It does so by encouraging a more holistic approach to problem solving and building design, while outlining how the values of cost efficiency and speed have polarized global construction techniques.

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CHAPTER I

A HOLISTIC APPROACH TO THINKING

Energy is a touchy subject. For the last hundred and fifty years or more, Americans have been virtually addicted to petroleum with no real thought towards the nature of their consumption. Many in today's society take for granted the depth with which oil has infiltrated our lives. When reflecting on their personal oil consumption, many Americans would likely identify gasoline or home heating as their individual energy portfolio, but the truth remains hidden for many. Most people, by now, recognize that our consumption patterns are unsustainable, though for many, the connection between these consumption patterns and their personal lifestyles remains unseen. In many ways, oil is the taboo drug of the modern era, but what happens when the supply runs short? Like all drugs, we're likely to suffer withdrawals when we can't get our fix. That's not to say that the centuries old relationship we've fostered with energy is one of gluttony and sin, however. Since the birth of invention itself, humans have relied on various forms of energy for survival. The first fire, discovered by primitive man, used a common form of energy for warmth and cooking. The wood that fueled these fires, much like oil, needed to be harvested and burnt in order to release its stored energy; energy that was then used to cook food - food that was then consumed to create body heat. Every living thing relies on some form of energy to survive. Whether it's food, sunlight, or extracted fuel, all organisms consume. Energy is at the very heart of life, and it's important to recognize that it exists in many forms and occupies a complex network through which it travels. Wood, oil, gas, food, body fat - it's all energy.

Hundreds of thousands of years after the first human cooked over a hearth, our relationship with energy has remained unchanged. We harvest fuel and we consume it. Perhaps the only real difference is in the source of our energy and the efficiency with which we've learned to wield it. There is one fact about energy that is often overlooked, however- it all comes from the same place. Looking at things with a broadened perspective can reveal hidden relationships that would otherwise have gone unnoticed. This is called holistic thinking, and it requires the individual to think beyond themselves - beyond the here and now - in order to see the nature of the systems at work. The food we eat, the wood we burn, the oil we combust; like a complicated family tree, all of these sources of energy can trace their heritage back to a single source when you step back far enough to see it.

If we zoom out to the stellar scale, we can look down on ourselves with a rational lens and begin to understand the nature of our existence all the better. Within our solar system, Earth is unique in its ability to host life. We float around inside the vacuum of space on our independent, isolated rock in what seems to be the most ideal location with the most ideal conditions to support life.* The earth, like many of the organisms on it, is a system in itself; a machine full of moving parts hurling its way through the cosmos. Like cells, humans, cities, and so on, the earth is a closed system and requires energy to sustain its functions, but that energy has to come from somewhere. So how did all this life start? Where did we come from if our surroundings are so desolate and barren? This closed system we call home needed a kickstart from an external source. Take a step back, and it

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* This is referred to as the Goldilocks Zone. Our planet orbits at the perfect distance from the sun to support liquid water. Any closer, and it would boil off. Any further away and it would freeze. Earth has found the orbit that's 'just right'.

becomes apparent that the the only source of energy input into a closed system like Earth's is the sun. The sun is at the heart of everything that makes this planet habitable. Everything. Whether we're burning wood, burning coal, burning calories, or even capturing wind energy*, the original source of all energy can be traced back to the sun.

Now try tracing your own energy to its roots. It takes energy to grow cells, to run, it even takes energy to eat food. Humans are complicated systems within themselves. Think of the human body like you would think of the Earth; take a step back from yourself and view your body as the same complicated machine- a closed system with an external source of energy input. In our case, that energy comes in the form of food. A hamburger, when digested, is broken down and converted into calories - a form of energy that our bodies use for everything from movement to cell growth. Take a step back again. To grow that meat, the cow (also a closed system in itself) needed its own external form of energy input, namely grass. The grass, at the base of the food chain, derived its energy input directly from the sun.

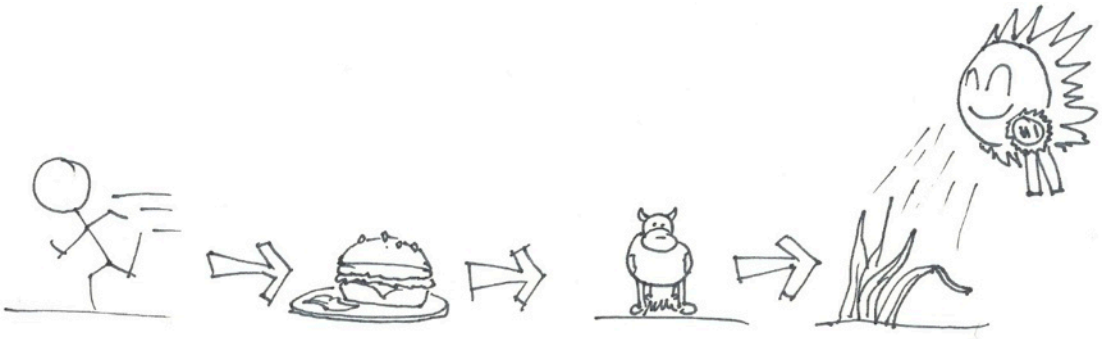

Figure 1: Tracing energy to its source.

* Wind is actually the product of a complicated process in which the sun's radiant energy is transferred through the atmosphere and converted into a kinetic force.

Even the meteorological systems that brought rain water to the grass are a product of solar input. Thus, if we follow the trail back through our energy - from system to subsequent system - we find that every calorie we burn is the product of energy from the sun. With only a few exceptions*, all sources of energy can trace their roots back to this powerhouse in the sky.

So why is this important for a discussion on peak oil? Any time we talk about energy, it's important to recognize that the conversation is always much larger than it would appear. Understanding the context of a particular problem is important in understanding its impacts. Shortsighted lines of thinking allow us to ignore the complex nature of a particular problem and prevents us from adequately developing a solution. Reliance on information gathered by a shortsighted analysis of a problem almost always produces the right answers to the wrong questions.

In order to contribute positively to the discussion on energy, we need a more expansive understanding of it. Recognizing that oil is a complex material with a complex trail to its roots is the first step toward a new method of thinking. A holistic approach to thinking is one where the problem is never taken at face value. All aspects are explored in depth in an attempt to truly understand the nature of the problem, especially when faced with such an uncertain energy future. What we assume is an energy issue, may not have an energy solution at all. As architect and planner Peter Calthorpe says:

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* Tidal energy, for example, is derived from the physical movement of ocean waters as a direct result of the moon's gravitational tug on the earth and is not a direct result of the sun's input to the system.

> "It's more important to rest the alternative strategies on the multiplicity of implications rather than trying to be reductionist here and say 'this is an energy issue.'"[*]

There's no doubt that our consumption of oil is creating a serious problem for our nation and for the world. By applying a holistic approach to thinking, we can begin to discover solutions that otherwise would have seemed entirely unrelated. Who knows? Maybe the answer isn't to reduce demand or develop alternatives. Maybe planting a particular strain of algae will do the trick. How could algae solve the peak oil problem? Maybe it couldn't. Or maybe there's some unseen connection. The point is, we'll never know unless we start understanding the problem broadly enough to find out. Holistic thinking isn't just about developing the best solution, it's about developing the solution no one managed to think of. Through understanding, we can find discovery. The first step in tackling the peak oil problem will be to thoroughly understand it and its implications.

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[*] Greene, Gregory, Barry Silverthorn, and Barrie Zwicker. *The End of Suburbia: Oil Depletion and the Collapse of the American Dream*. Toronto: Electric Wallpaper Co, 2004. Film.

CHAPTER II

THE PEAK OIL PROBLEM

Peak oil is commonly described as the point at which the rate of oil consumption exceeds the rate of its production. Globally, oil is produced and consumed on a massive scale and unsurprisingly, America is the world's largest consumer. The United States consumes 18.7 million barrels of oil per day. A close second, the European Union consumes 13.6 million barrels per day. China, which still relies heavily on coal as an energy source, places third at a consumption rate of 8.2 million barrels of oil per day.* Each of these three countries is grappling with massive oil consumption rates, but furthermore, none of them are producing anywhere near the amount their consuming. In fact, the United States and China produce less than half of the oil they consume and the European Union produces less than 15 percent. So how do we know when a country's oil production has peaked?

Let's say a hypothetical country had 200 billion barrels of oil sitting in fields underground. That country builds an oil infrastructure to extract the oil and uses it to power its economy. Currently, they're extracting it at a rate of about 1 billion barrels per year. As consumption rises, this number is forced to rise as well. As a result, the oil companies must extract some number of million barrels more than they did the previous year. Over many years of production, supply continues to meet demand. Eventually this

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* This data was estimated in 2009 and posted to the CIA's World Factbook Library. Unfortunately, the rate of consumption is always increasing, so data like this typically obsolesces within the year it's released. (https://www.cia.gov/library/publications/the-world-factbook/index.html)

country would have pumped 100 billion of its 200 billion barrels of oil from the ground. The tricky part is that the remaining 100 billion barrels are much harder to extract (naturally, we've pumped the easiest barrels first to garnish the most profit). So with the oil proving significantly more difficult to extract, maintaining a supply for the demand becomes a much more expensive process. Now, instead of drilling simple wells, this country is forced to move their facilities off shore to begin tapping the oil fields that lie deep beneath the ocean. This new form of exploratory drilling costs more money and has incredibly high risk. The price of oil increases respectively.

Despite the increased cost of production, the country is still producing plenty of oil. The cost to the consumers has risen, but technology has improved slightly, so it's still possible to produce what's required at an affordable rate. But every year that passes, the process gets more and more difficult and more and more expensive. Year after year passes, but no matter what they do, they can't seem to find new oil or develop new technologies fast enough to continue extracting the tough to find oil from the hard to reach places. They can no longer produce oil at a fast enough rate and affordable enough price to keep meeting demand in the traditional fashion, so the country's oil production plateaus. They're stuck producing 3 billion barrels a year while demand continues to rise.

Eventually, the cost of extracting this oil gets so high that to do so would mean selling the crude at a price that no one would ever pay for it. Other countries are still producing plenty of oil at reasonable prices, so there comes a point where it becomes much more expensive to produce the oil domestically than it would be to import it with excessive tariffs and levies. When a country reaches the point where it's producing at the

highest rate than it ever has or ever will again, it is generally considered to have peaked. Peak oil is not necessarily correlated to the specific quantity of oil remaining, though that may be a factor; it has everything to do with the global market, the cost of extraction, and demand.

Following the peak of oil, the common belief is that production will plateau. Oil is an exploratory industry, meaning that you have to find it in order to produce it. Once we've found the majority of all available oil*, there will be a period where that oil is extracted and produced at a fairly steady rate. Following that, discoveries of new oil will be fewer and father between. Regardless of technological innovation, oil production will eventually reach a point when maximum rate of discovery and extraction begins to determine the maximum amount of production. Peak countries are forced to import oil from other countries that can still manage to produce a surplus.

A generalized graph shows the relationship of oil production as it relates to the maximum extraction rate. Technological advances allow production rates to meet demand, but as oil becomes harder to find, extraction rates become the limiting factor.

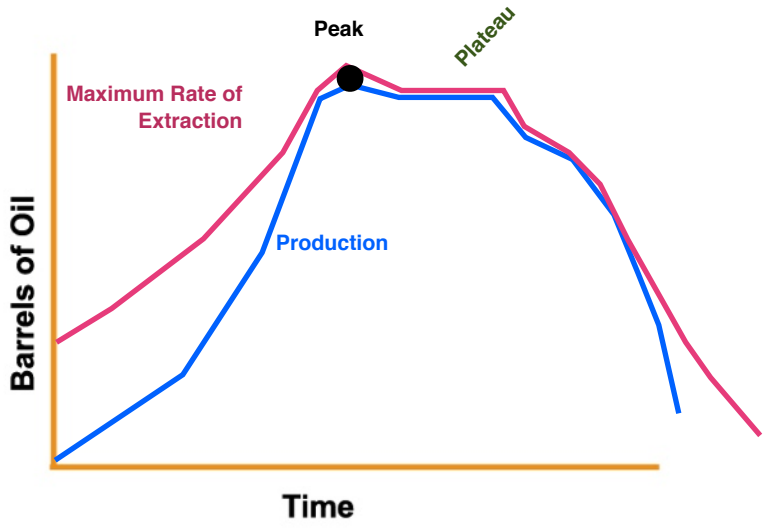

Figure 2: Oil production and extraction over time

* Many scientists believe we already have.

Although this scenario seems dramatic on a domestic scale, the world is able to maintain a balance. For countries who are no longer able to produce enough oil to meet their demand, there are other countries able to produce more than they need. This relationship can be kept balanced so long as political relationships remain tepid and global production rates maintain their ability to meet demand. The domestic peak model, however, also applies to the global market. When the entire world's rate of production can no longer match the cumulative rate of its consumption, even when extraction rates are pushed to their maximum, global oil will have peaked. This is what makes Peak Oil such a global concern. Where most developed economies rely on the availability of an inexpensive energy source, the idea of peak oil is almost terrifying. This may be why peak oil, as a theory, was long believed to be a myth; a clear case of denial.

The concept of peak oil dates back to 1956 when Marion Hubbert, a geophysicist with Shell Oil Company, theorized that oil production in any region would follow a bell shaped curve. Using some very complicated equations and recorded data on existing oil field trends, Hubbert was able to develop a process for calculating when a particular country's oil production was most likely to peak, though at the time, no one in the energy community believed that any one man could calculate a peak with any amount of accuracy.

Using his formula, Hubbert predicted that oil production in the United States would see its peak in the early 1970s. Although the energy community at the time found his hypothesis laughable, United States' oil production peaked in 1970 as predicted,

leading to an increased dependency on foreign imports. For the first time in its history, the United States was importing more oil than it was producing domestically.

In order to keep up with exponentially increasing demand and declining rates of production, the United States increased its dependence on foreign oil. Imports grew rapidly - until political tensions rose between the oil producing countries and the western world. immediately following our new found reliance on foreign oil, the major oil producing countries placed an embargo on oil trade and the issues with heavy reliance on foreign oil were finally realized. Hubbert, having proven that he correctly predicted the United States' oil peak, was vindicated and his reputation restored. Industry specialists everywhere recognized the value of his work and his is now the predominant method for calculating Peak Oil.*

The Hubbert Curve, as it's called, can also be used to analyze global oil production in much the same way it was used on a national scale. According to some professionals, the peak of global oil production has already happened. Timothy Beatley explains:

> "Global oil production has followed the bell-shaped Hubbert curve (apart from reductions due to the three oil crises of 1973, 1979, and 1991), and was on an upward trend until 2005. Since 2006, oil production has plateaued despite there being increased demand of around 2 to 3 percent

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* Newman, Peter, Beatley, Timothy, and Boyer, Heather. *Resilient Cities: Responding to Peak Oil and Climate Change*. Washington, DC: Island Press, 2009. Print. (p19-20)

(mainly due to China and India, though together they still only take 12 percent of the world oil production while the U.S. takes 26 percent)." *

Beatley believes this is an indication that global oil production has peaked and we are quickly approaching the decline of the plateau but, like all problems that threaten the status quo, peak oil has its defenders and its naysayers alike. Theories about what will happen to society when oil runs out abound, but what does peak oil really mean over the long run? Daniel Lerch, of the Post Carbon Institute, says: "

> 'Doomsayers' on one side warn of imminent mass shortages and the ensuing collapse of the global economic system. 'Cornucopians' on the other side say not to worry, because corporations and investors will automatically respond to higher oil prices with investments in exploration and technologies, quickly bringing supplies up and prices down." †

Whichever side you find yourself on, there is always one agreed upon fact - oil is finite; it will run out eventually. It's not a question of if, but of when.

If we trace the energy within oil back to its roots in the same manner as we traced the energy in a hamburger, we discover that oil, like everything else, has its roots in the sun. If we begin to apply a holistic approach to thinking to oil, we find that the substance

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* Newman, Peter, Beatley, Timothy, and Boyer, Heather. *Resilient Cities: Responding to Peak Oil and Climate Change*. Washington, DC: Island Press, 2009. Print. (p20)

† Lerch, Daniel. *Post Carbon Cities: Planning for Energy and Climate Uncertainty*. Sebastopol, Calif: Post Carbon Inst, 2007. Print.

is almost as rare to our planet as life is to our solar system. C.J. Campbell, trustee of the Oil Depletion Analysis Centre* and former oil industry geologist explains:

> "Oil comes from algal material... It transpires that the great bulk of the world's oil comes from only a small number of periods of extreme global warming, when seas and lakes became poisoned by excessive algal blooms. The soft remains of these organisms sank to the floors of the seas and lakes in which they lived. In many cases, they were oxidized by currents or consumed by bottom-living organisms, but where they fell into stagnant troughs, commonly formed by rifts as the geological plates moved apart, they were preserved and later buried beneath younger sediments. The two last epochs of prolific generation occurred about 90 million years ago, giving the huge deposits of the Caribbean borderlands, and 145 million years ago, giving those of the Middle East, North Sea and much of Russia." †

This is at the heart of one of the largest problems with oil as an energy source; namely that it is non-renewable. An energy source like oil, which is produced over extremely long periods of time and only under very select conditions, cannot be created, either naturally or artificially, fast enough to replace the current supplies. Regardless of how advanced our drilling technology becomes, there will come a point when it will simply be impossible to extract. When the oil's gone, it's gone.

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* "ODAC - The Oil Depletion Analysis Centre." *ODAC - The Oil Depletion Analysis Centre*. Web. 1 May 2011. <http://www.odac-info.org/about-odac>.

† Campbell, C J. "*The Peak of Oil: An Economic and Political Turning Point for the World*." *Making Urban Transport Sustainable*. (2003): 42-66. Print. (p43)

Given that it's impossible to state the exact quantity of undiscovered oil under the Earth's crust, it is impossible to identify a specific date when global oil production will peak. New discoveries are being made off shore and some are even being discovered in the ocean beneath the recently melted polar ice sheets. We can, however, take what we know and begin to extrapolate much in the way Hubbert did in the mid twentieth century. Because of the uncertainty involved, many professionals are now opting for the phrase 'world oil is peaking' rather than precisely positioning a peak date,[*] but conservative estimates from government sources in the United States and the United Kingdom suggest that the global oil peak will occur sometime between 2010 and 2020.[†] With that information, it's safe to say that the peak of oil will take place inside of a generation, for sure, making the need for a peak oil solution one of humanities most pressing matters.

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[*] Campbell, C J. "*The Peak of Oil: An Economic and Political Turning Point for the World*." *Making Urban Transport Sustainable*. (2003): 42-66. Print. (p43)

[†] Newman, Peter, Beatley, Timothy, and Boyer, Heather. *Resilient Cities: Responding to Peak Oil and Climate Change*. Washington, DC: Island Press, 2009. Print. (p12)

CHAPTER III

SOCIAL, PHYSICAL, AND POLITICAL RAMIFICATIONS

We know the end of oil is imminent, but many believe technology will save us. So what's the big deal? We're developing better electric cars, more efficient solar panels, and alternatives that make peak oil a non-issue, right? Not entirely. Most people are unaware how much their every day lives might be affected by the peak of oil production. Our lives are practically run on oil. The industries that employ us, the food that feeds us, the products that convenience us; almost all of it comes, in some part, from oil. The chart below shows the energy use by source of some of the largest energy consuming industries in America.

Table 1: Sources of energy by industry *

Sources	**Uses**				
	Transport	Agriculture	Residential	Commercial	Industry
Oil	97%	96%	12%	9%	12%
Gas	2%	-	43%	36%	40%
Coal	-	3%	-	1%	10%
Electricity	1%	-	42%	53%	27%
Other	-	-	4%	1%	11%

* Adapted from tables/charts provided by-
Lerch, Daniel. *Post Carbon Cities: Planning for Energy and Climate Uncertainty*. Sebastopol, Calif: Post Carbon Inst, 2007. Print.

Table 1 clearly shows that oil plays a large role in transportation and agricultural industries, but it's the effect on unseen uses of oil that will likely surprise many americans. By the close of the 20th Century, Oil had embedded itself deep within our economy, our political system, and our lives. Much of our country's infrastructure was designed on the premise of cheap, plentiful oil. But when oil is refined, transportation fuel is only one of a dozen products that refineries produced. Oil is used to create gasoline, jet fuel, and diesel, but it's also used in the production of everything from plastics to pharmaceuticals and plays a role in the production and distribution of just about every product in between. A 1956 cartoon produced by the American Petroleum Institute titled Destination Earth takes us on a journey across galaxies following an alien as he attempts to uncover the secret behind earth's incredible system of personal transportation. At the heart of it all, he discovers, is this magical material called Petroleum. The alien narrates:

> "Once they get oil out of the ground, it has to be moved... to fantastic processing plants called refineries. Crude oil goes in, and GREAT JUPITER the things that come out. Gasoline, for example - the most efficient moto-power source on earth - and asphalt, which makes smooth durable roads. It seems oil not only RUNS cars, it gives them something to run ON. Another

Figure 3: Destination Earth

> From refineries also come the lubricating oils and greases that keep those wheels turning in America. But that still isn't all. Crude oil, like everything else, is made up of billions of tiny molecules, and using the magic of research, oil companies compete with each other in taking the petroleum molecule apart and rearranging it into... well you name it. Fabric, tooth brushes, tires, insecticides, cosmetics, weed killers, a whole galaxy of things to make life better on earth." *

Although it's often given a negative image, oil has done humanity a lot of good. Despite the clear vested interest the American Petroleum Institute had in the making of this film, their claims are truthful. In fact, were it not for the availability of oil as a cheap energy source, many of the industries that constitute the backbone of our modern economies would not exist, advances in modern medicine and health care would have never been made, computer technologies would likely never have revolutionized modern communications, and we'd likely never have moved beyond hand crafts and manual labor economies. Employing oil as a cheap and abundant energy resource and converting it into gasoline and other fuels, we were able to figuratively shorten the distance between towns, cities, and other countries allowing for the world's societies to benefit from the global trade of ingenuity and invention. Oil allowed us to build the Hoover Dam, to pave Route 66, and to travel to the moon. In the development of power equipment, it allowed us to farm more land, feed more people, and reduce the need for manual labor. In short, it made

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* This short, 14 minute video is worth watching for anyone who enjoys the good old propaganda made in the cartoon format children enjoy so much.

(http://www.archive.org/details/Destinat1956)

life better. These advancements, however, not only use oil in their development, they require it in ever increasing amounts in order to maintain the lifestyles we've come to enjoy. With cheap oil as our aid, we've made some very permanent changes to the way we live, where we live, and what we live in. Many of these changes earned the stamp of progress, but won't be very easily undone when oil becomes markedly unaffordable.

As oil peaks and supplies begin to diminish, the price of crude oil will rise; gradually at first, but more dramatically as time goes on. All of the modern conveniences and products that rely on this cheap energy for their production and distribution will find their prices rising in kind. As the cost of finding and extracting the oil grows, so to will the cost of these products to the consumer. For some low income families, a minor increase in the cost of oil could mean the difference between making ends meet and crossing the line into poverty.

When this happens, the most obvious social impact will be on the consumer's ability to afford gasoline. Gasoline, since the release of the Ford Model T, has been the lifeblood of the American economy. It has allowed for the proliferation of personal automobile ownership and supported the consumerist culture we've grown to so accustomed to. More importantly, it's been the motivation behind the development of our country's infrastructure, which is almost entirely geared towards the automobile. Although roughly fifty percent of the world's population now live in urban communities, there are still vast numbers of people living well over 20 or 30 miles from where they work. As cities become increasingly more desirable places to live, they also begin to host some of the largest pools of jobs and in some American cities, this is already the case. In

Boston, for example, an employee making a lower middle class wage essentially has two choices: live in expensive, cramped quarters within city limits, or relocate outside of the city and deal with the hassle of commuting. For many people, the expense of city life is the toughest hurdle to overcome and what you often see is the people who can afford it end up living closest to where the jobs are. With that kind of demand, the real estate prices reflect the desirability of the Greater Boston Area. In effect, the rich moving inward and the poor opting for long commutes creates what might be called a Wealth Belt; a zone in which the wealthiest people live in the most desirable location in or just outside the urban center. In Boston, the first wealth belt includes communities like Needham, Newton, Wellesley, Dedham, Lexington, Woburn, Reading, and Cambridge.

This map is a depiction of the Wealth Belt condition. This map is generalized. Obviously, some poor communities exist within the wealth belts while some wealthy communities exist within the affordable region.

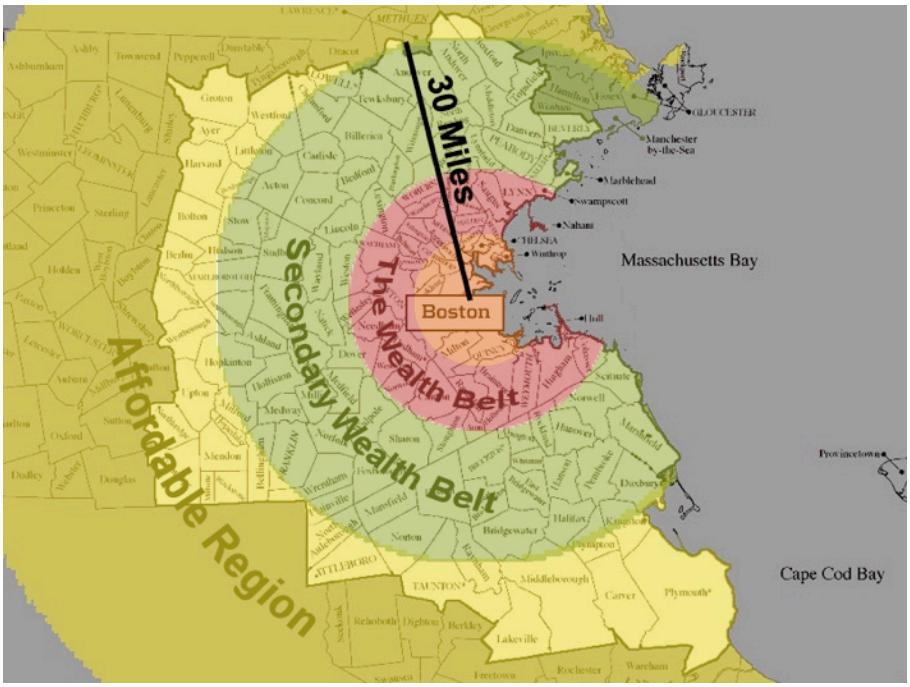

Figure 4: The Wealth Belts

Those who can't afford the Wealth Belt or find suitable (or suitably safe) housing within the city are forced to look beyond it. This creates a secondary wealth belt. An area

just outside the most desirable communities that is still within a reasonable commuting distance. Often, access to public transportation increases the desirability of these communities. In Boston's case these might include Concord, Carlisle, Bedford, Andover, and Lexington. The pattern continues and people keep moving outward until they reach a community that their salary can support at a distance they can manage to commute.

The areas surrounding the primary and secondary wealth belts are full of blue and white collar workers, a high percentage of whom commute 30 miles or more into Boston five days per week. As oil runs short, these people will be the first to feel the effects of increasing gasoline prices. Driving 30 miles each way every day could run a family upwards of $150 per month at $3 per gallon gasoline. As oil prices rise, and gasoline prices reach upwards of $10 per gallon or higher, that low wage worker has to sacrifice nearly $500 per month to keep commuting to their job. When you're only making a one to two thousand dollars per month, this becomes an excessive burden. Here we can start to see the gap between the rich and the poor grow.

The 1973 energy crisis gave Americans a taste of what a post-peak world might be like; and what a bad taste it was. Lines formed at the gas pumps and employees everywhere had to scrimp and save just so they could afford to get to work. Unfortunately, when the embargo was lifted, we cleansed our pallets and went on our merry way, consuming as if nothing had happened. What could have been a lesson, was forgotten on almost everyone. Missing an opportunity for what could have been the most important learning experience of a generation, we reinstated our ignorance while technology and research inspired by the crisis fell by the wayside. Projects aimed at

developing electric cars and energy efficient houses, for some reason, lost their steam.[*] This pattern of denial continued until 2008, when high gas prices took to the stage again. Decreases in the expected supply led to oil prices nearing $147 per barrel.[†] This resulted in price increases of U.S. gasoline to records over $4 per gallon. Suddenly the Toyota Prius, which was often mocked as being a hippie, yuppie car, gained a previously unknown level of prestige. Americans everywhere were learning to love their hybrids. In fact, hybrid cars become so popular - so marketable - that auto manufacturers began producing all their best selling models in hybrid form. Ford, GM, Toyota, Honda - They all jumped on the band wagon in this race for the best hybrid. We even began to see hybrid trucks. That's right. Instead of the unforgivable six miles per gallon these beasts used to get, they now commanded a "respectable" twelve mpg. For all their fame and popularity, however, there was one catch to this new wave of hybrid cars- you had to be able to afford one to benefit from their gas savings, effectively leaving the lower class to rot in their rusted out Hyundais.

Christopher Steiner, an author for Forbes Magazine, recognizes that as gasoline prices rise, the divide between the rich and the poor will grow. Primarily with regard to transportation, Steiner predicts that the increased cost of transportation fuel will drive those who can afford it to invest in alternatives like electric cars. These types of vehicles will be in demand because they allow us to maintain the status quo and transition to more sustainable lifestyles. The social divide, however, lies in the ability to afford these

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[*] It's theorized by some, with an overwhelming lack of evidence, that the electric car was a viable solution in the late 1970s and 80s but was inevitably sabotaged by the oil companies and oil company lobbyists in an attempt maintain the hold they had over American wallets.

[†] Hopkins, Kathryn. *Fuel prices: Iran missile launches send oil to $147 a barrel record*. The Guardian. Saturday 12 July 2008 (http://www.guardian.co.uk/business/2008/jul/12/oil.commodities)

vehicles. Many Americans don't have the means to buy, lease, or take out a line of credit for a new car and simply won't be able to afford one.* On top of this, there won't yet be a used car market for alternative vehicles so they'll be forced to continue using their obsolete gas guzzlers. This means that those people who can afford to escape the high prices of gasoline will and those who can't escape these rising prices will be trapped by them. Political intervention is likely, but some level suffering is inevitable.†

While the social impacts of increased oil costs will certainly be severe, the physical effects of a peak oil crisis are equally worthy of note. Outside of the obvious impacts on infrastructure‡, there are going to be a number of products impacted by an increasing price of oil; namely plastics and rubbers. When oil is turned from crude into a usable form, it's separated into a series of its baser parts. Some of these parts form the base for most of our automotive, heating, and jet fuels, but some of it is refined into building blocks for many of our modern materials.§ Everything from ball point pens to building materials now have some plastic or rubber components and, as a result, all will be sensitive to the price of oil. Although the price of oil will indeed directly affect the price of many goods, human ingenuity will likely triumph. Products like PVC plastics and petrochemical rubbers will find suitable heirs to their thrones. In fact, one company is

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* Especially Hybrids, which often run at a premium of around 150% the cost of a non-hybrid car. The Honda Civic, a popular car design spanning almost three decades, sells a non-hybrid model for around $16,000 while the hybrid model sells for around $24,000.

† Steiner, Christopher. *$20 Per Gallon: How the Inevitable Rise in the Price of Gasoline Will Change Our LIves for the Better*. New York: Grand Centeral Pub., 2009.

‡ Asphalt, the primary ingredient in surface paving, is derived from the oil refining process. Its price is directly proportional to the cost of a barrel of oil.

§ Gelpke, Basil, Ray McCormack, Daniel Schnyder, C J. Campbell, Matthew R. Simmons, Fadhil J. Al-Chalabi, and David L. Goodstein. *A Crude Awakening: The Oil Crash*. New York, N.Y.: Docurama, 2007.

already making a splash in the bioplastics market. Spudware has been producing plastic cutlery made from 80% potato starch and 20% soy oil that's just as durable as their plastic counterparts. The added bonus, for those environmentally conscious eaters, is that they're also biodegradable in about 180 days. Although they sell at about 9 cents per unit, their plastic competitors still generally sell for around 3 cents per unit, making this bioplastic 300% more expensive than their petrol-based counterparts.*

Plastics aren't the only thing whose price is contingent upon the availability of cheap oil, however. The increased cost of goods is likely to be consistent across the board. From toiletries to building materials, the rising cost of energy will mean a rising cost of living. None of the impacts will be as severe, however, as the climbing cost of food. As the cost of oil rises, one of the marvels of our modern world will begin to unravel. American agriculture, the food production powerhouse developed through early 20th century political action, is system of immense scale and intense design. With a booming post-WWII population came the need to feed them. We centralized, industrialized, and homogenized our agricultural practices in order to feed a nation with an exploding middle class and oil was at the heart of its development. The impact peak oil will have on this system is two fold: The first will come as a result of rising transportation costs, the second on the fertilizers that make it possible. Event though many think we could diversify our transportation network to include more electric vehicles and trains, shipping large quantities of food from far away places is simply

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* Despite having eaten with one of their spoons and saved it for reference, their website could not be located. The nearest to a direct source was a supplier-
"Green Party Supply - Spudware." *Green Party Supply*. Web. 10 Mar. 2011. <http://www.greenpartysupply.com/Spudware_Biodegradable_Compostable_Utensils_s/6.htm>.

inefficient. Most of America's food is grown in places like Southern California and the Mid West where year-round growing seasons and workable soil allow for a consistently regular food supply. In regions like the North Eastern United states, we line our grocery shelves with California tomatoes all year round. Vast plots of corn, pastures of cows, and groves of oranges are concentrated in a few favorable growing regions. The advent of cheap transportation fuel allowed us to begin selling apples from 1,500 miles away at a cheaper rate than apples sold locally. Christopher Steiner explains that this phenomenon is not exclusive to America:

> "In big grocers on the famous Citrus Coast of Spain, Argentine lemons line shelves like thousands of yellow soldiers while the region's own lemons rot on the ground in local citrus groves." *

At current rates, food can be transported for around 15 cents per pound.† As fuel prices rise, so too will the cost of transporting food, although it will likely be fairly slow and in small increments. The vast networks of interstate highways that have afforded the nation cheap state to state food trade will begin to act as one of its biggest obstacles. When a big rig truck gets 5 miles to the gallon and has to travel thousands of miles to make a delivery, an extra 20 cents per gallon is a pretty big problem.‡

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* Steiner, Christopher. *$20 Per Gallon: How the Inevitable Rise in the Price of Gasoline Will Change Our LIves for the Better*. New York: Grand Centeral Pub., 2009. (p175)

† Steiner, Christopher. *$20 Per Gallon: How the Inevitable Rise in the Price of Gasoline Will Change Our LIves for the Better*. New York: Grand Centeral Pub., 2009. (p183)

‡ There's a whole discussion about rail transport that could have (and does have) an entire book written on it. The long and short of it is this: America destroyed its rail system during its industrialization. When highways and semi-trucks became favorable, the rail lines were torn up and abandoned. To even consider it as a viable alternative to trucking, the network will need to be rebuilt.

This is not the whole of the issue, however. As critical an issue as the cost of transportation seems to be, it's often the hidden, surprising problems that wreak the most havoc. The largest impact, by far, on food prices will be in the ability to grow the food itself. The industrialization of our farms has left us with vast monocultures that have drained the land of its nutrients and productive value*. Michael Rupert, a passionate Peak Oil activist and slight extremist explains:

> "If you keep sucking nutrients out of the soil, the soil is useless. Throughout history, plant matter was allowed to decompose and replenish the soil. Crop rotation was important." †

Monocultures consistently suck the same portfolio of nutrients from the soil, stripping it of the essentials. Nitrogen, for example, is an important element to crop growth and must be replenished. To overcome this problem of nutrient depletion, farmers fertilize their fields; historically, with animal manure. As the need for more food increased and manure couldn't be produced in large enough quantities domestically, guano from Hawaii was shipped in to replenish our fields. Its potency as a fertilizer allowed more food production, though the shipping meant it came at a slightly increased cost.‡ With the advancement of oil research, it wasn't long before it was discovered that through refining oil into gasoline, fertilizing compounds could be produced. As a powerful petrochemical fertilizer, these compounds increased the productivity of the land by an extraordinary amount and could easily be produced domestically. Before long,

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* Monocultures are farms that primarily produce one major crop.

† Ruppert, Michael C, Kate Noble, and Chris Smith. *Collapse*. United States: Film Buff, 2010.

‡ Darlow Smithson Productions. *Atlas 4D*. UK Discovery Network. Film, 2010.

scientists were developing genetically modified crops that could crow in denser plots and yield larger amounts of food. This increased our domestic food production by an extraordinary amount, but relied heavily on a cheap supply of oil to be maintained.

The decreasing supply of oil will go hand in hand with a decreased supply of food. Although alternatives to petrochemical fertilizers do exist, they don't yield nearly the same results. Without these fertilizers to enhance the growing capacity of their land, national agricultural yields will drop. When you have 300 million mouths to feed and only 200 million mouths worth of food, you have a serious social problem on your hands. As Steiner explained, the problem is not isolated to America alone, so the possibility of food imports is slim when the rest of the globe will be suffering from similar shortages. Reverting back to more natural methods is also not an option because, as Steiner concludes, we just don't have the capacity in our food system to do it:

> "as romantic as manure is to naturally minded farmers, there simply isn't enough of it to keep the whole world in crops... We will face challenges beyond where our food comes from geographically. The most vexing question: how to feed our food."*

An entire volume could be written on all of the impacts peak oil will have, but but chances are, we'll find solutions for most of them. Replacing materials like plastics with some new alternative, for example, could be an easy venture and might even spawn a new industry ready to take up the challenge. In other cases, however, we've boxed ourselves into a corner. Our infrastructure, our food production system- these are the

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* Steiner, Christopher. *$20 Per Gallon: How the Inevitable Rise in the Price of Gasoline Will Change Our LIves for the Better*. New York: Grand Centeral Pub., 2009. (p188)

products of an age of cheap energy and prolific growth. We can look ahead and try to imagine the potentials of new technologies and research, and some may actually prove viable, but there are still a lot of hurdles to overcome when faced with a problem on such a massive scale.

CHAPTER IV

THE PROBLEMS AND POTENTIALS OF ALTERNATIVE ENERGY SOURCES

In every disaster scenario, there are those who submit that the end of the world is upon them and there are those with an intense faith placed in the ability overcome all odds. It's not fair to claim that either camp is correct. Throughout its history, humanity has proven incredibly tenacious; in the face of adversity, it has always found a way to persevere against even the most remote odds of success. On the other hand, we can't ignore the fact that hard times do exist. Many of history's most trying moments tested the resolve of human will to survive. The fear of failure is a strong motivator, and history shows us that we know how to rise to a challenge. Only acknowledging the extremes of any argument is to deny the solution a degree of reality. To say that the peak of oil will be the end of the world would be absurd. To claim it would be the end of humanity as we know it would be extreme. But to claim we'll find a way through the darkness and emerge on the other side unscathed and unchanged would simply be naive. We can't just assume things will work themselves out.*

With a holistic approach to thinking, we can begin to find the common threads and follow them to the truth behind the issue. We can begin to understand not just the nature of the problem but also the nature of its potential solutions and take the appropriate course of action. Will solar panels save us? Will electric cars replace our

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* I'll assume you know what they say about assuming.

combustion engines? Will advances in fertilizers allow us to continue to meet population demands? It's important to ask these questions instead of simply assuming we know the answer.

The peak oil problem is, at its heart, an energy supply problem. Through a better understanding of its roots, its nature, and its impacts, we now know that oil is a finite resource, has been seamlessly integrated into our modern economies, and has the potential to violently interrupt the lives of a lot of people upon its depletion. This is a firm understanding of the problem, but in order to act appropriately, we must also consider the potential solutions and attempt to understand them with the same holistic temperament.

There are a whole host of alternative fossil fuels that could be used in place of oil. The most toted is natural gas. As an energy source, natural gas is cleaner and more abundant in America than oil. It can be used in a liquid or gas form and can power homes, cars, and virtually everything in between. At first glance, it sounds like an incredible opportunity to wean ourselves off oil. Investigated with more scrutiny, however, the true nature of gas is exposed.

Natural gas, despite its popularity as an alternative, has a very close relationship with oil. The two are almost always found in the same places*. For this reason, their prices are closely linked. As oil prices rise, so to do natural gas prices. C.J. Campbell explains that natural gas was often made in the same time periods and with the same geological processes as oil. This means, as an alternative, it might suit well for a

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* And almost always in the same well. Natural gas tends to float above the surface of the oil in an underground well which is why, in the early days of oil excavation, you'd see those tall towers with jets of flames erupting from the top. Drillers had to burn off the natural gas in order to release the pressure and the oil.

transition off of oil (in some peak disaster preparedness initiative), but as a fuel, natural gas is subject to the same peaking problems as oil; once it's gone, it's gone. Most estimates of global natural gas production place its peak production somewhere between 2010 and 2030, meaning that any transition to natural gas is going to require a subsequent transition to another energy source.[*]

Coal was not a formed like other fossil fuels,[†] but is a common energy source just the same. More than half of the electricity generated in the United States comes from coal fired plants. Coal is a viable alternative to oil only in that there's still plenty of it to be found, but its users are under increasing pressure to seek alternatives because it's the worst polluting energy source currently used. This discussion aims to maintain an independence from the arguments for or against global climate change, but it's worth noting that coal is a dirty enough energy source that both climate change believers and naysayers recognize its disadvantages as an energy source. Technology is proving valuable in making a "clean coal" but it's not as clean as it sounds. The coal is still dirty, it's actually just the process of capturing the pollutants produced through firing and burying them underground that's considered "clean".

Hydrogen enjoyed its fifteen minutes of fame between 2008 and 2010. As a fuel, it's remarkably clean[‡], and has been proven to be scalable to automobiles and potentially larger applications. The drawback to hydrogen lies not in its use, but in its production. It

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[*] Newman, Peter, Beatley, Timothy, and Boyer, Heather. *Resilient Cities: Responding to Peak Oil and Climate Change*. Washington, DC: Island Press, 2009. Print. (p24)

[†] Coal, the kind we mine- not the kind we fire our grills with - is actually the remains of ancient forests, burned and buried, and is also non-renewable.

[‡] The process of burning hydrogen for fuel produces a harmless exhaust byproduct: pure water vapor.

requires quite a bit of energy to strip the source of hydrogen, water, into its atomic parts. Although hydrogen isn't being produced on a commercial scale for transportation infrastructure, the current methods employ large amounts of electricity (typically generated at coal fired plants) and consumes much more energy in its production than it yields in its use. Hydrogen is not an energy source, it's a means of storing energy. We could, potentially, use solar cells and wind turbines to produce energy and then store it in hydrogen fuel, but because of its inefficiencies, it's cheaper just to charge the battery in an electric car with a solar panel directly. With advances in technology, it is likely that hydrogen will become increasingly more viable, so there is a lot of potential for discovery, but its future is unknown.

Nuclear has been a hot button term ever since the tsunami of 2011 that devastated the northern coast of Japan. Nuclear is an energy source with a number of extremes. It's extremely clean and scalable to large geographical regions, but at the same time, can be extremely dangerous. In oder to discourage fear tactics, it should be made clear that nuclear is ONLY dangerous if the systems that keep it safe, the failsafes to those systems, and the failsafes to the failsafes all fail simultaneously.

Nuclear reactors use a process called nuclear fission to produce energy. One atom splits into two and the energy released is harnessed to produce electricity. The radioactive material used for this process is kept below cool water to regulate and control the fission reaction. When operating properly, nuclear fission is actually very safe and quite efficient. In the event of a large scale disaster, however, where successive system failsafes are ineffective, a plant runs the risk of a "melt down." Deprived of its temperature regulation,

the radioactive material at the heart of this system would heat up and the fission process would become uncontrollable. This scenario is incredibly rare.

The real issue with nuclear power isn't in the safety, but in the waste it produces. Although none of it comes in the form of emissions, the spent radioactive materials have no known disposal method. These materials are extremely hazardous and can contaminate ground water and food supplies. The current method for dealing with this waste product is to store it in barrels and bury it under ground.* This method of disposal is inherently unsustainable and leaves a problem in need of answers that future generations will have to grapple with. Nuclear has incredible potential as an energy source if the problems with disposal can be solved. Unfortunately for the industry, however, the 2011 Tsunami in Japan triggered global panic surrounding nuclear energy when one of its plants began to melt down. Despite constant reassurance by both scientists and public officials, the events in Japan may have put the final nail in the coffin for the fight to construct new nuclear plants.

Regardless of nuclear energy's falling popularity, other alternative, renewable energy sources have surged in popularity through much of the early twenty-first century. Solar panels, for example, have increased so much in efficiency and in affordability that they're now a practical means of personal energy generation. Similarly, wind power has overcome many political hurdles and is now proving its viability, despite its often famous opposition.

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* In a sealed, protected chamber. Preventing leaks is the highest priority on radioactive material disposal sites, but containment has been an issue in the past.

For example, in the spring of 2010, after years of heated debates, the Cape Wind Project of Massachusetts' Cape Cod Bay was cleared by the state's Secretary of Interior for construction. Even against opposition from the many wealthy residents of the Nantucket Sound community*, the project was approved. This represented a landmark moment in the fight for renewable energy. Having been extensively studied for the better part of a decade, the argument came down to two basic points; the rich folk liked their view and the public liked their clean energy. Wind isn't the only underdog story, either. Alternative technologies have been consistently gaining ground in the public eye since the early 1990s and have been in a constant state of upward development. They represent the hopes and dreams of a nation to progress forward into a more sustainable future.

Even the best technologies, however, could still benefit from a holistic approach to thinking. Can a solar panel produce enough energy in its life to make another solar panel? How about a wind turbine? These questions and more need to be answered before these technologies can be identified as suitable replacements.† Anyone who would suggest a substitute to oil will seamlessly integrate itself into our energy portfolio is ignoring the potential problems that exist with many alternative sources.

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* Including famous opposition from the Kennedy Family, whose compound enjoyed a view of the Nantucket Sound and felt the addition of windmills would decrease their quality of their view.

† In a 1997 report, Richard Corkish published an answer to the question in a paper titled "Can Solar Cells Ever Recapture the Energy Invested in their Manufacture?" The short answer is "Yes," but the study lacks a certain depth that a holistic approach to thinking might uncover.

Corkish, Richard. "Can Solar Cells Ever Recapture the Energy Invested in Their Manufacture." *California State University, Dominguez Hills*. Australia and New Zealand Solar Energy Society, 1997. Web. 10 Mar. 2011. <http://www.csudh.edu/oliver/smt310-handouts/solarpan/pvpayback.htm>.

Alternative energy technologies do have the potential to carry us through the transition into a post-oil world, but it is important to keep reminding ourselves than an increased cost of oil means an increased cost of all energy. That's not to say that these increased costs couldn't be leveraged against some other function of the economy, though. Steven Chu, President Obama's Secretary of Energy explains,

> "When people say 'The price of energy will go up, is that possible?' Yes, absolutely possible. Probable. However, the cost of [energy] has stimulated a lot of innovation and the United States should realize this as a business opportunity. We have incredible intellectual capital in the United States. Why don't we say we can find the solutions and not only that, we can export [them] to the rest of the world." *

While we can't predict the future, we can make statements about what we know will happen. The price of oil will go up. Alternatives will help alleviate the problem to some degree. Advances in technology will help alleviate the problem to some degree.† Human ingenuity will contribute to the solutions. People will continue to live. The world will change. But most importantly, the price of oil will go up.

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* Taken from an interview prior to his appointment as the Secretary of Energy,
Klein, Larry, Cass Sapir, Doug Quade, and Jay O. Sanders. *The Big Energy Gamble*. United States: PBS Video, 2009.

CHAPTER V

THE BENEFITS OF THE END OF OIL

While lost in the discussion on Peak Oil, it's easy to forget to step back and look at things from a different perspective. When things change, or are about to change, we tend to get caught up in the plethora of problems and fail to recognize the potential for positive scenarios to exist. A reappraisal of the situation with a cool head can reveal that the scales aren't nearly as imbalanced as they may have seemed; hardship and compromise can often be met with discovery and invention. Perhaps the end of oil will make our lives profoundly different, but who ever said all change is bad change?

Bill McKibben, in his book *Deep Economy*, suggests that as energy prices rise, Americans will find themselves with much less "stuff". Stuff, he says, is the collection of material things we surround ourselves with, but he asks the question, "Is more better?":

> "In some sense, you could say that the years following World War II in America have been a loosely controlled experiment designed to answer this very question. The environmentalist Alan Durning found that in 1991 the average American family owned twice as many cars, drove two and a half times as far, used twenty-one times as much plastic, and traveled twenty-five times farther by air than did the average family in 1951. We are, to use the very literal vernacular, living three times as large. Our homes are bigger: the size of new houses has doubled since 1970, even as the average number of people living in each one has shrunk. Despite all that extra space, they are

stuffed to the rafters with belongings, enough so that an entire new industry - the storage locker - has sprung up and indeed has reached a huge size itself. We have all sorts of other new delights and powers: we can communicate online, watch a hundred cable stations, find food from every corner of the world. Some people have clearly taken more than their share of all this new stuff, but still, on average, all of us in the West are living lives materially more abundant than most people did a generation ago... What's odd is, none of this stuff appears to have made us happier. All that material progress - all the billions of barrels of oil and millions of acres of trees that it took to create it - seems not to have moved the satisfaction meter an inch. In 1946, the United States was the happiest country among four advanced economies; thirty years later, it was eighth among eleven advanced countries; a decade after that it ranked tenth among twenty-three nations, many of them from the third world. There have been steady decreases in the percentage of americans who say that their marriages are happy, that they are satisfied with their jobs, that they find a great deal of pleasure in the place they live... That's not to say that getting richer caused these problems, only that it didn't alleviate them. All in all, we have more stuff and less happiness."[*]

Although the connection between stuff and happiness is not directly evident, McKibben's theory suggests that the high-speed, high-efficiency, high-paced lifestyle

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[*] McKibben, Bill. *Deep Economy: The Wealth of Communities and the Durable Future*. New York: Times Books, 2007. Print. p34-35

Americans have developed over the last sixty years has allowed us to collect more material things, but something about this lifestyle has resulted in a noticeably less satisfied populous. Perhaps, McKibben postulates, in the pursuit of all that stuff, we lost touch with the baser elements of life that unconsciously promoted health and happiness; walking in the woods, spending time with family, having sit-down meals- one of these things might not be the source of happiness, but it might be possible that the cumulative sacrifice of all of them leaves us profoundly unhappy. The argument may be made, then, that as energy prices soar, a rediscovery of the elements that made life so much happier prior to World War II may be experienced. Peak oil could, potentially, result in a much happier America. It's hard to feel bad about not being able to buy that new car when you're feeling so good about not having to work overtime to buy that new car, right?

Christopher Steiner, in his book *$20 Per Gallon: How the Inevitable Rise in the Price of Gasoline Will Change Our Lives for the Better*, echoes these sentiments. He speculates that as gas prices rise, our communities will become much more dense and focus their energies inward. People will begin to rediscover talents like sewing or home improvement and what once was a trade that then became a hobby will become a trade all over again. Steiner suspects that as people begin utilizing their neighbors and neighboring communities as a regional supply network for goods and services, many people will begin to experience a greater sense of connection and community identity. He continues this line of thinking and suggests that a higher degree of connectivity could result in a decreased degree of anonymity and potentially result a significant reduction in crime.*

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* The logic might go: You'd never steal from your brother, and you'd never steal from your neighbor, so you'd never steal from someone if you knew they were your neighbor's brother.

Often, the disadvantages brought on by a particular problem have the opportunity to turn into one of its biggest benefits. As peak oil forces changes to the way our businesses and government agencies operate, it could have a similar effect. In a post oil world, members of a community might feel more connected to their justice departments and legislative bodies. Perhaps the connection people once felt to the police officers of their community might be renewed. Michael Jones, chief of the Suwanee, Georgia Police Department says:

> "When my father had his beat fifty years ago in Rome, Georgia, he walked it. Everybody knew him. He got Christmas gifts from just about every person in his patrol area. They didn't give him gifts because he was a police officer, they gave him gifts because he was their friend. That's he kind of thing we want to get back here. Years ago nobody thought about conserving gasoline but now we're forced to do things differently. When all we do is drive around, you have an effect that we call the Legless Police, because people only see their officers from the shoulders up. But now we're putting people on the ground where we need them instead of having them just randomly riding around. Whereas before people only saw officers in

negative situations, when something has gone wrong, now they see us every day, in positive, normal situations." *

It's clear that for all the modern conveniences an age of cheap energy has supported, there are a wealth of pre-oil benefits waiting to be rediscovered. The potential doesn't stop their, either. Perhaps food production will become more local and as a result, people will become much more connected to the sources of their food and may take greater care in what they eat. Maybe peak oil will be the answer to America's childhood obesity issue. Perhaps when people are forced to resort to walking or biking as a primary means of transportation, exercise will be part of daily life and people won't have to go to the gym anymore, freeing up hundreds of dollars in income and keeping people healthier than they've ever been before. Perhaps, in a search for some member of the community capable of performing some specific service, new friendships are forged between people whose paths would have otherwise never crossed.

There's always the possibility that, generations after the end of oil, people will look to the transition period with a sense of nostalgia; remembering what it was like to discover and create alternative ways of living that ultimately enhanced our lives. "The age of rediscovery and invention", they might call it. A century from now people may look back with a sense of pride, remembering the problem we were faced with and the

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* Steiner's book is organized into chapters titled Chapter $4, Chapter $6, Chapter $8, ect. He suggests we may begin to see benefits like these as early as $6 gasoline. At one point in the book, he recognizes that people generally try to maintain the status quo and are unlikely to really begin to change until gas prices reach a point where they can no longer deny the severity of their situation. At $4 per gallon, memories of $3 gas are still fresh in our minds and we will hold onto hope that more comfortable prices will return. He postulates that it would take a 300% increase (to $6) before that denial period is over.

Steiner, Christopher. *$20 Per Gallon: How the Inevitable Rise in the Price of Gasoline Will Change Our LIves for the Better*. New York: Grand Centeral Pub., 2009. (p188)

tenacity with which we overcame it. If we can remember, while looking forward, that for every disaster there is potential for discovery, the future may not seem so grim after all. It's important to remind ourselves that humans are complicated organisms living in a complicated system and the outcome to a particular problem is just as complicated to predict. After all, humanity is incredibly resilient. To ignore the possibility that we'll find some good within the bad is to ignore the very thing that makes us human - Creativity.

CHAPTER VI

THE PROBABLE SCENARIOS

Given that it's nearly impossible to predict what might happen as energy prices rise, most authorities on the subject tend to provide a range of scenarios. The work commonly published on the topic tends to lean toward two likely scenarios; societal collapse or human perseverance. It would be unfair to say that these arguments hold an equal level of popularity. Those lining the collapse side of the fence have flooded the media and shelves with page after page of reasons why mankind simply won't make it through the end of oil. These fear tactics are poor examples of fact-based arguments and do an injustice to the intelligence of the general population. Those that line the side of perseverance have a strong belief that humanity is resilient and believe that peak oil is no big deal; just another bump in the road. They believe there's nothing worth raising awareness about and so they tend to write less on the subject than their counter parts. Much like our modern political system, however, these two parties do have their moderates and it's these people that tend to offer the most believable, well rounded philosophies.

Peter Newman, Timothy Beatley, and Heather Boyer produced a book titled: Resilient Cities: Responding to Peak Oil and Climate Change. Their philosophy was that the end of oil, coupled with the issues surrounding climate change, would prove to be one of the largest problems humanity has ever had to solve. Using a holistic approach to thinking, they proposed four possible scenarios (the fourth being their own prescription)

of what might happen to our cities and urban lives in the event of a permanent global energy crisis. Their scenarios are 1. Collapse, 2. Ruralized City, 3. Divided City, and 4. Resilient City.

If we adapt their theories for the whole of humanity - instead of just for cities - and distill them down to their baser parts, we can develop an understanding of the range of possible scenarios for a peak oil crisis. These scenarios, as I have adapted them, are: 1. Selective Collapse, 2. Employment of Smaller Communities, 3. A Greater Social Divide, and 4. Increased Resiliency.

SCENARIO 1: SELECTIVE COLLAPSE

However unlikely, we have to at least acknowledge these extremes exist. The authors of Resilient Cities explain:

> "We do not like to think about cities collapsing, but history is littered with fallen cities. Ephesus, in modern-day Turkey, was the second largest city in the Roman Empire. A thriving port city, it was abandoned in [1000 C.E.][*] when it could no longer function as a port due to the river silting up because the trees in the surrounding hills were all removed. Ephesus did not see the link between its environmental mismanagement, war, and its economy, but today you can walk in the ruins of a once great city port that used to be on the mediterranean coast but is now five miles inland due to erosion." [†]

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[*] The original text listed the date "1,000 A.D." Because of its historically religious meaning, the standard A.D. and B.C. notations have since been abandoned in favor of a new system. C.E., meaning Common Era, and B.C.E., meaning Before Common Era, are now the preferred method of notating dates.

[†] Newman, Peter, Beatley, Timothy, and Boyer, Heather. *Resilient Cities: Responding to Peak Oil and Climate Change*. Washington, DC: Island Press, 2009. Print. p37

History is, indeed, littered with these collapsed cities. In fact, whole civilizations have collapsed throughout history. Even the Roman Empire, once the strongest, most expansive empire in the world, eventually collapsed.

We often misrepresent what collapse means, however. When we say "the Roman Empire collapsed," we do not mean that every Roman in the world suddenly died and their cities were abandoned only to be discovered years later by unknowing archeologists. Collapse is just a scary way of saying "things changed, and fairly dramatically at that; the status quo was not maintained." This is the real nature of collapse.

In some of the more established countries like the United States, collapse would be experienced on a regional scale, not a national one. Places like Las Vegas, for example, which relies heavily on transportation infrastructure to import supplies and bring in people, may find itself struggling. A city like that could suffer severe economic hardships. Arguably, Detroit collapsed in the 1980s, but for fundamentally different reasons. The question still remains, however, could a modern American city be abandoned like Ephesus? However unlikely, it is possible.

SCENARIO 2: EMPLOYMENT OF SMALLER COMMUNITIES

The authors of Resilient Cities suggest that one possible scenario our cities might undergo would be a sort of reverse-urbanization. In their scenario title Ruralized City, they say:

"One of the key ideas being presented as a response to peak oil is that our cities will create a more sustainable semi-rural lifestyle." *

The term Ruralized City evokes the image of a flight to the country side, which is inappropriate because there simply isn't enough developed land to support a de-urbanization trend. Urbanism has not only become a strong component of modern culture, it's become the focus of most of our nation's economic growth. Ruralization is not likely. It would be more accurate to say that in an age without oil, people will begin to develop smaller, more local networks and communities.

In the Employment of Smaller Communities scenario, the change will not necessarily be physical. As global trade shrinks and people begin to establish more local connections, the transformation into this scenario would be mostly social. As we begin to develop tighter, more intimate relationships with other members of our communities, we'll begin to create a support network that transforms the way we live. Unfortunately, not all regions are equipped with the proper human and infrastructural capital to completely turn reliance inward.

The suburb is one such example. When discussing peak oil, many extremists enjoy imagining the death of the suburb. It's been demonized throughout much of the late twentieth and early twenty-first centuries, leaving it with a poor reputation amongst architects and planners. Suburbs are isolated, homogenized, and diversity-poor, which gives them a disadvantage, for sure, but those who prescribe to a holistic approach to

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* Newman, Peter, Beatley, Timothy, and Boyer, Heather. *Resilient Cities: Responding to Peak Oil and Climate Change*. Washington, DC: Island Press, 2009. Print. p42

thinking should avoid writing them off so quickly. David Holmgren, author of Retrofitting the Suburbs, writes,

> "'Suburban Sprawl' in fact gives us an advantage. Detached houses are easy to retrofit, and the space around them allows for solar access and space for food production. A water supply is already in place, our pampered, unproductive ornamental gardens have fertile soils and ready access to nutrients, and we live in ideal areas with mild climates, access to the sea, the city, and inland country."*

The suburbs may prove to be the most difficult to adapt to a changing way of life, specifically because of the significant lack of resources they have on hand, but they're not without their advantages. Suburban families may find their bedroom community's lawns turning into massive home gardens. New partnerships could be formed on the foundation of the community's social and intellectual capital. Relationships like this might find those with green thumbs growing more tomatoes in their gardens and exchanging them with their neighbor, who may have some knack for fixing gardening tools. Suburbs are not dead zones and should not be discounted until the last building is razed. In the Employment of Smaller Communities scenario, collapse is prevented by the reallocation of social capital, but the change is not without its difficulties and expenses. For all we know, the interstate highway system may find itself, under the guiding hand of government intervention, transforming into a high speed rail system. Nothing is certain, especially when talking about such a complex system as human development.

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* Newman, Peter, Beatley, Timothy, and Boyer, Heather. *Resilient Cities: Responding to Peak Oil and Climate Change*. Washington, DC: Island Press, 2009. Print. p42

SCENARIO 3: GREATER SOCIAL DIVIDE

In this scenario, the essence of Newman, Beatley, and Boyer's argument stays the same. They say:

> "In the divided city scenario the wealthy recognize that they need to optimize their choices and begin to form exclusive neighborhoods and self sufficient centers with all the best transit and walkability. They will have all necessary services within a short distance and all institutions for supporting such centers available locally. Likewise, all the best solar design and renewable technology will be built into these exclusive areas. As the threat of oil scarcity begins to bite they will retreat more and more inside these eco-enclaves, guarding their rights with... the biggest barrier of all - real estate prices." *

The authors here paint a picture of villainous intention that needs to be examined a bit more closely. If we change the tone slightly, we can adapt this description to one with a less antagonizing explanation. In the Greater Social Divide scenario, the likelihood of the rich prioritizing their needs over those of the poor does exist, but it would be more realistic to say that it will be less out of pure intention and more as a result of market forces. As the pressures of peak oil mount - remember, these pressures will come slowly, not overnight - products that alleviate these pressures will be in high demand. As energy technologies, walkable communities, and other forms of sustainable life become more desirable, their prices will begin to exhibit a premium. Those who can afford to pay for

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* Newman, Peter, Beatley, Timothy, and Boyer, Heather. *Resilient Cities: Responding to Peak Oil and Climate Change*. Washington, DC: Island Press, 2009. Print. p47-48

them will continue to do so, those who cannot will be forced to seek cheaper options. We've seen this already with hybrid cars and wealth belts around cities. It's not unreasonable to imagine the same effect on a larger scale.

The Greater Social Divide scenario finds a middle ground between the Selective Collapse and Employment of Smaller Communities scenarios. In Selective Collapse, the status quo is changed dramatically. In Employment of Smaller Communities, the status quo has changed slightly, but equitably. In the Greater Social Divide scenario, the status quo has stayed the same for some people and changed for others. Using the existing free market as evidence, we can begin to understand that without government intervention, this scenario is by far the most likely.

SCENARIO 4: INCREASED RESILIENCY

Newman, Beatley, and Boyer use their fourth scenario as a platform on which to preach their own solutions, although most of their work is focused on reducing carbon emissions and avoiding global climate change. For the sake of keeping balanced scales, the Increased Resiliency scenario here suggests that mankind continues on unscathed.* In this scenario, mankind has defeated the odds and successfully prepared themselves for the problems surrounding Peak Oil. Characteristics of the other three scenarios exist here, but are products of a much less turbulent process. Cities like Las Vegas, sitting in its desert oasis, are transformed or dissolved as a conscious act in recognition of the coming hardship, communities take stock of their social capital and put the frameworks in place for a new level of interdependency, and political actions are taken to ensure that the social

* Not to be confused with "unchanged". It's very likely that a lot will change.

divide between the rich and the poor cannot expand. In this scenario, as in all others, there is hardship in the face of adversity, but people have acted intelligently and swiftly to react to the problems as the problems develop instead of being forced to just submit to the effects after they've run their course.

What will really happen in a peak oil energy crisis is yet to be discovered. The best we can do when looking forward is to use what we know, extrapolate, and guess at what we don't. Although we cannot predict future problems, there will always be a certain degree to which we can brace ourselves against their impacts - this distinction is important. The most we can hope to do is guess, but educated guesses are only as good as the lines of thinking that developed them. Without acknowledging the full range of possibilities, a guess is simply a gamble, but when a holistic approach to thinking is used, the process of making the guess can be informative.*

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* Liken it to this: If someone's about to punch you in the face or stomach, but you don't know which, you can either try to predict which it will be and protect that region, resulting in either avoiding the punch or taking a lot of pain, or you can turn around and let them strike your back instead, reducing the impact significantly. In either case, you're bound to learn something about your opponent's attack pattern, but it might be much harder to bounce back while nursing a black eye. By exposing your back, you can protect both regions, take a bit of a hit, but still learn which region your opponent was aiming for. Informative.

CHAPTER VII
WHAT PEAK OIL MEANS FOR ARCHITECTURE

So the big question is: What does peak oil mean for architecture? The answer, if there is one, is very hard to define. Outside of educated guesses, we simply do not know. The four scenarios previously outlined represent a broad, far reaching, very basic range of the possible outcomes, but there's no way of knowing how the specifics will work themselves out until after it's happened. If you told one hundred architects what we know about peak oil and asked them to independently propose an architectural design solution, you would likely have one hundred very different proposals. Many would likely focus on energy use, but it's unlikely that any one proposal would represent the definitive solution to a peak oil problem.

Architecture has long been thought of as a commodity. While it still exists as artful and expressive, architecture in the modern world has very much moved beyond the high-design that it once represented and now exists, essentially, as a demand response. People want it, architect's design it. As peak oil pressures rise, we'll likely see owners communicating a need for energy efficiency and resource independence to architects - who will be more than willing to add these fee-raising features - and our buildings will change as a simple response to the needs of the world. I argue that this is not enough. It's neither fast enough nor creative enough a solution to guide the world into a post-oil age.

Architects need to lead the pack. They need to charge ahead into uncharted waters and pave the roads for the world to follow. Consider that we spend over 90% of our entire lives inside of buildings; sounds like they're in a pretty good position to educate... inspire.... transform.

The truth is that Architecture* has been in a perpetual state of identity crisis for well over a hundred years. The early half of the twentieth century saw some of the most violent evolutions of architectural form, expression, and meaning since its conception as a profession. Architects have long been searching for purpose in a world where the role of the professional architect almost always appears in flux. Modernism, perhaps the field's most dramatic period of departure and redefinition, epitomizes the nature of this search for meaning with the fundamental question, "Who are architects and what are we for?" As architects are forced to rise to the challenge of peak oil, it's likely they'll find themselves asking a similar question.

In 1919, Walter Gropius, famous for later beginning the Bauhaus School of Architecture and Design in Germany, asked, "What is architecture?" The eternal and illusive question. His answer was:

> "The crystalline expression of man's noblest thoughts, his ardour, his humanity, his faith, his religion! That is what it once WAS! But who of those living in our age that is cursed with practicality still comprehends its all-embracing, soul-giving nature? We walk through our streets and cities and

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* In this chapter, big "A" Architecture denotes the field of study or practice of design. Not to be confused with little "a" architecture, the physical manifestation of that practice. Though convention would not always capitalize the A as is done here, the distinction is important throughout the rest of this argument.

do not howl with shame at such deserts of ugliness! Let us be quite clear: these grey, hollow, spiritless mock-ups, in which we live and work, will be shameful evidence for posterity of the spiritual decent into hell of our generation, which forgot that great, unique art: architecture."*

It's clear that Gropius was battling with the nature of architecture. He challenged that below efficiency of cost, below efficiency of construction, below even the utility of the building, the spirit of architecture was essentially lost. The struggle in his mind, then, was how can we find it again?

In the early 1930s, Le Corbusier, perhaps one of the Modernist movement's most well known architects, famously likened the building to the automobile and the airplane. He watched as the world's industries exploded with creativity and invention all around around. The car manufacturers developed newer, sleeker designs and faster, cheaper methods of production. The airplane, in a constant struggle to shed pounds and fulfill its function, was always evolving more efficient methods of getting and staying airborne. These things, Corbusier believed, were the epitome of beauty. In these industries, the purpose - the spirit of design - was what gave their creations soul. The smooth lines of an airplane were beautiful for no other reason than they did exactly what they were supposed to do, as efficiently as was possible to do, and all without hiding it beneath some jazzed up shell. The wings weren't made to look like a bird, they were made work work, work well, and display that functionality to the rest of the world.

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* From a four-page leaflet published at the Arbeitsrat Fur Kunst, a lecture put on in Berlin. The leaflet gave no names but featured three manifesto-like texts by Walter Gropius, Bruno Taut, and Adolf Behne.

Conrads, Ulrich. *Programs and Manifestoes on 20th-Century Architecture*. Cambridge, Mass: MIT Press, 1970. Print. p46

The building, as he saw it, was no different than these utilitarian devices. It was a "machine for living."* Le Corbusier, like Gropius, felt architecture should have a mission, a purpose, and he knew how to define it. In introducing his chosen mission, he states: "Architecture is a thing of art, a phenomenon of the emotions, lying outside questions of construction and beyond them. The purpose of construction is TO MAKE THIS HOLD TOGETHER; of architecture TO MOVE US."†

Although many people disagreed strongly with the product of Corbusier's philosophies, the fundamental argument he produced is right on track - Architecture shouldn't strive to be something it's not, it should strive to be itself and to do so in the best way possible. This means that in a peak oil crisis, architecture needs an identity, an identity that architects will need to define soon. It's not simple enough to turn our buildings into solar energy farms - they're not solar energy farms, they're buildings. That's not to say that our buildings shouldn't incorporate solar power or other green features, but that these features shouldn't define them.

At its most basic, architecture is a refuge, a protector, a utility in which we live and work. At it's most complicated, it's an expression of culture, art, or symbolism. There is no one answer to Gropius' question, "What is architecture?" Architecture is different to everyone who designs it, to everyone who experiences it, and to every era that it houses.

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* Corbusier famously used this line (a number of times) in specific reference to housing, but it has since become ubiquitous with the core of the Modernist movement of the early twentieth century.

Le, Corbusier, and Frederick Etchells. *Towards a New Architecture*. London: Architectural Press, 1946. Print. p95

† Le, Corbusier, and Frederick Etchells. *Towards a New Architecture*. London: Architectural Press, 1946. Print. p18

Architecture is physical. It's economic. It's is political. It can refuse change or it can embrace it. Architecture, as a practice, as a design process, as a field of study is intangible. The physical manifestation of our architecture (little "a") is the product of Architecture (big "A"), the philosophies and processes that design it.* Higher energy prices will indeed change our architecture, but a change in our architecture is not necessarily synonymous with a change in our Architecture. The works of Le Corbusier, Walter Gropius, and others whose philosophies became the poster-children of the Modern movement were proposing a change to Architecture - the way we design, why we design, how we design, and what we design for - which resulted in a change to architecture - what we designed. This is an important distinction because it means the question, What is architecture? might be better written: Why is architecture?

If we ask this question, why is architecture?, we find there is no answer. That's not to say that the question can't be answered, but rather that the question can be answered infinitely; it's an answer in a constant state of redefinition. Architecture and architecture are eternally engaged in a dance through time. Their partners? Cause and effect. Though their respective movements may not mirror one another's, their best performance is one in which the communication between their motion is balanced to perfection. At times, the curtain rises to find Cause engaged with Architecture while Effect and architecture take the second act. At other times, Cause takes architecture partner. Effect, eyeing the big "A" wallflower, prepares it for the next act. One pair always leading another. When cause inspires change in Architecture, architecture follows. Similarly, when cause prompts a change in architecture, Architecture is forced to catch up.

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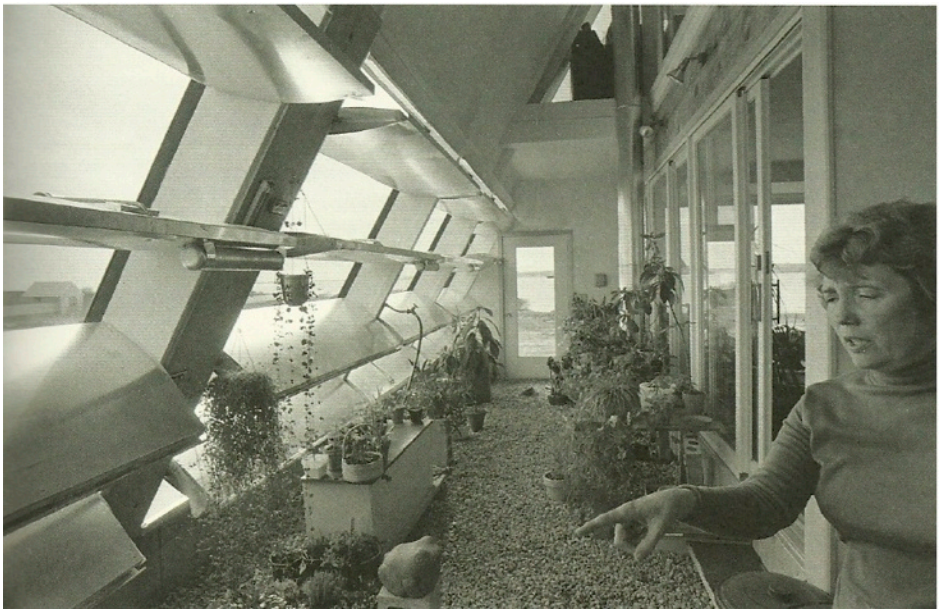
* Pay attention to big "A" little "a"

Peak oil will change the way we live and the way we function. Architecture has long been the pursuit of a vessel that contains those things; a place in which we can live and function in comfort. Understanding the relationship between Architecture and architecture can better serve to answer the question: What does peak oil mean for Architecture? It means that big "A" needs to preempt the problem by effecting a change to little "a" before peak oil changes it first. To continue the metaphor of dance, when peak oil assumes the role of Cause and throws architecture out onto the dance floor, Architecture would do well to interject and ask for architecture's hand before Effect steps in and forces the two a's to do a two-step that no one wants to see.



House of Junius Eddy, Little Compton, Rhode Island (1975)*

Figure 5: Little "a" leads the dance, big "A" follows -
Following the energy crisis of 1973, the need for more energy efficiency in buildings led to the construction of this experimental home. Employing solar hot water heaters, integrated solar panels, and automatic Skylid shutters, the building reduced the stresses resulting from an increased cost of energy. The cause, energy shortage, created a need for the architecture to change. The Architecture followed.

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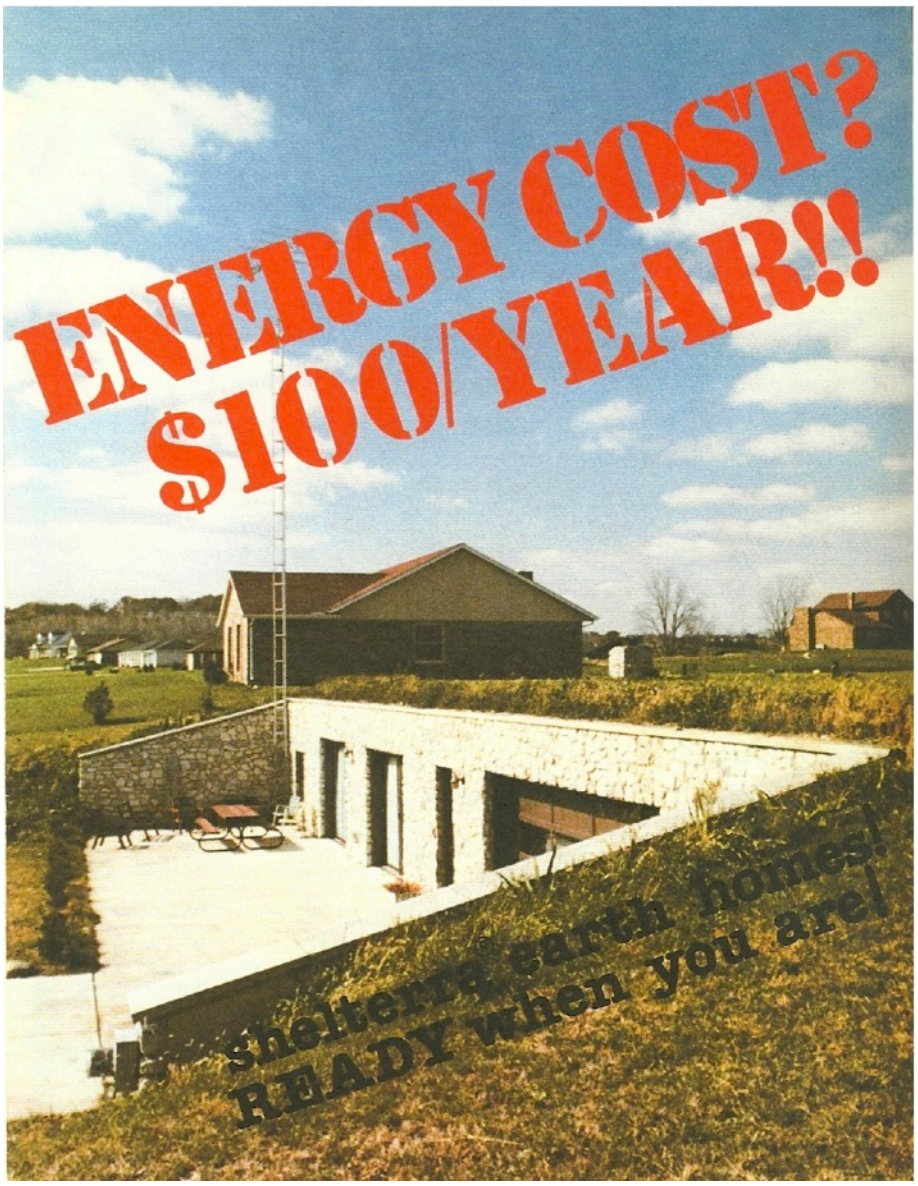
* Chodikoff, Ian. "*Sorry, Out of Gas: Architecture's Response to the 1973 Oil Crisis*." Canadian Architect. 53.1 (2008). Print. p144



Shelterra Advertisement (1979)*

Figure 6: Big "A" leads the dance, little "a" follows -
Following the 1973 Energy Crisis, as people's lives began to change, architects assumed their role as problem solvers and used their creativity to find a solution. This advertisement, which reads "ENERGY COST? $100/YEAR!! Shelterra earth homes! READY when you are!" displays one manifestation of a movement towards 'underground' architecture. The cause, changes in the way we lived and to the cost of living, created a need for Architecture to change. The architecture followed.

* Chodikoff, Ian. "*Sorry, Out of Gas: Architecture's Response to the 1973 Oil Crisis*." Canadian Architect. 53.1 (2008). Print. p92

CHAPTER VIII

REACTIVE ARCHITECTURE V.S. PREPARED ARCHITECTURE

Whether big "A" leads little "a" or the other way around, Architects - first and foremost - are problem solvers. It doesn't matter if it's determining the best way to compose a structural system or establishing which form is the most expressive; at their core, architects enjoy problem solving. It could even be argued that they've managed to turn problem solving into an art within itself. Problem solving, designing, perfecting- these are the things architects bring to the table in any project.

Architects aren't the only problem solvers, either. The world is full of them. In fact, Nature counts itself amongst the top echelon of problem solvers, constantly adapting and evolving new ways of overcoming obstacles. Charles Darwin, often called the father of evolutionary theory, wrote the following in his sketchbook in preparation for his famous work, *On the Origin of Species*:

> "An individual organism placed under new conditions often varies in a small degree and in very trifling respects such as stature, fatness, sometimes colour, health, habits in animals and probably disposition. Also habits of life develope [sic] certain parts. Disuse atrophies. Most of these slight variations tend to become hereditary... The nature of the external conditions tends to

effect some definite change in all or greater part of offspring - little food, small size." *

In this process of vary-and-select, vary-and-select, nature is a reactive system. When a new adversity presents itself, organisms begin to change in response, passing down genetic instructions to their offspring and equipping them with the tools to handle whatever hardship their ancestors had faced. It is, perhaps, the most efficient form of change possible. When a problem is known, adjustments can be made accordingly to custom tailor an appropriate solution. Evolution works this way, by waiting for problems to present themselves and equipping future generations against them. This is largely a form of hindsight development and acts as a reactive process.

Like nature, Architecture has been, primarily, a reactive organism. When public utilities were introduced, it added indoor plumbing and baths; Darwin would say the outhouse atrophied. When electricity became accessible to the general population, it wired our homes; the gas lamp atrophied. When energy became scarce in the 1970s, it installed solar panels and insulation.† This process could be called Reactive Architecture; Architecture that waits for a particular problem to appear and then finds the appropriate

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* The above passage was taken from a publication produced by Darwin's son, Francis Darwin, following Charles Darwin's death. Francis collected his fathers notes and published them for presentation to Cambridge University in 1909. The publication is filled with blocks of text, written by Francis, that read: (illegible) and (sentence incomplete). It presents an interesting glimpse into the mind of Charles Darwin before his famous theory was finished. Darwin was clearly a holistic thinker, always questioning the true nature of things and refusing to accept face values.

Darwin, Charles. *The Foundations of the Origin of Species: A Sketch Written in 1842*, Edited by Francis Darwin. Univ of South Carolina Pr, 2010. Print. (p1)

† Although it would be nice to say our insatiable appetite for energy atrophied, not all evolutionary traits are met with the loss of another. Sometimes we find a few appendices.

solution. Prior to the industrial revolution and the advent of the International Style,* this process of slow, hindsight driven evolution of architectural principles resulted in regional architectures- what many people consider "vernacular" architecture - where the adversities of the past informed the development of future construction techniques. Following the industrial revolution, it appears that the speed with which our abilities were expanding began to inform the care with which our architecture was evolving. The International Style, for all its theoretical merits, pushed the envelope too quickly. In the name of intellectual progress, steel and glass replaced wood and clapboard. Though this resulted in countless advancements in building design, high-rise engineering, and pre-fabrication techniques, it had a number of adverse effects. Roofs leaked, large panes of glass flew out of their frames, interiors felt cold and inhospitable. The speed with which our architectural theory evolved created incredible Architecture, but terrible architecture. It is clear that speed is a highly influential factor when organisms evolve, and nature seems to have picked up on that also.

In his book, Darwin finalizes his theories on evolution and adaptation by begining to establish the circumstances in which this sort of evolutionary change is possible. He makes it clear that for variations and changes to occur, there must be a slow and steady influence. An evolutionary change cannot occur overnight or even over a generation, according to Darwin. It requires many subtle changes taking place over many subsequent generations. This means that the most efficient evolution occurs and impacts on organisms are experienced gradually, over long periods of time. Forcing immediate

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* The common title given to the culmination of Modernism in the steel-and-glass skyscrapers, synonymous with globalization.

change is simply not productive, even when that change is necessary. Organisms introduced to dramatically new environments often die. Exposure to such rapid change results not in a slow, reactive evolution, but in a quick decimation of populations. Those organisms that survive, generally adapt to such an adversity, but the death toll is often significant and unavoidable.*

Figure 7: The risk of the unforseen
When explorers first began to settle the New World, they brought with them a series of illnesses that the Native Americans had never encountered. Lacking the necessary immunities, vast amounts of the Native American population were decimated. Those who survived, eventually developed the necessary immunities, but not before a massive loss of life.

Reactive Architecture demonstrates the same weakness. When an extreme adversity impacts architecture or the people living within it, there is often a large degree of suffering before a solution is found. Natural disasters and other large scale catastrophes destroy property and kill thousands of people before a proper solution can be discovered. Earthquakes, droughts, fires- Architecture has discovered ways of preventing or mitigating the impacts of such disasters, but not before it knew that such forces existed in the first place.

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* The complete collection of Charles Darwin's work can be found online in scans of original prints. It includes not only published works but also letters and correspondences, early notes and sketches, and subsequent works of note from other authors.

"The Works of Charles Darwin." *The Complete Work of Charles Darwin Online*. Ed. John Van Wyhe. National University of Singapore, 2002. Web. 10 Mar. 2011. <http://darwin-online.org.uk/>.

In 1666, for example, when most buildings were still framed with wood, a fire broke out in London, England. It started in the house of Thomas Fraynor, the king's baker, in the dead of night. The family smelled smoke and fled across the rooftops of nearby houses. With narrow streets and plenty of wood to fuel it, the fire made quick work of the city and by dawn had engulfed the London Bridge. The bridge acted as a firebreak and prevented the destruction from raging its way into the neighboring towns, but wind pushed it north and west until virtually all of the city of london was consumed. 373 acres were destroyed along with 13,200 houses, 84 churches, and 44 company buildings. This tragic event that destroyed the livelihoods of so many people, also motivated the change that pushed London into a new age of masonry construction. To prevent a disaster of this nature from ever occurring again, damaged buildings were demolished and completely reconstructed in brick or stone, streets were widened where they could be, and a new understanding of the dangers of fire humbled all Londoners. In this case, Reactive Architecture will have undoubtedly saved the lives of thousands of people from future fires, but it did so at the expense of the

Figure 8: A Painting of the 1666 Great Fire of London by Jan Wyck.

thousands of livelihoods.* Reactive Architecture, as a slow, evolutionary process is highly efficient, but in the face of dramatic change, it will always be too slow to take the appropriate action.

So what would the process be called that looks ahead and attempts to solve the problem before it comes? Prepared architecture does just that. If Reactive Architecture is the process of waiting for a problem to surface and developing a solution that works, Prepared Architecture might be viewed as its direct opposite. Prepared Architecture is architecture that is designed as a solution to a future problem. It aims to look ahead and predict what adversities might impose themselves and then positions itself to overcome them. Nature does not tend to do much of this, and for good reason. The process of designing Prepared Architecture has a supreme disadvantage: the future is impossible to predict, though that doesn't stop architects from trying. Do not make the mistake, however, of confusing prediction with planning. Planning employs some degree of prediction, but focuses more intently on controlling the future. Most architects, whether they admit to it or not, aspire to have a certain amount of control over the future. Whether its controlling how a family might live in a home or controlling how a home might influence its neighborhood, architects like to plan things out, but prediction is still not their strong suit.

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* The BBC provides an excellent resource for anyone interested in this fire or other key events in history and often provides a list of references including period pieces.

Robinson, Bruce. "London's Burning: The Great Fire." *BBC.co.uk*. British Broadcasting Corporation, 29 Mar. 2011. Web. 10 Apr. 2011. <http://www.bbc.co.uk/history/british/civil_war_revolution/great_fire_01.shtml>.

Stewart Brand, author of How Buildings Learn, has this to say about the distinct difference between the reactive processes of nature and the hopeful processes of architecture:

> "The Darwinian mechanism of vary-and-select, vary-and-select has one enormous difference from the process of design. It operates by hindsight rather than foresight. Evolution is always away from known problems rather than toward imagined goals. It doesn't seek to maximize theoretical fitness; it minimizes experienced unfitness."*

Architects almost instinctively try to predict the future. Space planning is an exercise of prediction. In some cases, predictions attempt to reach only a year or two beyond the present. In others, they might reach generations into the future. Stephen Colbert, the comedic host of the Colbert Report and fake republican news pundit, highlighted the extremes of Prepared Architecture on a June 28th, 2010 episode.

Figure 9: Vivos to the rescue
This rendering, from the Vivos website, shows the organization of spaces in one of their underground bunkers. The site claims these bunkers will protect against any civilization-destroying disaster, including an impact from Nibiru, the mythical planet depicted on a 4,500 year old Sumarian tablet predicting a collision with the planet Earth. **

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* Brand, Stewart. *How Buildings Learn: What Happens After They're Built*. New York, NY: Viking, 1994. Print. p188

** *Vivos - Underground Shelter Network for Surviving 2012 and Beyond*. The Vivos Group. Web. 10 Mar. 2011. <http://www.terravivos.com/>.

Commenting on a Fox News broadcast from earlier that week, Colbert poked fun at the new industry of "Doomsday Bunkers" that have been cropping up throughout the nation. As Robert Vicino, of the Vivos Group, a company designing and construction these bunkers, explains:

"Lounges and kitchens and private bedroom suites... effectively it's a turnkey underground cruise ship!... It may not be an event that happens this year or next, it could be twenty-five years from now or a hundred years from now. It's a generational thing that will be passed down to their children and grand children." *

So why is Prepared Architecture subjected to the cheap jokes of comedians? For the same reason there aren't more examples of it. Prepared Architecture will never find itself in the limelight because the problem with prediction is that it's almost always wrong. When architects make predictions and the predicted events never come to pass, the architecture either fades into obscurity or becomes the laughing stock of the field. Those few examples of successful

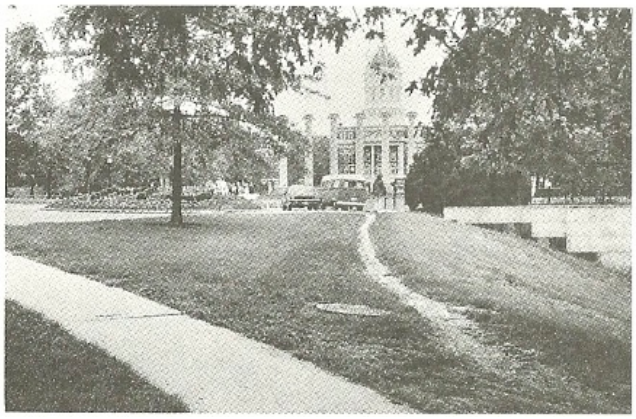

Figure 10: Cow paths
The most obvious examples of the wrong predictions in action can be seen on most college campuses. This photo shows the University of Missouri campus and how a campus planner's idea of where people might walk was way off target. Students developed their own network of cowpaths connecting the spaces they frequented.*

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* The original Fox News broadcast could not be located

"Doomsday Bunkers" *Colbert Nation | The Colbert Report*. Comedy Central, 28 June 2010. Web. 10 Mar. 2011. <http://www.colbertnation.com/the-colbert-report-videos/313677/june-28-2010/doomsday-bunkers>.

Prepared Architecture, whose predictions turned out to be right, tend to blend in with the Reactive Architecture cropping up around them.

In the discussion on Peak Oil, where a potential disaster looms on the horizon, the instinct may be to develop solutions that will help to mitigate the stresses caused by the problem in the future, but without knowing exactly what those stresses will be, how can we work to develop the right solution? It might seem logical that with the end of oil comes a need for decreased energy consumption. The architect may develop buildings that contain the latest and greatest in energy efficiency technologies. He or she may discern that the need for reduced consumption would require these technologies. He or she may decide that integrating them into the building before the crisis begins would prepare the building for such a crisis. However likely it is that this prediction is right, what if it's not? Stewart Brand writes, "All buildings are predictions. All predictions are wrong." [†] It's not necessarily that the prediction is wrong, but more so that the response to the prediction is wrong. The building is wrong. There will always be things we know - people will need buildings, energy will be scarce, and something will need to change - but what that something is, is still unknown.

Most predictions are not necessarily as grand as the Vivos Doomsday Bunker is. In fact, most predictions are small, innocuous, and often overlooked. In the design of a commercial building, an Architect may decide that the future of office computing is in fiberoptic cables. Technology will advance and the likely points to a market explosion of

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[*] Brand, Stewart. *How Buildings Learn: What Happens After They're Built*. New York, NY: Viking, 1994. Print. p187

[†] Brand, Stewart. *How Buildings Learn: What Happens After They're Built*. New York, NY: Viking, 1994. Print. p178

fiberoptics. In designing the service spaces of the building, the architect may call for specifically sized channels and mounting equipment to support the new technology so that it will be easily integrated when the new cables are finally released. Then, a few years down the road, new advancements in wireless technology take the communications industry by storm and the service spaces, designed for cables, go unused. In this example, the prediction was not wrong- technology did advance and the nature of office communications did change - it was the solution to the prediction that was wrong - specifying a design for a specific technology. Because most predictions within architecture are of this nature - small, innocuous, and often overlooked - their impacts are fairly unrecognizable, even when they're successful.

A man in New Orleans may not have thought twice about the hatch in his roof until Hurricane Katrina flooded the ground level of his home and the hatch was there to allow him outside. His neighbor, on the other hand, who spent six hours attempting to break through his home's roofing material to escape, likely wonders why no one thought to add a hatch.*

Figure 11: Aftermath of Katrina

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* Photo by Reuters - David Philip, photographer

Phillip, David. "Hurricane Katrina - Rescues and Looting at Home, Men and Equipment in Iraq." *Nerdylorrin.net*. Reuters, 13 Aug. 2011. Web. 16 Dec. 2011. <http://www.nerdylorrin.net/jerry/Katrina/KatrinaRooftopRescues.html>.

Prepared Architecture, like reactive architecture, has its drawbacks. Prediction is essentially a guessing game and no matter how detailed the data or how strongly the research points toward a particular course of action. The future is simply too full of variables to predict. With Prepared Architecture, where the choices made are at best educated guesses, the probability of guessing right is slim. When guessing wrong could mean the livelihoods of many people, it's a risk simply not worth taking.

CHAPTER IX

PREPARED + REACTIVE = ADAPTIVE ARCHITECTURE

Accepting the fact that Reactive Architecture is a natural process with inherent flaws and that Prepared Architecture is a human process with inconsistent rates of success, what, then, is the answer to the peak oil problem? Instead of relying on reaction to develop the proper solution or putting faith in the ability to predict the future, the most reliable course of action would be to combine the two approaches.

We need to PREPARE our buildings to REACT to future problems.

The combination of these two approaches to design produces a new theory surrounding architecture that employs a holistic approach to thinking and aims to develop architecture that can adjust and adapt to future pressures. This theory might be called Adaptive Architecture and would combine the advantages of the natural reactive system with the strengths of preparedness for the future. Adaptive Architecture is not a product of design, but rather an approach to design that employes a holistic approach to thinking. Using the Adaptive Architecture theory, we can design buildings in a much more careful, controlled way that simultaneously increases their longevity and maintains their adaptability. Such an approach would not only be applicable to the Peak Oil dilemma, but could apply to any number of adversities that might impose themselves on buildings in the future. In the previous example involving fiberoptic cables and finding the wrong answer to the right problem, had the architect used an Adaptive Architecture theory, The

result would have been very different. Instead of designing for a very specific anticipated technology, they'd have designed their building to accept almost any new technology, whatever it may be.

At its core, Adaptive Architecture is a four dimensional architecture; height, width, depth, and time are all equally considered. The understanding of time as it relates to buildings is crucial in the successful application of adaptability. Within the design process, architects often consider the spacial characteristics without much thought towards the temporal characteristics and tend to build in the moment as a result. When time is not considered, an architect can often sign a building's death certificate before it's even been built. Stewart Brand's book, *How Buildings Learn: What Happens After They're Built*, is an excellent study of the relationship between buildings an time. Brand, an outsider to the field of architecture, provides a refreshing perspective to the subject:

> "Between the world and our idea of the world is a fascinating kink. Architecture, we imagine, is permanent. And so our buildings thwart us. Because they discount time, they misuse time. Almost no buildings adapt well. They're designed not to adapt; also budgeted and financed not to, constructed not to, administered not to, maintained not to, regulated and taxed not to, even remodeled not to. But all buildings (except monuments) adapt anyway, however poorly, because the usages in and around them are changing constantly." *

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* Brand, Stewart. *How Buildings Learn: What Happens After They're Built*. New York, NY: Viking, 1994. Print. p2

Buildings are often too strict on their occupants in this regard. They make change difficult by being difficult to adapt when the need arises. These two images present an interesting case for why time in buildings should not be discounted:

Figure 12: Brand's comparison

The first image is a watercolor produced for the auction of two identical Louisiana homes in 1857. The second image, taken 136 years after, is of the same two homes in 1993. Of all the precedents that exist in support of a theory surrounding buildings changing through time, these two are by far the easiest to understand.

At a glance, the viewer can discern that the two buildings, which were once exactly alike, have changed significantly in the 136 years since their construction. But even more than that - they've changed in significantly different ways. The house on the left, likely to provide some shade from the hot Louisiana sun, added a double story set of covered balconies. The house on the right, whose first floor was converted to commercial space, expanded the building with a two story addition to the right and a single story addition towards the street. The house on the left grew an additional story upward while the house on the right added a clear story, attic, and some exterior down lighting for night

time enjoyment of the first floor's roof deck. Both took on their own architectural style, covering the original brickwork with stucco scored to look like stone. Hints of the original structures can still be seen in the organization of the windows, the location of the entries, and the cornice dentals (which were more repeated than maintained), but the differences in growth patterns are emblematic of the fourth dimension of Architecture. These buildings changed as occupant after occupant staked their claim to some portion of its transformation.

Time holds many pressures for buildings, both from the people within them and the forces around them. Historically, buildings were designed to last; the Greek and Roman temples of antiquity are testament enough of that. But following the industrial revolution, the world was swept up in a fit of disposability and consumerism. Americans were likely the worst offenders in this regard. We changed the way we lived and this translated into a change in the way we built. Susan Strasser, author of the book Waste and Want: A Social History of Trash, says:

> "The modern relationship to the material world linked products made to be used only once, municipal waste collection, and attitudes that equated handy new inventions with ease and prosperity. A technological and organizational revolution in production and distribution constituted the basis for this modern relationship. The physical volume produced by American industry nearly tripled and the horsepower of industrial machinery quadrupled

between 1899 and 1927. American industry spewed out a wealth of standardized, uniform goods..." *

Architecture, for similar reasons, began to take on some of these characteristics. Standardized methods and mass produced lumber allowed for a cookie cutter approach to home building, homogenizing construction methods everywhere. Developments in steel construction allowed International Style steel-and-glass sky scrapers to sprout up across the globe; All of it spurred on by the More-Quicker-Cheaper! campaign. But most of the time, in this explosion of cheap construction and drastic shift in national mentality, longevity was almost never considered. For all the experienced benefits they provided, these methods of construction sacrificed the timelessness of our buildings. Even with perfect maintenance, modern buildings are lucky to have a lifespan of 50-70 years. When longevity is compromised, so too is adaptability. Many, if not all, of our modern buildings are the product of this More-Quicker-Cheaper! campaign and are inherently UN-adaptable as a result.

A building designed to last less than a hundred years is much more likely to succumb to the pressures of a peak oil problem than one prepared to survive longer. In many cases, buildings are razed simply because they can't easily be adapted to a new use. They're simply too specific - too built for the moment to continue living beyond it.

The peak oil problem will demand adaptability from our architecture. It will be the job of the architect to use an Adaptive Architecture approach and ensure that their buildings are prepared to react to whatever pressures might emerge. A building whose

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* Strasser, Susan. *Waste and Want: A Social History of Trash*. New York: Metropolitan Books, 1999. Print. p170

longevity and fourth dimension potential are explored in the design process will find itself better suited to outlast the pressures of a future problem. As one of the most pressing issue to date,* peak oil provides us with a scenario in which to imagine an Adaptive Architecture theory's potential impact.

Adaptive Architecture is not a solution for peak oil alone, it's a comprehensive strategy for design and could potentially be applicable to any problems our future may hold. But thinking about longevity and calling it adaptive is not comprehensive enough. There must be a framework or set of principles within which tenets of an Adaptive Architecture theory can be practiced.

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* Not to discount the importance of issues such as climate change, availability of fresh water, and social justice.

CHAPTER X

DESIGNING

ADAPTIVE ARCHITECTURE

So how do we define Adaptive Architecture? How do we design it? At its core, Adaptive Architecture employs a theory known as the Six Shearing Layers of Change. Established by Frank Duffy, cofounder of the british design firm DEGW and president of the Royal Institute of British Architects from 1993 to 1995, this theory is the epitome of fourth-dimensional thinking in architecture. Duffy says:

> "Our basic argument is that there isn't such a thing as a building. A building, properly conceived, is several layers of longevity of built components." *

Duffy believed that the layers of a building - both physical and social - tended to change at different rates. This suggests that a layer like the structure of a building changes at a

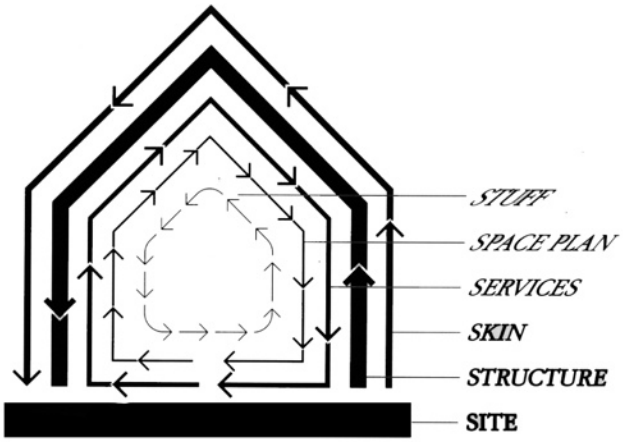

Figure 13: The six shearing layers of change

* Brand, Stewart. *How Buildings Learn: What Happens After They're Built*. New York, NY: Viking, 1994. Print. p12

significantly slower rate than the use of a building might. While the building may have a dozen uses in its lifetime, it will likely only have one structure. The Six S's - six differently paced layers of change - form the basis for all adaptive architecture. From slowest to fastest, these layers are: Site, Structure, Skin, Services, Space Plan, and Stuff.*

SITE - Site is both the physical, geographical location of the building as well as the context within which it sits. Generally, streets change very little while the buildings on them evolve. Site is the slowest of the six layers.

These two images of Boston's North End demonstrate the slow rate of the Site layer changes. The first image, an aerial photo from 1923, shows the organic nature of street organization. On the top left of the photo, you can see what is now the Charleston Bridge. Some of the major roads have been highlighted in Red.

In this 2010 image of Boston's North End, it is clear that many of the streets, or at least their organizing geometries, are still visible in the layout of the city. Important to also note is the chasm bisecting the city. Interstate 93 (highlighted in blue) has obviously sliced its way through the city, changing the Site layer significantly. Although the Site layer is by far the slowest to change, it is important to remember that nothing is permanent, even in the slowest layer. In recent years, under the massive infrastructure project known as Boston's Big Dig, interstate 93 was buried in a tunnel beneath the city and the street level returned to surface traffic. Pedestrian avenues, parks, and memorials enliven this once deadened space. (diagrams by author)

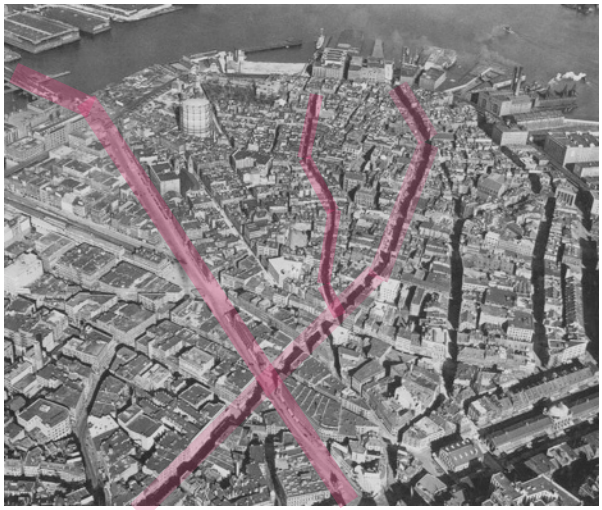

Figure 14: The permanence of Site in Boston's North End

* Brand, Stewart. *How Buildings Learn: What Happens After They're Built*. New York, NY: Viking, 1994. Print. p13

STRUCTURE - Structure is the second slowest layer of change but is, by far, the most important. Structure is the skeleton of a building. It's the framework on which everything else depends on. A well designed and well built structure can last 300 years or more if taken care of. Structure is also only effective if it maintains a degree of independence from the other Shearing Layers of Change.

The top image on the right shows the success of timber framing's Structure layer. Because the structure is strong and independent of the other layers, the space around it maintains a high level of flexibility. The owner of this home placed a counter and sink beneath a load carrying beam. In traditional stud construction, this condition may have been built using a 2x4 stud wall with a double plate above to support the floor joists as shown in the bottom image. If the owner intended to

Figure 15: Timber vs Standard Framing

remodel their stud framed house, they would find that in order to place an open kitchen where this load bearing wall wall exists would require an extensive and expensive construction process. First, the floor joists above would need to be supported on either side while the load bearing stud wall is removed, then a new, heavy beam capable of supporting all of the loads from the floor above would be built in place and columns would have to be located accordingly so ensure the beam doesn't sag. Finally, the temporary supports holding up the floor joists would have to be removed. Then the finish work would need to be started to bury the ugly construction condition beneath sheetrock and moldings. Structure is a critical component of adaptability and, as the slowest moving layer within a building, is the most important layer to get right.

SKIN - The skin of a building, like the structure, should have a certain degree of independence from the other layers. It's unique in that it often takes on two identities in modern architecture- both function and form. The skin is called the skin because, like human skin, it protects the interior layers from external forces. This is its function; to insulate, protect from weather, and provide a degree of privacy to its occupants (or none at all in the case of glass houses). In its second role, it exists as an expressive element. The skin often contributes to the stylistic design of a building, in many cases displaying materials or form to meet the Architect's vision. As both expressive and functional, the Skin layer has to meet a lot of expectations. Because of its exposure to the surrounding context, a skin can also have an impact beyond a single building. A simple update to the skin, as in the example below, can begin to have an economic impact on its neighborhood.

The Cafe Verde (the squat building in the middle) on Essex Street in Lawrence, Massachusetts was opened in 2010. It moved into a run down, vacant building and began to transform the nature of the street around it. Lawrence has a notoriously high crime rate and most of its residents live below the poverty line. These before (top) and after (bottom) photos show how a change in the Skin of the building can be as extensive or subtle as required. A good skin is easy to work with, easy to maintain, and easy to update. In this case, all of the windows and doors on the facade of the building were maintained. The brick, which was formerly painted, was cleaned and restored. The largest change, as is the case in many small urban centers like this one, was in the street level window front, where the color and material beneath the archway changed from glass, covered by bars and a roll down metal screen, to wood with some windows and a recessed entryway.

Figure 16: Cafe Verde: Before and after

As advancements in technology surrounding energy efficiencies in windows, insulation, and other Skin elements are developed, it will be important for the skin to allow for upgrades in both quality and style. Ease of application contributes greatly to the ability of owners to upgrade their building envelope. In fact, many north eastern homes built over the last 150 to 200 years are still uninsulated. Were it not such a difficult process, many Americans would have insulated their older buildings with newer spray foams or cellulose, but the process often requires tearing out the interior finish material or removing the exterior sheathing, both of which are costly and time consuming.

SERVICES - The Services layer is not necessarily a layer that many architects consider in the design process. Most of the time, services aren't even considered

"architectural" and are often hidden in shafts and within the left-over spaces in a building. Despite their obvious neglect, the Service layer is just as important to the building's function as its roof, windows, and walls. Services, as Stewart Brand describes them, are the "working guts of a building: communications wiring, electrical wiring, plumbing, sprinkler systems, HVAC (Heating Ventilating and Air Conditioning), and moving parts like elevators and escalators."* If we compare a building to the human body again, where Structure is the skeleton, Services could be likened to our circulatory and nervous systems. These are critical systems not only to a building's performance, but also to its occupant's comfort, and the latter is frequently contended issue.

HVAC engineers often battle with architects over the placement and size of duct work within a building. The HVAC engineer, whose primary concern is the health and safety of the building's occupants, may recommend a certain sized round duct to provide enough ventilation to a room. The Architect may argue that to do so would force a reorganization of the primary living spaces and refuse to change the scheme. Since the architect is often at the helm of the design phases, they instruct the HVAC engineer to work around the problem. The HVAC engineer, having been beaten, is forced to choose a smaller, rectangular duct to fit within the designed space. Two years after construction, occupants in the building complain that it starts to smell when more than half a dozen people are using the room and another HVAC engineer is hired to inspect the current system and design a new one if required. The new engineer realizes that the current ductwork has too much static pressure and not enough volume to handle refreshing the air

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* Brand, Stewart. *How Buildings Learn: What Happens After They're Built*. New York, NY: Viking, 1994. Print. p13

within the space, so they specify a larger round duct to fix the problem. Because the chase space was specifically not to handle large round ducts, the new ones have to be run along the ceiling. In the end, the architect's grand design was ruined anyway.

Services are seemingly innocuous because they're often hidden within the bowels of our buildings, but they play an important role in human health and comfort. Also, as society changes and technologically advances, we're beginning to see new needs for services that were once never considered. The design of a building does not, by any means, have to be centered around the services, but for a building to remain adaptable, the Service layer should be thoroughly considered in the architect's conception of the design, especially with regard to the building's adaptability and it's relation to time.

SPACE PLAN - The Space Plan layer might better be called the Programming Layer, but in the interest if keeping it the Six S's, we'll go with Space Plan. The Space Plan is basically the layout of everything on the interior of the building. Where the walls are placed, where the doors go, which rooms serve which functions - these are all examples of space planning. In the field of

This bubble diagram was developed as an aid to better understand the complicated relationships between people and spaces within a building. (Photo By Author)

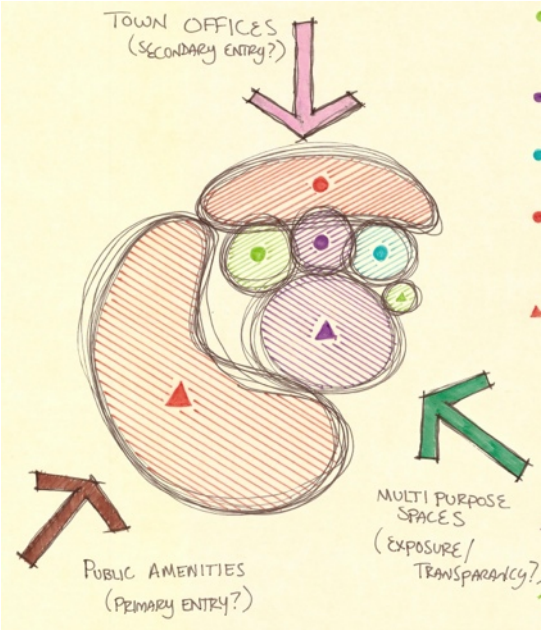


Figure 17: Bubble diagramming

Architecture, this is perhaps its crowning achievement. Architects have developed an intricate system for designing and organizing the program of a building and it's almost risen to the level of an art form in itself.

When designing a building, architects will almost always sit down with a client prior to the start of the design process to get a sense of what exactly the building will contain. This process is generally called Pre-Design and forms the base on which all future architectural decisions are built upon. A company looking to expand their business may go to an architect with the need for manufacturing floor space, a new employee wellness center, and a larger public showroom. It's the architect's job to take that information and organize it into a building design- including spaces the client may not have known they needed; two bathrooms to handle the increased clientele, a kitchen and break room for employees, a series of storage rooms to house extra product samples for the showroom, etc. The architect, as a space planner, is a programmatic problem solver.

The activities that contribute to the rate of change in the Space Plan layer are already fairly important to the architect, so all that's left is for the architect to recognize and understand this layer's relationship to the others and its relationship to time. Unlike the previous layers, the Space Plan layer changes rather quickly; on an order of magnitude of between 3 and 30 years depending on the type of building. A retail space, for example, may find itself changing on an annual basis to accommodate new products or new methods of displaying them. A small storefront in a downtown may find it brings in a new tenant once every 3 or 4 years. Each tenant then remodels the space to suit their needs. The space plan of a house, on the other hand, may not change more than once or

twice in a life time. Perhaps the formal dinning room is removed, the kitchen enlarged, and an eat-in kitchen style dining area added, but it's not common to see a home turned into a retail outlet or visa versa.

When Architects use space planning, it's often in the initial design of the building and a well designed space plan is likely to accommodate its occupants uses perfectly, however fast they change. But without recognizing that the Space Plan layer is the second fastest changing layer in the system, the wrong choices may be made with regard to the Structure or Skin layers. Suppose the plan calls for a one story building filled to the brim with small offices. The space plan of this arrangement might make it easy to suggest that the close

Figure 18: Cafe Verde: Interior

The interior of Cafe Verde demonstrates what a change to the space plan layer means for a building. In this case, the existing open plan allowed for an easy conversion of the old workshop space into a trendy cafe. The room in the rear of the building had a higher ceiling than the main building and when the dividing wall was removed, this space proved an excellent venue for live music. Were it not for the relationship between the old space plan (workshop/commercial use) and the building's open plan structure, the potential for a cafe space like this would have never been discovered.

proximity of separating walls means a wide span column grid can be avoided; just use the interior walls as bearing walls and the cost of columns can be crossed from the budget. Twenty years later, however, that building may get purchased and converted into a dance studio. Since the Architect relied on the separating walls to support the loads of the roof, the space isn't easily converted to an open plan. The bearing walls are not easily removed and the process of adapting the space into a dance studio, karate dojo, or open office plan is impeded.

STUFF - Stuff is the final and fastest changing layer. It's composed of chairs, desks, phones, pictures, appliances, and everything else in our homes that isn't nailed down or permanent. Often it's not one of the architect's greatest concerns, but it should still be considered for its frequency of change. The Stuff layer, like Space Plan, changes as it's occupants need it to. The location of a piece of furniture may move out of whimsy or utility. The size of furniture may change as families grow or as styles change. People, although often creatures of habit, do not necessarily enjoy stagnation. With the ability to move around our stuff, our homes and offices become extensions of ourselves and we manipulate them accordingly. Because of its rapid rate of change and incredibly personal nature, an architect can't easily design for the Stuff layer in the way they might design for Space Plan or Structure. They can, however, avoid designing against it. For example, built in furniture within a home looks great for the first few photos, but over time, as it's used and understood, the ability to change it is impeding to the people occupying the space. Similarly, over-designing a space for particular types of Stuff is equally limiting.

For example, a bedroom designed with only one location with which to place a bed may find itself working against the rate of change of the Stuff layer. Because it can't be planned for as intently as Structure or Skin might be, the Stuff layer requires an architect to be conscious of its relationship to the other layers and its relationship to time, without trying to control it too heavily. Like all the layers of change, flexibility is key.

Figure 19: The glass house
Philip Johnson's Glass House in New Cannan, Connecticut (1949) is an example of such a bedroom. Although the nature of the house was one of overt exposure and expression, were someone to occupy this bedroom and desire to change the placement of the bed, they would soon find they are limited to the wall it's currently placed against.*

When all of the six layers are working together towards the future adaptability of a building and their relationship to one another and to time is respected, Adaptive Architecture can be produced. The key to designing Adaptive Architecture is to demonstrate an understanding of the Shearing Layers of Change and to recognize their varying degrees of independence and interdependence. When we understand these relationships, we can plan for their abilities to react. These layers all change at different rates. When the differently paced

*Philip Johnson Glass House. National Trust for Historic Preservation. Website. Date of Access: May 4, 2011. <http://philipjohnsonglasshouse.org/>

systems of Site, Structure, Skin, Services, Space Plan, and Stuff fail to work in harmony, the faster-paced layers of change are impeded by the slower paced ones. Similarly, the slower paced layers might be chewed up and destroyed by the faster paced ones. When Services are integrated with Structure (as is the case in stud framed homes, for example, where the piping and wiring is often run through holes drilled into the structural studs), the need for the Services layer to change is impeded by the slower paced structure. Similarly, when the Space Plan changes rapidly and interior walls all act as structural walls, the Structure layer is chewed apart by the constant change.

The purpose of the shearing layers of change is intended, like Adaptive Architecture itself, not to prescribe a particular method as a solution, but to provide a framework within which we can design better buildings. When a building retires, its resume should read:

> "3,000 arrangements of Stuff, 75 different Space Plans, 50 Services updates, 10 Skin upgrades, 1 Structure- slightly altered and expanded 5 times, and a Site that gained as much from my presence as I did from it."

In many ways, Architects already use the six layers in their design process. As Peter Calthorpe describes, "What stays fixed in the drawings will stay fixed in the building over time. The column grid will be in the bottom layer." The industry doesn't need to recognize that different layers exist, but rather that these layers have such differently paced rates of change. Understanding this in a more holistic way will lead to more informed, more adaptive building designs.

Even materials can be thought of with an adaptive philosophy. Wood, which is a soft, easy to work with, readily available material, has a lot of economic advantages to its use in construction. It can be shaped quickly and nailed together securely. It's drawback is that - over time - it begins to warp, crack, and decay. Without constant inspection and maintenance, wood can be very quickly destroyed. Stone, on the other hand, is much more difficult to work with, much harder to acquire, and significantly more expensive to use as a building material. Unlike wood, however, stone is an incredibly durable material. A masonry building can be left unattended, at the mercy of the weather and the elements, for decades and still be useable. In architecture, the appropriate material is often chosen first by cost, second by appearance, and third by quality, but if Adaptive Architecture is the goal, then the building's life span should almost always take first place in this list. If a client has no intention of ensuring their building lasts through the ages, choosing an inexpensive material is wise, though the building will not be adaptive. If, on the other hand, a client hopes to pass their building down from generation to generation or to sell it in the future, then longer lived materials would be the appropriate choice and Adaptive Architecture the appropriate method. Although Adaptive Architecture prescribes no specific materials or methods, it is not without definition. Adaptive Architecture is an approach and, although it may be difficult to define what it is or what it looks like, it's fairly easy to define what it isn't.

CHAPTER XI
RECOGNIZING UN-ADAPTIVE ARCHITECTURE

Partially instigated by the abundance of cheap energy experienced in the 19th and 20th centuries, construction methods across the globe have developed a series of techniques and standards that has essentially homogenized the industry. Although these techniques have led to efficiencies and ease of construction, the commonly accepted benefit to the standardization of construction practices is through the regulation of safety in buildings. Building codes, for all their benefits, are potentially one of the largest antagonists to an Adaptive Architecture theory. To realize Adaptive Architecture, we have to learn to look beyond the construction practices that have become commonplace and the codes that have supported them. Although there isn't one, true method of designing it, Adaptive Architecture might be best defined by observing what inhibits adaptability. By establishing these qualities in modern day design and construction techniques, we can identify those characteristics that make them inherently un-adaptive. In the United States - partly because it's the most popular building type and, therefore, widely constructed in mass - the single family home stands as the poster child for un-adaptive architecture. To review the standard practices of residential construction is to begin to get a sense of what Adaptive Architecture isn't.

These two diagrams represent the two most common types of framing in the residential construction industry. Balloon Framing (right) builds the exterior walls out of single length studs and then hang floor joists from them. The other, platform framing (left), uses many of the same techniques, but builds a house one story at a time, resting floor joists on top of the walls below them. Regardless of whether a home is balloon framed or platform framed, this process of stud construction is commonly referred to as "stick built", and forms the backbone of the residential construction industry. It is a construction method built on ubiquitous materials and super-standardized assembly techniques. South Shore Custom Homes, a residential construction company located in Hope Valley, Rhode Island describes:

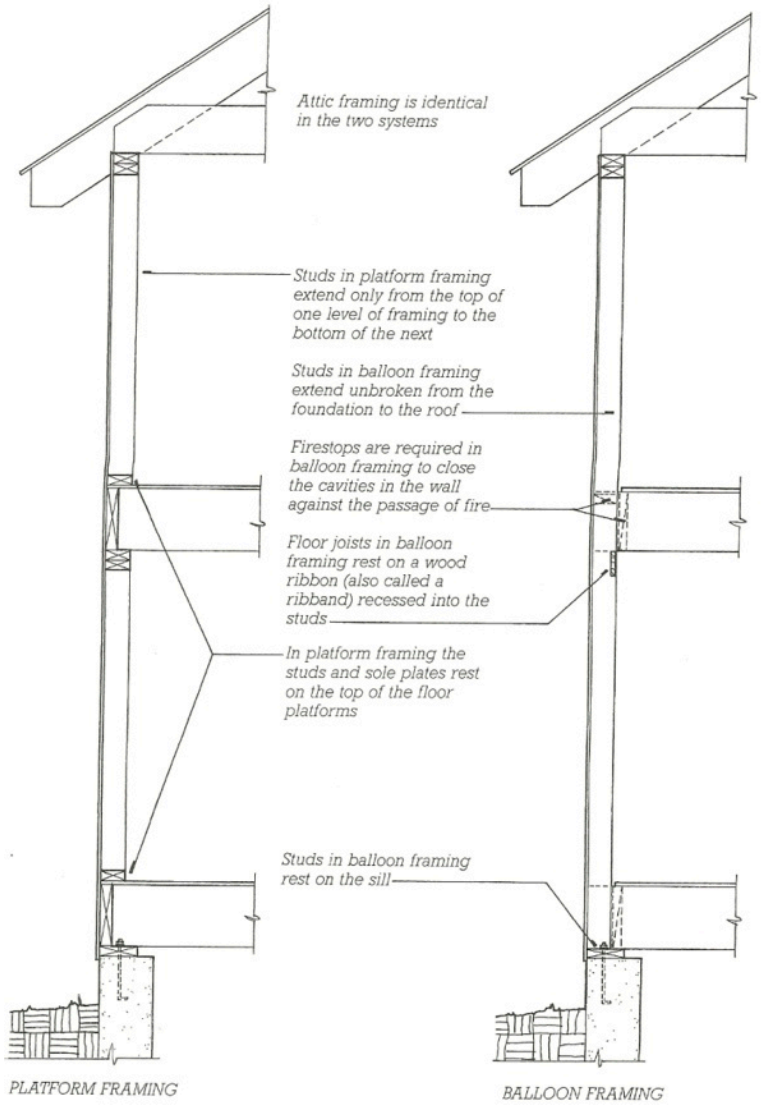


Figure 20: Balloon and Platform Framing

"Stick-built construction, deemed traditional by all standards of the trade, is the process of building a home on site with conventional wood-frame assembly. A stick-built, or site-built, home generally requires 12-18 months to complete, but the flexibility to change plans along the way and throughout the process is a considerable advantage to other construction methods." *

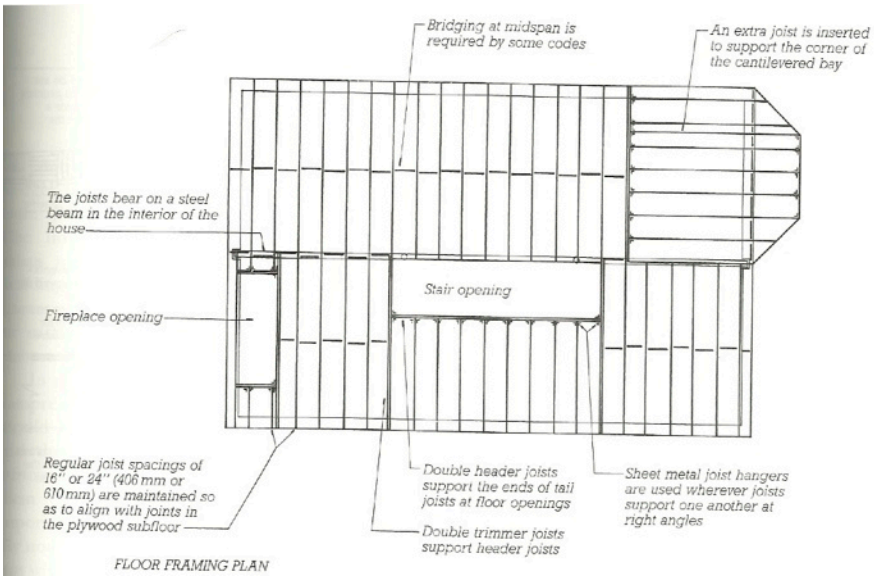


Figure 21: Standard Floor Framing

Although this is the common attitude amongst residential home builders, what they neglect to mention is that stick built homes - for all their advantages and ease of construction - integrate the six shearing layers of change so tightly with one another that the ability to significantly modify one of these homes is almost non-existent.

* South Shore Custom Homes, Inc. Website. Date of Access: May 5th, 2011. <http://www.southshoreri.com/stick_built_homes.html>

In construction like this, the house's initial design is the driving force behind all of its framing decisions. The location of the stairs in the home above determines exactly how the floor joists will run, where they will connect, and in what direction they will need to span. Although openings for stairs and fireplaces aren't under any extreme pressure to change, as this diagram shows, attempting to move them to another part of the house would prove very difficult.

Similar to openings between floors, openings within walls are often also as significantly limiting in traditional stick built construction. As these diagrams show, the standard method for framing is to begin with the established design and frame out the required openings, areas where walls join, and any other key features of the design. When this design-driven framing is completed, the remaining spaces between

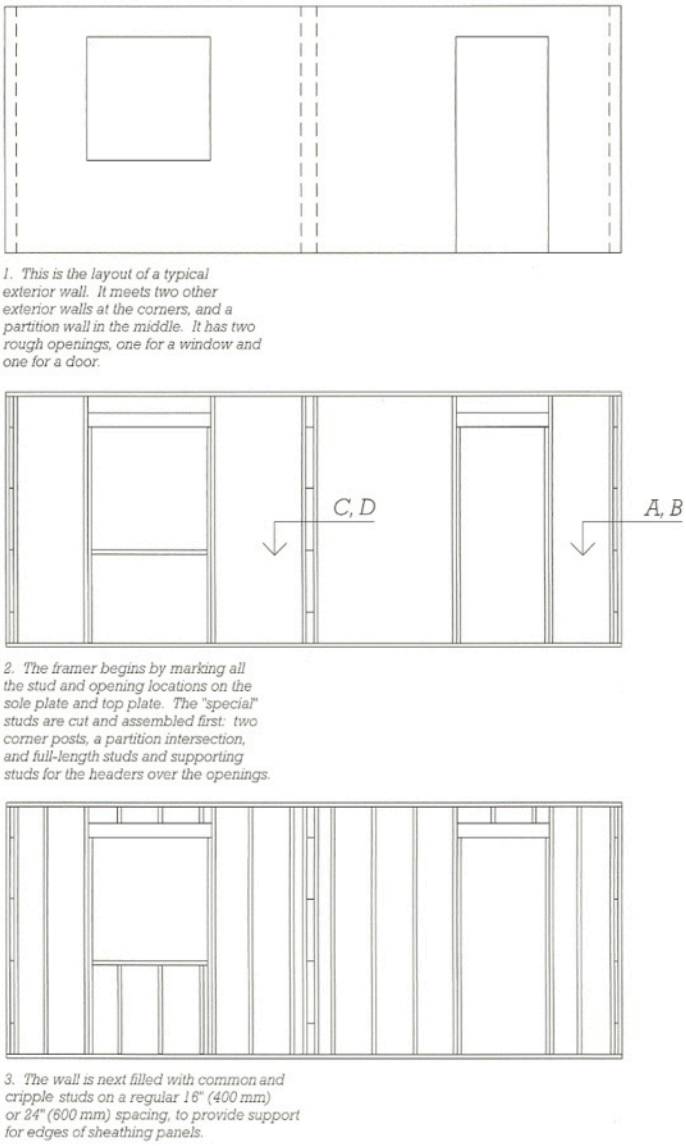


Figure 22: Wall Framing Practices

studs are filled. These studs are typically placed sixteen inches on center until the cavity is filled and the wall can carry the compressive loads from the floor or roof above. This process means that virtually every opening in the construction of a stick built residence is difficult to change because they're hard-coded into the structure of the building. That's not to say that all windows and doors are permanent once installed. Window openings can be fairly easily closed up and can also be added where needed with a bit of effort - but the process of changing an opening on the envelope requires a reconfiguration of the underlying stud structure, reconfiguration of the exterior envelope, and patching of the interior finishes.

When the studs within a wall are simultaneously carrying the structural loads while framing openings in the skin, change becomes a complicated process. Where windows are removed, excess studs typically remain in the walls leading to an unnecessary amount of thermal breaks in the wall assembly. This means that the envelope, which is now deeply integrated with the structure, allows heat to travel from the interior to the exterior on a cold winter day or visa versa on a hot summer afternoon. While it's cheap to build, easy to tailor on site, and delivers a finished product that is very much enjoyable, the downsides to this sot of integration of layers can lead to unexpected costs down the road, making it highly un-adaptive.

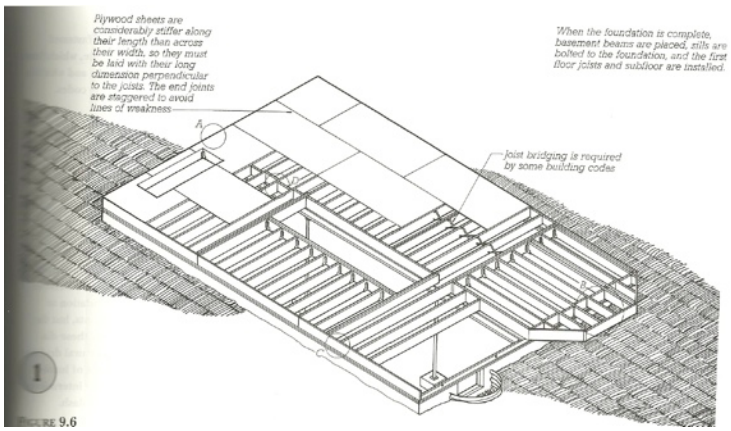
Similarly, the ability to easily custom frame any sized opening within a wall can often lead architects to make un-adaptive choices when designing buildings. While most windows are purchased in conventional dimensions, the stick framing and the ease with which it can be customized can prove a hinderance to repairs over time. This is especially

true when talking about window and door openings. If the structure and envelope are integrated with one another, then a non-standard window opening is likely going to stay that way; non-standard. This means that while the openings have been sized according to a window during design, replacement windows will need to be sized according to the opening later down the line.

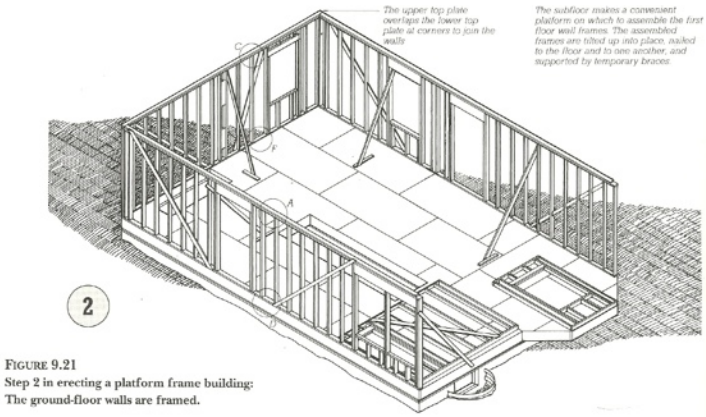
The windows shown on the right, installed in every apartment in the Squire Village Apartment complex of Sunderland, Massachusetts, are one such example of this. The ease of constructing custom sizes inspired poor design choices. Measuring around six feet by three feet, these sliding aluminum framed windows admit quite a bit of light, but also allow the loss of quite of bit of heat in the winter months. The apartment complex, built in 1969, has never been able to replace these windows with more efficient ones. The windows are now over forty years old and growing leakier with every year. Although replacing windows is generally considered an expensive task, in this case, it's virtually impossible. To replace these windows would require one of two things: the manufacture of brand new custom sized windows to fit the

Figure 23: Non-Standard Windows

existing openings, or the reframing of the existing openings to fit less expensive standard sized windows. In either case, the stick built methods that constructed this apartment complex so quickly and efficiently are now threatening to bankrupt it.



The faults of stick built construction extend well beyond the envelope and floors, however. As this illustration series shows, The integration of layers in a typical stick built house is present in virtually every aspect of it's construction. The house begins with a concrete, cmu, rammed earth, or other type of foundation. This foundation typically occupies the foot print of the house and determines, once it's completed, the outer limits of the envelope. Contrary to the claims of South Shore Builders, once the



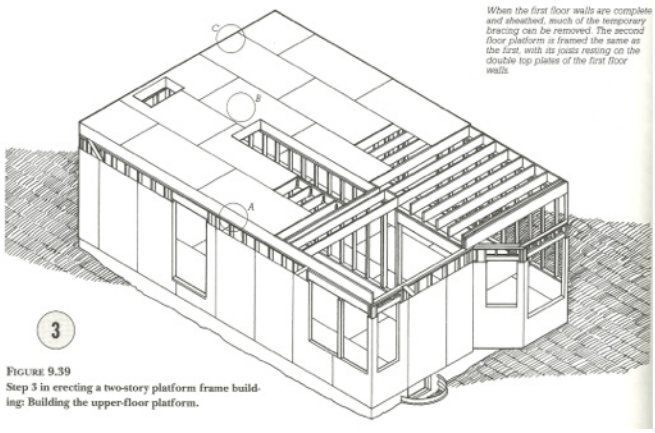
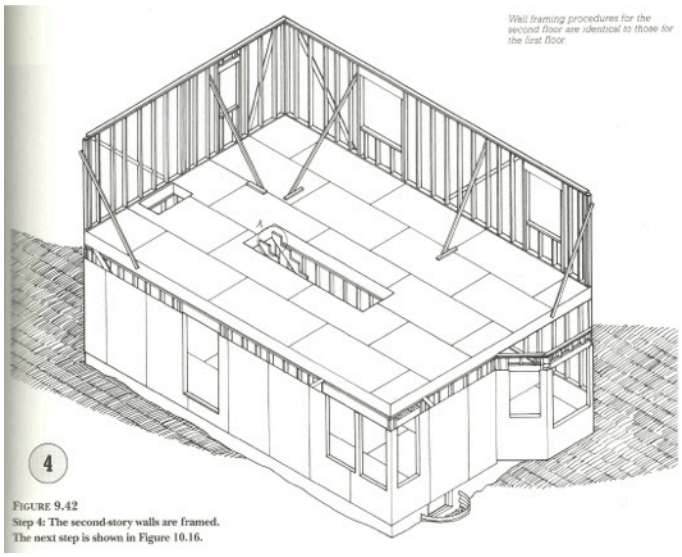


Figure 24: Stick frame construction from the ground up

foundation is finished, it is very unforgiving changing anything outside this footprint becomes nearly impossible. Following the foundation, the ground floor is built and sheathed to provide a platform on which to construct the walls of the house. These walls, as discussed earlier, are framed according to the original design and then raised into place, where they're connected to the floor. The third step, once the exterior walls have been sheathed, is to construct the second story's floor system on top of the first floor's walls. With the floor plates sandwiched in this way, between the top of the first floor walls and the bottom of the second floor walls, everything becomes a very permanent installation. Similarly, the sheathing process for both walls and floors, develops its own problem. Once these sheathing layers are covered up and hidden beneath their finish layers, they're very difficult to both change and repair. The only reason stick built walls



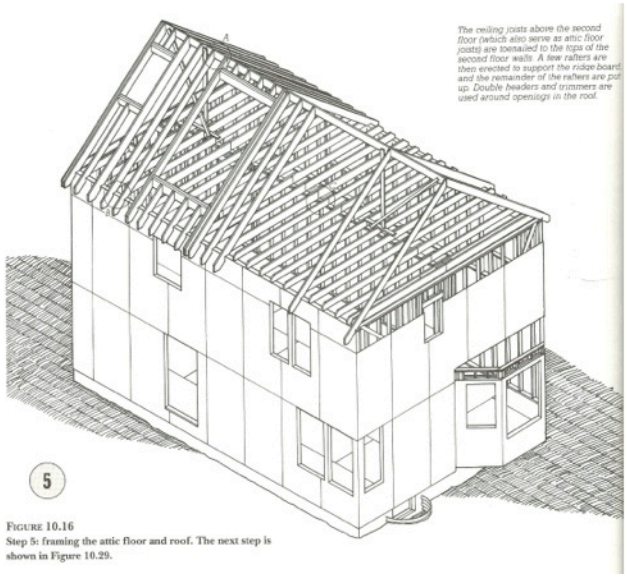


Figure 25: Stick frame construction comes together

require sheathing in this way is because the connections made between the numerous studs within a wall are so week on their own that, were it not for the sheathing tying them all together, the house would fall apart like a deck of cards. While studs are great at handling compressive loads from above, they do not perform well in resisting lateral wind loads.

The roof, unlike most walls or floors, can actually be one of the most difficult parts of a house to construct. Complicated roof forms require complicated structural connections. Steps 5 and 6 in the sequence show how variations in roof form often require complicated openings and roof members in order to remain structural. When all of the structure is built, the house is effectively complete. Walls, windows, doors, envelope, and footprint have all been pre-determined by the elements of one layer of change. While Structure is indeed the most important layer, allowing for such a heavy integration of multiple layers into it produces a house that is

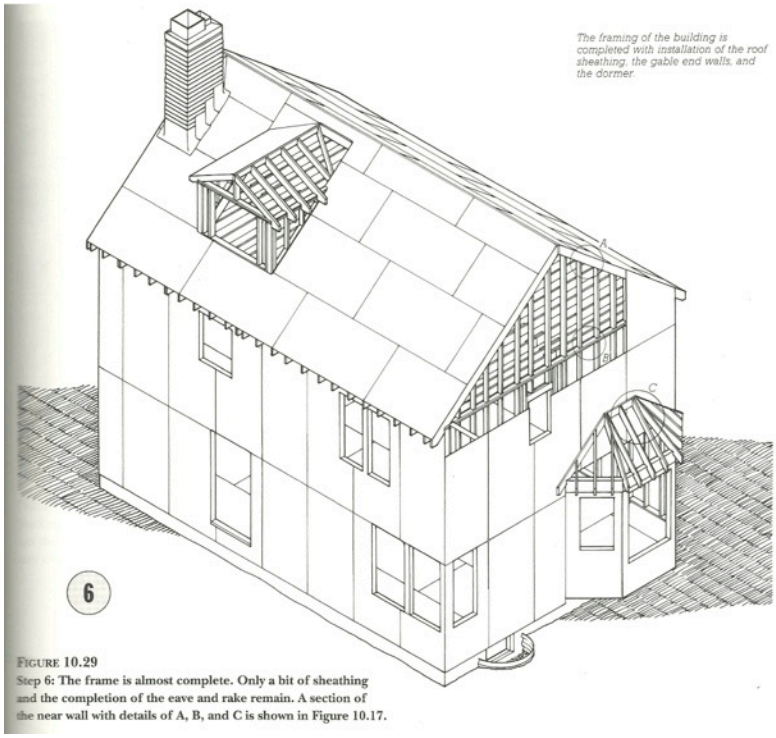
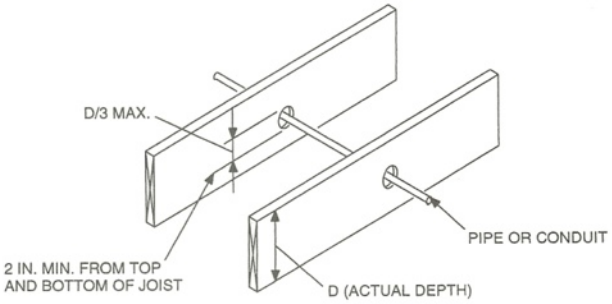


Figure 26: Stick frame construction completion

likely to adequately serve its occupants for the first 40 - 50 years of its life but may find itself struggling to keep up beyond that.

Following this process of construction, the remaining work commences. After spending all that time and energy framing floor joists and wall studs, various sub contractors will now come in and tear it all apart. Because the desire to hide a building's services is so strong, plumbing, wiring, and other elements of the Services layer are embedded as deeply as possible into the walls, floors, and roofs of the Structure layer. It's become such common practice to drill holes into floor joists that even modern building codes have a regulation for it to ensure the structural integrity of the member isn't compromised. Plumbing can be the worst offender in this regard, as it seeks to both reach its destination with the shortest length of pipe possible and allow for hazardous effluent waste to safely leave in the opposite direction. While basements or crawl spaces are traditionally reserved to house the often messy net of plumbing tubes



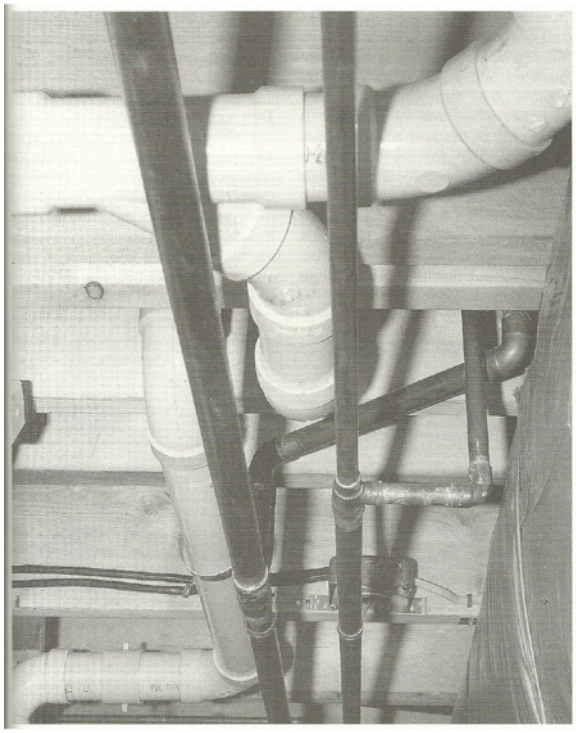


Figure 27: Utilities, the stuff of nightmares

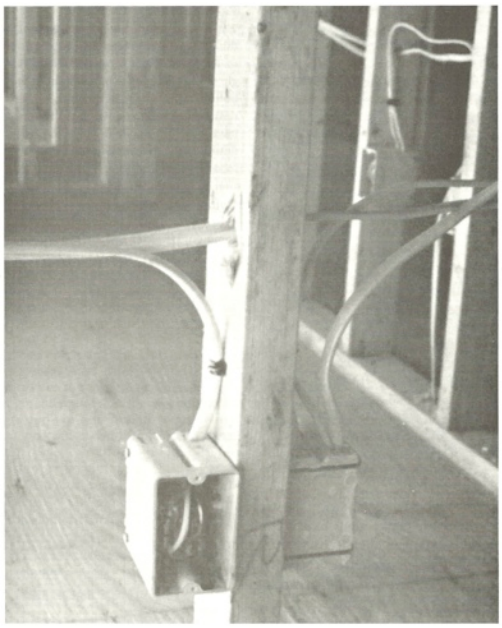
and pipes, there is often a need to conceal them within the depth of the floor plate. This requires significant cutting of the structure which, if done correctly, may not reduce the structural integrity of the joist, but will certainly make it difficult to replace the services in the future. As seen in the bottom image, The need to hide a piping system within the ceiling of this space has driven the pipes through both the floor joists and the header joists.* When services are integrated so deeply into structure like this, the result is as hard to adapt as custom window openings. In the future, if a bathroom is relocated or a sink moved to the other side of the kitchen, all of the piping will have to be re-run and new holes will need to be drilled through the floor joists to accept them. While wood is an inherently forgiving material, construction in this way means that the house is ultimately not immortal. It will either have to freeze in time and disallow changes or risk changing more than the shearing layers of change can handle. There are only so many holes you can drill into structural members before they're not

Figure 28: Holes are permanent fixtures

* Header joists are the joists that frame the floor around the exterior footprint of a building and provide a nailing surface connection for the end of floor joists. In this picture, it is seen in the background. A hole has been drilled to accept a pipe and a second hole can be seen with no pipe yet installed.

longer structural. Constructing in this way automatically gives a building a half life. This is essentially un-adaptive.

Electrical wiring operates in much the same way as plumbing - cutting through structural members in an attempt to reach its destination and remain hidden. While the boxes are moveable so long as there's a stud to attach them too, the writing is forced to run through holes in the studs and is often installed at just the right length, with no excess, so relocating an outlet may be out of the question without a whole new length of wire.



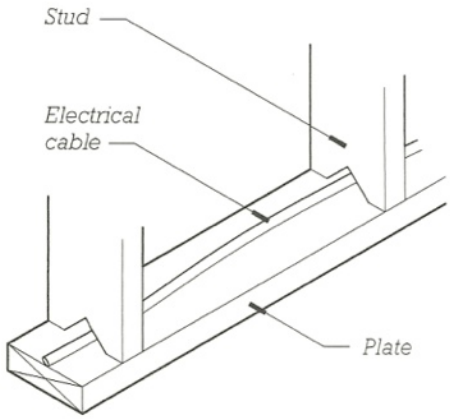


Figure 29: Electrical wiring buried in walls

On exterior walls, where structure is often integrated with the thermal envelope and skin, services have caused serious issues with energy efficiency. Because they often take up space within a wall cavity and compress the insulation to make room for them, services have been proven to reduce the energy efficiency of a wall as if a hole had been cut right out of it. Recognized as a problem, some contractors are beginning to experiment with new methods of installing these services. The diagram above shows an expensive, time

consuming, and still not quite ideal method for keeping the electrical wiring out of the space where insulation should be. By cutting notches at the base of all the studs, a channel is created to run any wiring that needs to go through the wall. Although this method is significantly better than running wiring through the center of a wall's studs, it's still far from ideal because the services are still hidden behind the finish materials. It is progress, though.

Similarly, advances in engineered wood members like the open-web truss joists, pictured on the right, are reducing the need to drill through solid sawn joists by providing open spaces for services to pass through. Although the spaces are still not the ideal shape or size for some mechanical ducts and other services, it does point out that as pressures mount, the standard methods of construction can be motivated to change. Reactive Architecture processes will tend to invent new ways of building things that would have been considered pointless or expensive in the past.

Figure 30: New technology provides new opportunities

Despite all of the above examples of why standardized stick built construction is un-adaptable, there do exist examples of how it has been partially adaptable. For example, although sheetrock, carpet, tile, and wainscoting tend to hide our services within the walls and floors, the finish materials do provide an interesting separation

between some of the shearing layers of change. The Structure layer, to which the sheetrock and carpet is applied, is separated from the Stuff layer by a removable, replaceable barrier. It allows occupants to change the color of their space, tear out their old carpet, move around their family photos, and tack up posters of their favorite movies without interfering with the structure beneath these surfaces. The inside of a house may go through a series of evolutions in style over the ages without ever having removed a stud.

Roofing and siding work in much the same way. They're designed, manufactured, and installed with the intention of being replaced. These layers that exist as the interior and exterior finish tend to remain separated because of all the wear and attention they get. The process by which roofs are siding are installed allows for the easy replacement of the roofing and siding material and also makes adaptability fairly easy. When technology changes and provides a better performing material, the owner can upgrade without much headache. In recent years many home owners have been opting for standing seam metal roofing as a replacement to their existing asphalt shingles because of the experienced

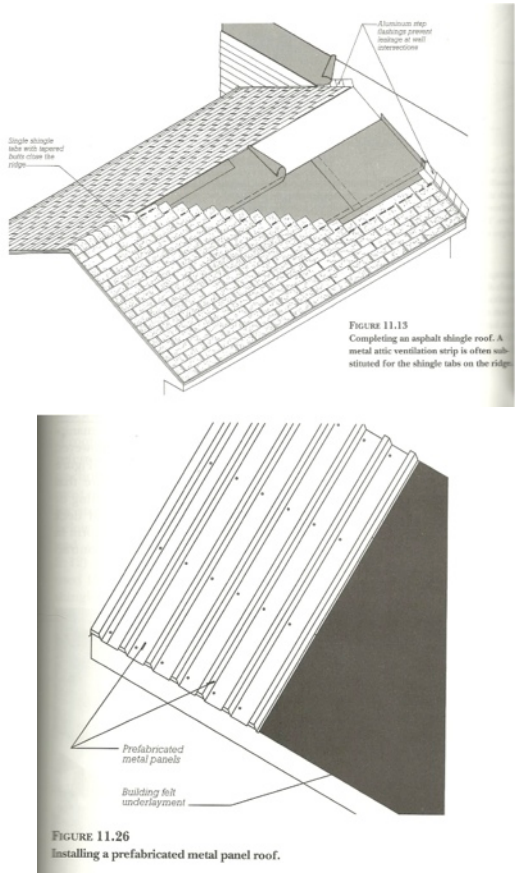


Figure 31: Roofing Systems

long life and durability of a metal roof. The flexibility of keeping the roofing finish independent of the structure or envelope means that this Skin layer can be easily replaced.

Not all roofs, however, are as adaptable as pitched roofs might be. Flat roofs, often considered one of the worst products ever spawned by the Modern movement, are the perfect example of how invention can lead a historically adaptable construction method into an incredibly un-adaptable state. The image on the next page shows the typical layers and construction process that a flat roof employs to produce these iconically modern building tops.

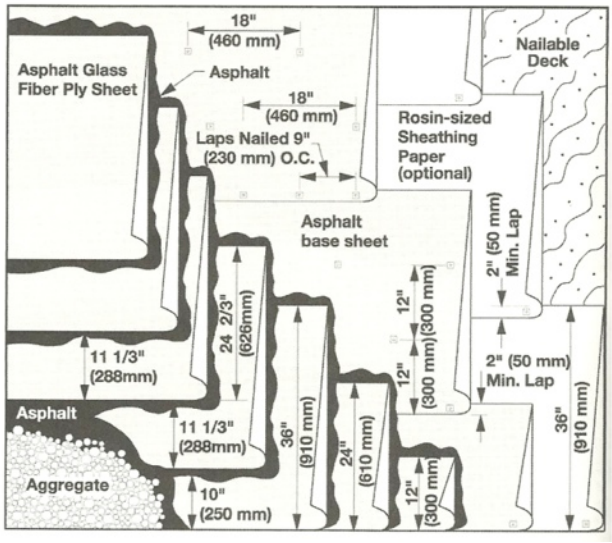


Figure 32: Flat roofing system

While a flat roof provides a building with extra space on which to recreate, store out-door furniture, or locate service equipment, it also performs rather terribly as a roof. Flat roofs are almost always leaky and, what's worse, when they sprout a leak it's almost impossible to identify the source. The series of horizontal layers of asphalt, sheathing papers, and gravel allow any water that might find its way into the building to do so in the most indirect, inconspicuous manner possible. Maintenance and replacement of flat roof decks is costly and labor intensive; two qualities that make it such an un-adaptive design decision.

Having easily identified which methods of construction stand as the antithesis to Adaptive Architecture, it is necessary to exhibit some methods of construction that are on their way to becoming adaptive. Through a combination of financial investment and an educated work force, timber framed buildings are beginning to increase in popularity over stick built buildings. As the value of their strong, independent structural systems are rediscovered, their ability to compete with the cost efficiencies of stick built buildings is being established.

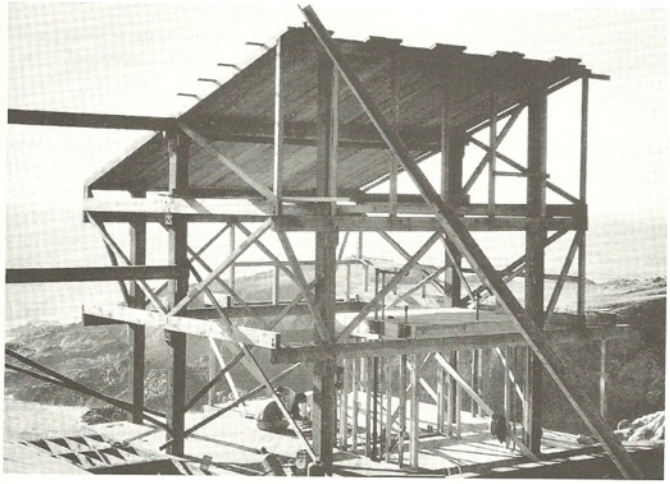


Figure 33: Sea Ranch Condominiums, Northern CA (1965)
Designed by architects Moore, Lyndon, Turnbull, and Whitaker and structural engineer Patrick Morreau.

The images on the right show an example of a timber framed building that demonstrates the values of independent shearing layers of change over those of stud construction. The bottom picture shows the first obvious advantage: the Structure layer is independent of all other layers and is entirely free standing. The stud framed building types discussed earlier

required a redundancy of wood studs as well as a binding sheathing layer that secured it all together and prevent it from falling down. The result of a free standing structure such as the one seen at Sea Ranch Condominiums, where the exterior openings, interior spaces, and faster-paced layers of change are unimpeded by the integration of structure, is that interior walls and floors can be installed virtually anywhere while exterior wall openings can be removed and added without fear of compromising the structural integrity of the building.

Although most people consider timber framing a historic practice that has only just been copied for its appearance, modern examples exist as proof that, at the heart of their revival, timber framed buildings are re-discoveries of the values of longevity.

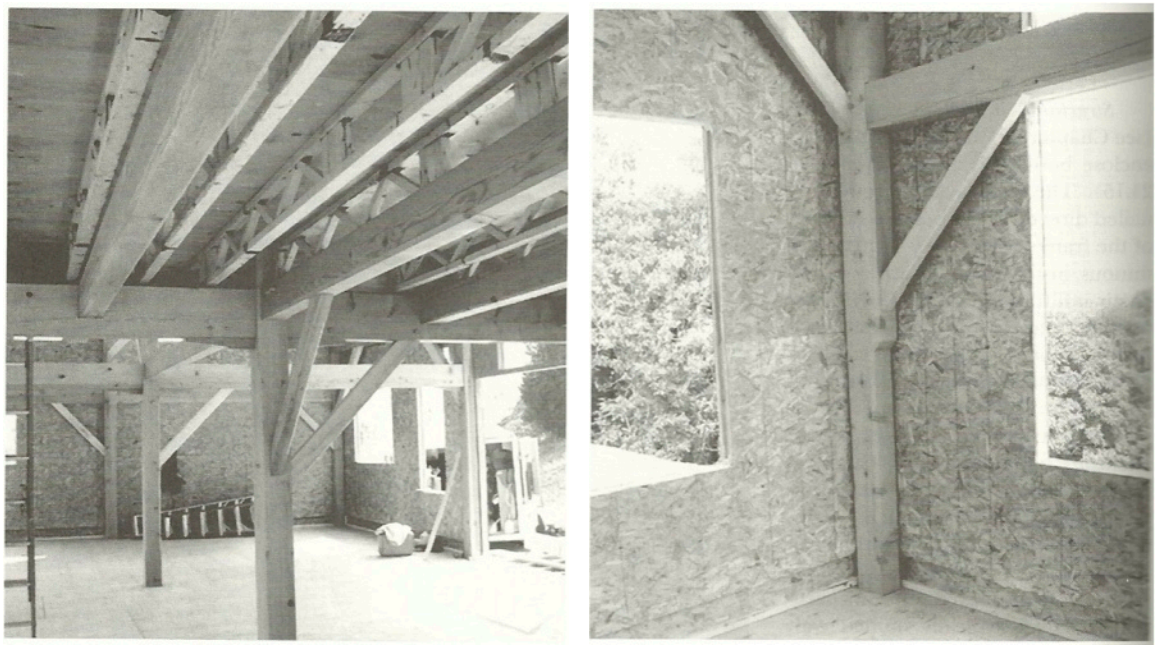


Figure 34: Timber Framed Home
Designed and constructed by Benson Woodworking of Alstead, New Hampshire

In the case of this home, pictured above, timber framing was the foundation for invention. A combination of old technique and new technology developed a system in

which timber framing provided the core structure of the building while SIPS*formed an energy efficient envelope. Similarly, open web truss joists provided support for the floor above and simultaneously provide space for the services to run. The image below on the right shows how notches in the base of the SIP panels allow for wiring and other small services to be run through the wall, remaining hidden without compromising the integrity of the panel. Because of the holistic approach to thinking and attention to the shearing layers of change that was behind the process of designing this timber framed home, it will likely stand, for a very long time as an example of Adaptive Architecture. Without prescribing a particular method of construction that is appropriate for the realization of Adaptive Architecture, it is difficult, still, to define it. The important thing to understand when trying to define Adaptive Architecture, then, is this:

For Adaptive Architecture to exist, it must first live
to see the day when it can be adapted.

A building that obsolesces within the lifetime of its designer has no chance to adapt. It's quickly torn down and new architecture sprouts up in its place. Christopher Alexander, a California architect famous for his book, *A Pattern Language*, has this to say about designing long lived buildings:

> "Longevity has no chance without serious structure. A building's foundation and frame should be capable of living 300 years. That's beyond the economic lifetime of any of the players. But construction for long life is

* SIPS (Structurally Insulated Panels) are pre-fabricated wall and roof panels made from sandwiching insulating foam between two sheets of ply wood or OSB (Oriented Strand Board).

what invites the long term tampering it takes for a building to reach an adapted state."*

As explained before, Structure is on the front lines of the fight for adaptability. It is the most important of the six Shearing Layers of Change, without which, the other layers can't exist. In order to realize an Adaptive Architecture theory, we have to be able to think beyond our economic lifetimes to justify the intense investment in structure that is required to develop a 300 year building.

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* Brand, Stewart. *How Buildings Learn: What Happens After They're Built*. New York, NY: Viking, 1994. Print. (p194)

† All images and precedents discussed in this chapter were borrowed from:

Allen, Edward, Rob Thallon, and Joseph Iano. *Fundamentals of Residential Construction*. Hoboken, New Jersey: J. Wiley & Sons, 2006. Print.

CHAPTER XII

THE 300 YEAR BUILDING

Let's begin by acknowledging that calling something a 300 year building is just a way of saying it's "an incredibly long lived building." The idea is that a 300 year building is generational. It's something passed on from person to person, each of whom injects a little bit of themselves into its adaptive layers. The 300 year building is not required to live through all 300 years, nor is it required to die when it concludes its third century. The 300 year building is goal; a benchmark.

When designed properly, the 300 year building is never stagnant; it welcomes change and facilitates it gladly. It is both a thing of history and a modern legend, establishing its identity through the ages and accumulating layers of human investment along the way. The 300 year building is not necessarily a building, it's a continuity of construction. A tagline for this philosophy might be:

"A building is not something you finish.
A building is something you start." *

It would be difficult to identify a modern example of a 300 year building. Virtually every example of post World War II architecture has both an air of permanence and a significant lack of it. Their insensitivity towards time produces buildings that are so un-adaptable, they stay the same for decades. They aren't altered and, as a result, nothing

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* Brand, Stewart. *How Buildings Learn: What Happens After They're Built*. New York, NY: Viking, 1994. Print. p188

happens with them until the cost of demolition no longer exceeds the cost of repairs. Boston City Hall will likely be one such example.

Figure 35: Boston City Hall (1969)
Designed by Kallman, McKinnell & Knowles

There are examples of 300 year buildings still standing in America, though almost none of them are modern examples. These historic buildings have stood the test of time and have reached an age where their patina is almost endearing. More often than not, the long life experienced by these buildings is the result of rigorous maintenance, generational care, and a sturdy set of bones. The Fairbanks house in Dedham, Massachusetts, is one such example. It stands as the country's oldest timber framed home and, despite its sagging roofs, had housed the Fairbanks family for a little over 355 years before it was opened for tours.

Figure 36: The Fairbanks House
(circa 1636)
The massive chimney helps to support the expansive roof surface, which has sagged as a result of 375 harsh New England Winters.

Jonathan Fayerbanke build this timber framed home for his family in the new Massachusetts colony. Although relatively small at first, the house grew a number of times between 1636 and 1725. The family replaced its thatched roof to one of slate and then later to wood shingles. Part of the house was extended (to the left in the photo) to connect it to the adjacent barn. Another addition was made (in the foreground of the photo) and a shed dormer was added. After suffering from New England's heavy snow loads, the newer shed roof was steepened until it was practically flush with the original roof. Over the course of its evolution, the Fairbanks House had grown from four rooms to fourteen, plus an attic and various basements.*

The last of the Fairbanks' moved out of the house in 1991, when it was opened to the public as a historic site. Tours are given through the miraculously well constructed and maintained timber framed home where visitors can view, first hand, the marvels of 17th century craftsmanship.†

Figure 37: Fairbanks kitchen

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* Brand, Stewart. *How Buildings Learn: What Happens After They're Built*. New York, NY: Viking, 1994. Print. p121

† "Fairbanks House." *Fairbanks House Historical Site in Dedham, MA - Home Page*. Web. 10 Mar. 2011. <http://www.fairbankshouse.org/>.

In 1980, for Boston's 350 Celebration, A replica of the Fairbanks House's remarkable timber frame structure was constructed using period tools and methods. (pictured below)* Although timber framing is not the only construction method capable of producing a 300 year building, the Fairbanks House is a testament to its value. It also highlights some important facets of the 300 year building. It's clear that the Fairbanks house was able to survive as long as it did because of it's heavy timber frame and the generations of people that maintained it. Structure is clearly important in supporting the durability and adaptability of architecture. It also shows us that Adaptive Architecture doesn't require the invention of of new technologies to exist. We can achieve it with the tools we've had for hundreds of years.

Figure 38: Fairbanks reconstruction

Houses don't tend to go through as many revisions as commercial buildings might, but as the Fairbanks House demonstrates, 300 year buildings are certainly no stranger to transformation. The extensions of the main house, addition of a connected outhouse, and expansion of the main floor with the construction of a shed dormer were all

* Howe, Jeffery. "Digital Archive of American Architecture." *A Digital Archive of American Architecture*. Boston College, 2000. Web. 10 Mar. 2011. <http://www.bc.edu/bc_org/avp/cas/fnart/fa267/>.

made possible by the forgiving nature of the Structure layer within the building. The heavy timbers were easy enough to swap out, cut into, attach to, and enhance. this meant that the process of adapting the building was made easier by the building itself; it facilitated adaptation.

Had the structure of the Fairbanks House not been as well constructed and forgiving as it was, the burden of expansion or renovation would have ultimately led to its deconstruction. The only reason the house lived 375 years-and-counting is because of the combined efforts of the family it housed and the structure that housed them. In a 300 year building, when all of the six Shearing Layers of Change are working in unison towards adaptability, this kind of reciprocity between buildings and occupants will be the norm.

We'll need to design our buildings for a long life if we're ever going to reach a point where we're able to adapt them. It will require not only a shift in construction techniques, but a departure from the current mindset that buildings are commodities. Thinking about buildings in this way is a radical departure from the way we look at buildings now, but Adaptive Architecture and the 300 Year Building philosophy will begin to change the way we understand the nature of "old" buildings and will demand the reevaluation of commonly held notions around what is "historic" and, more specifically, what is "Vernacular."

CHAPTER XIII

REDEFINING "VERNACULAR"

The nature of old buildings is a difficult one to define; they are, at once, cherished and despised. Some people look to old buildings with a sense of nostalgia, while others view them with disgust. Though there seems to be some disjuncture between the two parties, there is a distinct difference between "old" buildings and "dead" buildings.

"Dead" buildings are those old buildings that have stopped adapting and been left to rot. They've stagnated and failed to keep up with the pace of their shearing layers of change. Alternatively, an "old" building still pleases and charms its occupants. Its shearing layers of change still function with ease and it expresses its age proudly by displaying the layers of history it has accumulated. Dead buildings are failures, sprinting towards retirement, while old buildings continue to please. How, then, do we make the distinction between old buildings and dead ones? The best buildings, the ones we come to love and appreciate, are the ones that accumulate years of history in their layers. They develop and demonstrate a maturity - a patina - that they wear proudly. Stewart Brand suggests:

> "Age is so valued that in America it is far more often fake than real. In a pub-style bar and restaurant you find British antique oak wall paneling - perfectly replicated in high-density polyurethane. On the roof are fiber-cement shingles molded and colored to look like warn natural slate.

> It seems there is an ideal degree of aging which is admired. Things should not be new, but neither should they be rotten with age... Buildings should be just ripe - worn but still fully functional." *

Good buildings are not simply adaptable buildings. Adaptivity is only one example of the mark of a good building. In fact, an example of Adaptive Architecture may not be considered good architecture at all. Until it's had an opportunity to prove itself, it may just be "ordinary." The Fairbanks House, for example, was likely nothing special when it was constructed in the 1600s but has since developed a personality of its own. It's held by many in reverence for both its ability to stand the tests of time and its layers of accumulated human investment. People seem to appreciate the history visible within a particular building, but more than that, they enjoy the ability to personally add to that history. They enjoy the ability to preserve a bit of themselves - of their era - in the physical environment. An Adaptive Architecture building can only really reach its true potential once its been tinkered with, until then, it's just an empty canvas. If we aspire to make good buildings, we must first utilize an Adaptive Architecture theory and then let our buildings prove themselves in the temporal arena. This combination of age and adaptability is what makes "old" buildings so enjoyable, so aged, so ripe.

With this understanding of old buildings, we can see that Adaptive Architecture is a multi-step process. It starts when the architect designs a building with the six shearing layers of change in mind. Then, when constructed, the building evolves, grows, and adapts, accumulating history, character, and value along the way. Adaptive Architecture,

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* Brand, Stewart. *How Buildings Learn: What Happens After They're Built*. New York, NY: Viking, 1994. Print. p10

by allowing a building to live hundreds of years, has the ability to preserve the history of that building, but just because a building preserves some of its history does not mean that new histories cannot be written. Modernists might argue that clinging to the past is a hurdle to designing the future, but modern historic preservation practices are beginning to challenge that assumption.

In fact, the movement that has resulted in countless historic districts across the country, might be credited with more than just the protection of iconic or historic American buildings. Though it's often viewed as the antithesis to Modernism, standing in the way of the "progress," by preserving the very elements of "tradition" that modernists found so revolting, it has developed a following that has since turned historic preservation into an industry in and of itself.

Prior to the industrial revolution, Architecture, as a field of design, was essentially the process of replicating the forms and styles of the past to evoke a sense of age and order. In the early and mid 1900s, when the Modern movement gained ground, these notions surrounding architecture were largely abandoned. Modernists the world over began producing "new" buildings that reflected their values. Buildings like the Villa

Savoye, by Le Corbusier, stand as examples of this movement and represent a goal to define what could happen when architecture departed from tradition. The common conception is that the historic preservation movement's mission has been to provide a legislative basis for preventing anything iconically "modern" from taking the place of anything overwhelmingly "traditional," [*] Although we're now learning that this may not be the case.

Figure 39: Villa Savoye (1930)
Designed by Le Corbusier

Many people site the attempts to preserve Mount Vernon, the home built and occupied by George Washington, and the well documented battle to save New York's Pennsylvania Station as the start of the historic preservation movement. These efforts, started in 1853 and 1963 respectively, paint the picture of the individual rising up to prevent the destruction of history. At the heart of this argument was that "old" buildings have character and value and have every right to exist in the new American landscape.[†]

In fact, while many believe preservationists are interested in preventing modern architecture from transforming the character of their neighborhoods, it may be better defined as an effort in participatory development. Arguably, the aim of most

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[*] Brand, Stewart. *How Buildings Learn: What Happens After They're Built*. New York, NY: Viking, 1994. Print. p88

[†] Page, Max, and Mason, Randall. *Giving Preservation a History: Histories of Historic Preservation in the United States*. New York: Routledge, 2004. Print. (p4)

preservationists isn't to prevent anything, but rather to have a hand in establishing the value of the buildings in their communities. They're rallying not for "old" cities, but charming cities; cities in which the human story can be observed in their very fabric. In their book, *Giving Preservation a History*, Max Page and Randall Mason explain:

> "The current generation of practicing preservationists are creating a watershed for the field. The techniques, theories, and public policies inherited by today's practitioners hark to the time when the inherent historical values of old buildings, and the material integrity of those artifacts, were seen as sufficient foundations for the field. Now, in the wake of epistemological and political revolutions since the 1960s - from civil rights and women's rights to postmodernism - the political values of preservation, and its value in shaping personal social-group, and national identity, are paramount. Economic interests, once banished as the enemy, play an ever-greater role in preservation - sometimes for better and sometimes for worse." *

As our society changes - and our attitude towards old buildings changes with it - the nature of preservation will also change. Page and Mason go on to explain that the commonly held conceptions that preservation was "only a campaign to parcel off a few buildings from the depredations of the market" is not the whole story. Preservation was often found in conjunction with larger urban development movements and can be seen as "part of a larger 'history industry' that includes museums, monuments and memorials,

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* Page, Max, and Mason, Randall. *Giving Preservation a History: Histories of Historic Preservation in the United States*. New York: Routledge, 2004. Print. p5

collecting, historical fiction, and other historical undertakings."[*] The idea that historic preservation sprouted up, as if overnight, in he 1960s and 70s to combat the evils of Modernism and modern industry is clearly questionable, but the public perception of the two fields locked in good-vs-evil combat is palpable. Whether it was source of the preservation movement or not, however, the interesting dichotomy between the "modern" and the "traditional" deserves to be explored in greater depth. The question, phrased correctly, might ask why the dichotomy existed in the first place?

With this in mind, it might be said that the opposition to modern architecture was not so much against the "new" but rather against the ignorance of the new. When observing America's historic landscape and the seeming modernist infection that has taken it over, the impression might be that modern architects tend to destroy a building with character not in favor of a building with none, but in favor of a building without even the ability to develop character in the future. This is an important distinction. The "new" is absent adaptability and therefore, absent the ability to develop a character of its own. Like framing a blank canvas behind an impenetrable shield of glass, the observer is left with the impression that new buildings are devoid of the ability to collect layers of human investment and develop the character that was visible in the old buildings they replaced. With no layers of human investment evident within them, modern buildings often appear to have died before ever having lived. In fact, a preservationist in the future might not preserve a building for the sake of its visual appearance but rather for the sake

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[*] Page, Max, and Mason, Randall. *Giving Preservation a History: Histories of Historic Preservation in the United States*. New York: Routledge, 2004. Print. p6-7

of its ability to accumulate history and character in such a participatory way. Stewart Brand postulates:

> "Suppose preservationists taught some of the design courses for architects, developers, and planners. The subject would not be how to make new buildings look like old ones. It would be: how to design new buildings that will endear themselves to preservationists sixty years from now. Take all that a century of sophisticated building preservation has learned about materials, space-planning, scale, mutability, adaptability, functional tradition, functional originality, and sheer flash, and apply it to new construction."*

The goal, then, would be not to build in imitation of the old, nor in search of something iconically "new," but rather to build in a manner that allows the new to become the old; a manner in which the cumulative human investment - the layers of history that only time can create - contributes to the inherent social, cultural, and economic value of a building.

Understanding what makes an old building so valuable allows us to reconnect the two parties - modernists and traditionalists - with a common understanding of value. A building doesn't need to be made of stone or brick in order to develop a sense of history, but conversely, a building constructed of steel and glass may never have the opportunity to. Generally, the perception is that the use of traditional materials in traditional ways is akin to imitation, replication, and fakery. In many ways, this notion is correct, though

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* Brand, Stewart. *How Buildings Learn: What Happens After They're Built*. New York, NY: Viking, 1994. Print. p109

often misunderstood. In the campaign for the "new," Architects have avoided anything that might be labeled "vernacular" for fear of being too traditionalist. In order for Adaptive Architecture to be successful, however, Architects will need to recognize that tradition is not always in contest with progress and that, in many cases, what's traditional now was once considered progress. Every new development begins with invention, and all invention begins with motivation. To understand the nature of old buildings and to allow for the existence of the 300 year building, there will need to be a change in the common perceptions surrounding the "vernacular" in conjunction with those surrounding "old" buildings.

Martin Heidegger was famous for his work on architectural philosophy. Although his writing is fairly illusive, his process was strong. Heidegger was fond of dissecting language to find its true meaning. He would attempt to follow the usage of a particular worth through history in order to understand the basic, primitive meaning with which it was first used.* If we follow the methods of Heidegger, we can trace the origins of the word vernacular to a very specific meaning. The Oxford English Dictionary's earliest known appearance of the word was in 1601. Then, and for approximately two hundred and fifty years following, the word applied only to the study of language. It's definition reads:

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* Martin Heidegger gave a talk titled Building, Dwelling, Thinking in 1951. In this piece, he attempted to understand what it means to dwell by uncovering the roots of the actual word and its origins. He follows them back many iterations to understand the primitive meaning of the word and, thus, better understand the modern meaning of dwelling.

Leach, Neil. *Rethinking Architecture: A Reader in Cultural Theory*. New York: Routledge, 1997. Print.

"adj. That writes, uses, or speaks the native or indigenous language of a country or district."

Almost all of the documented uses of the word appear to be with specific regard to language and dialects - that is, until 1857, when it first appeared in context with architecture. It was used by G.G. Scott in his piece, *Remarks Secular and Domestic Architecture*. Here, G.G. Scott used the word in discussing the language of architecture. The final entry in the Oxford English Dictionary for Vernacular is a version of its use first recorded in 1910. It reads, quite simply, "A vernacular style of building" and accurately defines how the word is used in the field today.*

Somewhere along the lines of history, the meaning of vernacular changed from something definitively regional to something vaguely stylistic. Today, among most Modernists, this definition is still accepted: "To build a vernacular building is to build with vernacular style." This belief is fundamentally incorrect and must be redefined.

We know that buildings, like organisms in nature, can evolve using the Darwinian process of vary-and-select. In most cases, as discussed in conjunction with Reactive Architecture, these changes are responses to the pressures of outside forces. Evolution builds off the cumulative experiences of the past. In imitating the best qualities of their architectural ancestors, buildings can become finely attuned to their local climate, weather, cultures, and societies. Henry Glassie, a folklorist with a specialty in vernacular architecture is often quoted as saying:

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* Vernacular, n. Oxford English Dictionary. 2010. Oxford University Press. Date of access: May 4, 2011. <http://www.oed.com.silk.library.umass.edu/>

"A search for pattern in folk material yields regions, where a search for pattern in popular material yields periods." *

In the context of architecture, periods can be understood as stylistic while regions can be understood as vernacular. With this clarifications we can begin to understand how the definition of vernacular needs to be revised. In order to allow for Adaptive Architecture to take form, unimpeded by arguments surrounding style, what's understood as "vernacular" needs to be divorced from what's understood as "style." This means that vernacular architecture is not synonymous with stylistic architecture; Vernacular, as it should be defined, is purely regional and associated not with the architectural product, but with the process that developed it. Whether through materials, methods, culture, spiritual influence, or any number of other reasons for constructing in an identifiably regional way, Vernacular is independent of style and subservient to intention.

Figure 40: Alamo Square, San Francisco, CA
These homes, featured by the nineties television sitcom Full House, are commonly considered to be a vernacular architecture of San Francisco. It is easy to see how their charm, character, and visual harmony can lead to the belief that these represent the vernacular architecture of the region, but in fact their visual harmony is a product only of style, and not of intention. If anything from these houses were to be considered vernacular, it would be their relationship to the hilly topography of the city and the visual harmony that the downhill progression forms in their architecture. Intention, not style, is at the heart of vernacular.

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* Brand, Stewart. *How Buildings Learn: What Happens After They're Built*. New York, NY: Viking, 1994. Print. p133

What becomes "traditional" is not necessarily the result of commonly applied aesthetics, it's the imitation of successful architectural solutions. As Brand writes, "most traditions were once someone's bright idea which was successful enough to persist long enough for people to forget that it was once someone's bright idea."* In the modern world, however, the imitation of what is considered "vernacular" has ceased to emulate these architectural solutions and has instead distilled them into an applied style- with no truth to its construction or representation.

Figure 41: Taos Pueblo (Circa 1000 C.E.)
Taos Pueblo, New Mexico

In the discussion of style versus intention, where style is applied and intention is inherent, there are many buildings that stand out as perfect examples of each. Taos Pueblo, a Native American village in New Mexico, and Hotel Santa Fe in Arizona are two such examples.

Figure 42: Hotel Santa Fe (Date Unknown)
Santa Fe, New Mexico

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* Brand, Stewart. *How Buildings Learn: What Happens After They're Built*. New York, NY: Viking, 1994. Print. p143

Taos Pueblo, the oldest continually occupied native american village still in existence, stands atop a plateau at the base of a series of mountains. It has been discovered, through archeological evidence, that this Native American pueblo town has been continuously occupied for over 1,000 years, though the Taos people had lived in this valley for much longer than that. Folklore and detailed oral histories explain exactly how old the village is, why and how it was constructed, and are passed down from generation to generation but these histories, for religious reasons, are not divulged to outsiders. There is enough visual, archeological, and historic proof, however, that supports the claim that the village existed long before any arguments surrounding the style of architecture were even begun.

What makes Taos Pueblo so interesting for discussion is that it satisfies two arguments at once. First, the people of this village, for thousands of years, have maintained, rebuilt, and added to the architecture constantly. The village stands as the epitome of adaptability. The whole construct reflects their culture and continues to grow and evolve as needed. In fact, some of the dwellings standing today are over 500 years old and still in very good condition.* The second point of interest in this village is in the way it so honestly stands as an example of true vernacular architecture. Because it was originally constructed in an era and region not dominated by architects and stylists, its form, materials, location, and organization are the direct result of the needs of the people and their available recourses. The most plentiful material - desert sand - became the building block for almost all of the construction elements. Combinations of earth, water, and straw were packed into brick molds and allowed to dry under the hot desert sun into

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* Taos Pueblo. Website. Date of Access: May 4, 2011. <http://www.taospueblo.com/>

firm adobe bricks. Wood timbers were converted into roof beams and doors, but had to be harvested and carried down from the treacherous mountains, which made them hard to acquire. This is why most desert dwellings like these were historically never made from wood - it simply wasn't available in the necessary quantities, so it was saved for very special applications. Adobe had its own distinct advantage, however. Being a product of the desert, it was also well equipped to protect against it. Adobe dwellings are very successful at disallowing radiative heat from entering into the home during the day. Adobe can absorb the sun's heat and store it until night, providing the residents with 24 hour comfort. Centuries of regionally motivated invention and development produced an architecture that suited its occupants and climate perfectly. Vernacular, in this case, was the process of overcoming adversities through building techniques that served as solutions.

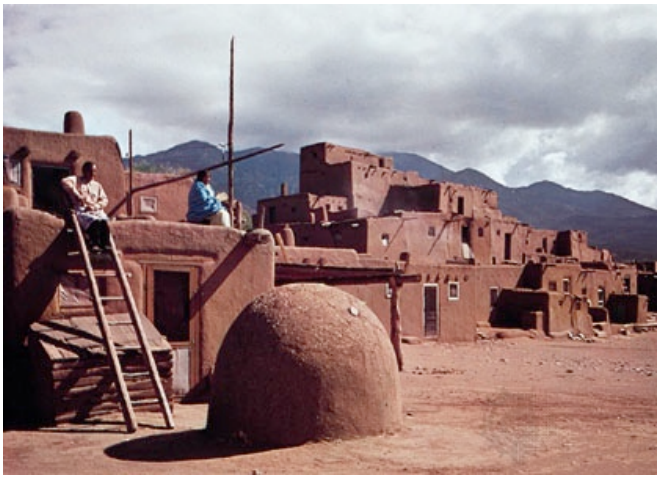

Figure 43: Taos Pueblo Exterior
Residents of Taos Pueblo navigate the series of stacked dwellings with a series of staircases and ladders. The ladders, in particular, are an example of this culture's adaptability in construction. Stairs, being fairly permanent, were only advantageous where it was sure the structures wouldn't change. As dwellings grew and moved around, however, ladders could be moved around with them.

Counter to the grace with which Taos Pueblo demonstrates intention in vernacular, the role of style is exemplified by the Santa Fe Style of architectural design. This movement, as its title indicates, was the late 20th century attempt at replicating the attractive style of the iconic pueblo desert dwellings. The adobe building, because it was

so efficient and so perfectly suited to its environment, became the standard historic dwelling type throughout the southwestern United States. Santa Fe Style attempted to replicate this visual harmony but neglected to acknowledge the reasons that brought it into existence in the first place. What was once a tried and true method became a style - a commodity - to be applied in a cheap attempt at capitalizing on its historic value. The Hotel Santa Fe, in Santa Fe, New Mexico*, is the perfect example of this flagrant misuse of vernacular elements. It's no secret, when you observe the photograph to the right, that this building was designed to replicate the form and style of the Taos Pueblo village. First, the "form" of the Taos Pueblo village was imitated, despite the fact that Taos' form was the result of centuries of tinkering with development, progression, and social structures. Their way of life dictated this construction and the culture supported it. Hotel Santa Fe ignores time in this regard and has been constructed only to look as if it's

Figure 44: Taos Pueblo - Hotel Santa Fe Comparison

* Hotel Santa Fe. Website. Date of Access: May 4, 2011. <http://www.hotelsantafe.com/>

the product of the same history.

Compounding the issue is the use of materials in the construction of the hotel. At first glance, Hotel Santa Fe appears to be constructed using the same techniques that Taos Pueblo used, but this is not the case. Although Taos Pueblo was, in fact, built of adobe brick and covered in a thin layer of mud or stucco to protect from the elements, it was done using local sand and for very specific reasons. Hotel Santa Fe also uses a type of stucco, but in this case, it's applied to stud framed walls, is dyed to look like traditional sand colored finish, and shares no connection with the surrounding environment.

Figure 45: Hotel Santa Fe - Patio

Furthermore, the round wooden beams seen in the Taos Pueblo, painstakingly dragged from the neighboring mountain to fill a roofing need, are replicated in the Hotel Santa Fe with no real structural purpose. Because of the nature of the hotel business, where the goal is to provide a memorable experience and create a place that feels "regional," it is likely that destination hotels like the Hotel Santa Fe are the worst offenders when it comes to vernacular. The result of such a pressure on style, however, is what could be called the Disney World Dilemma, where all of the experiences are false

and “Architecture” fails to be present. Style is the result of an imitation of vernacular, whereas intention is the result of vernacular emulation. This is an important distinction when attempting to redefine vernacular, because it lends itself to the realization that Adaptive Architecture must learn to emulate all of the best qualities of its architectural ancestry and avoid, at all costs, imitating their visual resultants. If imitation is the sincerest form of flattery, emulation might be the sincerest form of adulation.

Figure 46: Hotel Santa Fe - “Santa Fe” Suite
As this photograph shows, there is virtually no correlation between the “style” expressed on the exterior and the construction of the interior. None of the wooden beams, which should be visible in the interior spaces, continue beyond the exterior facade. The false adobe and stucco walls are reveal themselves to be mere gypsum wall board on the interior of the space and, outside of a few color and interior decoration choices, the decor and style of living reflect anything but the culture that the exterior of the hotel imitates.

To copy vernacular style is not to build vernacular buildings. To build vernacular buildings, a design must respond to the local conditions that brought the “vernacular” into visual harmony in the first place. Hot sun leads to adobe brick dwellings. Heavy snowfall leads to steep pitched roofs. Torrential rains lead to expansive roof overhangs. An abundance of forestry leads to intricate wood joinery. To be vernacular is not to be regional in style, but in intention.

CHAPTER XIV

THE BUILDING THAT LEARNS TO FISH

Accepting the fact that peak oil is a unique problem that will soon be demanding the attention of architects, planners, and builders everywhere, we come to the conclusion that an equally unique solution is needed. Our conceptions must change and our common practices must evolve. Prediction, we've established, is too uncertain to rest the lives and livelihoods of people on. Conversely, reaction requires time and a certain amount of suffering at the hands of adversity before it can be utilized. The solution, therefore, is Adaptive Architecture - Prepare our buildings to react to future problems and allow them adapt accordingly.

To adopt such a philosophy will not be easy, especially on a large scale. Adaptive Architecture requires a holistic approach to thinking that extends beyond the bounds of the typical individual's concern; beyond the economic lifespan of the average person. Despite this fact, there's an entire field of professionals out there with skill and ability to lead our buildings on the road to adaptability- the role of they architect is about to change.

Adaptive Architecture prescribes no style. It has no opinion about whether form should follow function or whether the opposite is true. There exists, in Adaptive Architecture, flexibility within the solutions to the peak oil problem. Every architect may design their own unique solution, and each may be just as valuable as the next at providing a method for designing Adaptive Architecture, but the only they'll be

successful is if adhere to one simple principle- Buildings exist in time and must respond to this fact. The Six Shearing Layers of Change - Site, Structure, Skin, Space Plan, and Stuff - exist as a framework within which we can design our buildings. What the final products look like is of no concern- It's how they act that matters.

For a successful example of Adaptive Architecture to exist, there will need to be a change in the notions surrounding what buildings should cost. There is no way around the fact that Adaptive Architecture is expensive architecture. Building a 300 year building means investing beyond your lifetime. The immense financial investment this represents can be a deterrent to clients and professionals alike. With time, however, we may begin to see inexpensive forms of building that still manage to adhere to the underlying principles of an Adaptive Architecture approach. For all we know, stick builders will find the perfect balance between adaptability and efficiency and our current construction methods won't need to drastically change.

Some examples of Adaptive Architecture might even exist with the express purpose of being inexpensive. Taking advantage of the problem solving capital of architects, inexpensive Adaptive Architecture solutions may be discovered that ensure the economic viability of the theory. But regardless of cost, to realize the dream of truly Adaptive Architecture, the construction industry will need to evolve along with the design process - although it may prove difficult. James Howard Kunstler, author of *The Long Emergency*, explains:

> "The cultural inertia [of the construction trades] is tremendous. The home builders have certain ways of delivering their products... They're

used to it, they know exactly how to do it, it's still working for them, and they don't want to change."*

Architects will likely find themselves in a unique position to motivate the required change amongst builders. Asking clients to spend a bit more money and asking builders to learn new methods of construction will not produce positive reactions at first, but it will be the job of the architect to encourage a holistic approach to thinking and inspire interest in the transition. It will be their job to take the lead and usher our built environment into the new age. As the stewards of Adaptive Architecture, they will need to inspire change, not just submit to it.

Architecture has had its fill of identity crisis after identity crisis over the last hundred and fifty years. It's time architects defined their identity and lived up to their respected title. The age old motto "ignorance is bliss," needs to be swept from our memories as we learn to employ a deeper, more sophisticated understanding of the way we live. This is the architect's dilemma- Not to ask "What is Architecture?" but to answer "Why is Architecture?"

The Adaptive Architecture conversation is not centered around whether architecture is art or whether it's a craft. Architects should not fall on either side of this line. They are singularly neither artists, nor craftsman, though they may do a bit of each. Architecture isn't art, though it is artful. It isn't craft, though it is certainly crafted. Architecture is architecture. It should have its own identity and that identity should be synonymous with the ability to craft our world artfully.

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* Greene, Gregory, Barry Silverthorn, and Barrie Zwicker. *The End of Suburbia: Oil Depletion and the Collapse of the American Dream*. Toronto: Electric Wallpaper Co, 2004. Film.

As for the construction industry, the architect's job is to recognize that convention became conventional because it worked well. They will need to remember this when attempting to design Adaptive Architecture. Challenging the established standards will be required, but facilitating them where necessary is essential.

Timber framing has emerged as an example throughout this work. Though it might be one of the many possible methods of designing Adaptive Architecture, it's not necessarily the prescribed solution. It stands out as an example not because it's fundamentally better than any other method of building, but because it's known. We have experience in the design and construction of timber framing dating back hundreds of years. It's regular, it's understood, it's proven, and it works. While there's no one method of producing Adaptive Architecture, the best methods will not deviate into the realm of the exotic. We live in square rooms under pitched roofs for a reason. Whether or not that reason is still valid in the modern world is unimportant for this discussion; a dramatic upheaval of the norms in any peak oil solution is almost certain to result in the general dismissal of the approach. As Darwin explained, the best method for initiating change in an organism comes from the slow and steady introduction of it. We should avoid, at all costs, introducing a shock to the system, but should also prevent it from falling into a paralyzing lethargy.

All buildings should hold the Six Shearing Layers of Change and the principles of Adaptive Architecture in the highest regard and should continue to do so for the duration of their lives. Architects should aim to design buildings that are loved, not temporarily admired. Buildings should be judged not for what they are, but for how they proved

themselves through time. Only by respecting the way our architecture evolves can we really begin to prepare it for future pressures.

Adaptive Architecture creates a new correlation between buildings and time. It produces buildings that are inherently flexible and adaptable and encourages a new relationship between buildings and their occupants. Redefining our misconceptions will enhance the architect's ability to deliver Adaptive Architecture. It will allow for goals that extend beyond our physical and economic lifetimes. As our way of life changes, so too will our Architecture and as our architecture changes, so too will our way of life.* Adaptive Architecture is perhaps both the most efficient and the most responsible answer to the peak oil problem, specifically because it's not an answer at all. Adaptive Architecture is an equation that produces a solution; it's ready to accept the variables and discover the answer. Adaptive Architecture is prepared to react.

There's a well known Chinese proverb that states:

> "If you give a man a fish, he will eat for a day. If you teach a man to fish, he will eat for a lifetime."

Our buildings need to learn to fish. And if they're ever going to respond to the pressures of the coming energy crisis, our architects will need to teach them how.

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* Big "A" little "a" again

CHAPTER XV

THESIS PROJECT: SCHOOL FOR THE BUILT ENVIRONMENT

Having established a theoretical basis for a new design philosophy, it is important to begin to consider the real world implications of it. It's easy to suggest we build flexible, adaptive buildings, but in reality, it's a difficult bill to foot without careful consideration and thorough analysis. As outlined in previous chapters, Adaptive Architecture has no pure, distinct definition. There aren't right ways and wrong ways to produce it and the theory is entirely without prescription. The challenge, then, is to begin to experiment with the tenets of such a theory and explore the potential problems they might pose the design process.

As a template for an Adaptive Architecture approach, the program for the School of the Built Environment was used. The School of the Built Environment is hopefully going to become a real project at the University of Massachusetts Amherst campus. Such a school would combine the Architecture, Landscape Architecture, and Building Construction Technology programs under one roof. The facility would provide shops, labs, studios, offices, seminar rooms, and gallery spaces amongst other uses and the combined programs would require approximately 60-70,000 square feet of space to accommodate these uses. On top of the immediate needs of a facility of this type, a building of this size, on a university campus, is going to be under a constant pressure to change. Whether it amounts to offices being relocated, class rooms being subdivided, or

whole floors being converted into laboratory space, there is a distinct need for university buildings to maintain some level of flexibility in their space plan so they can facilitate future uses, if the need arises. For these reasons, the program, size, and setting of the School of the Built Environment project exists as an ideal template against which to test a theory of adaptability.

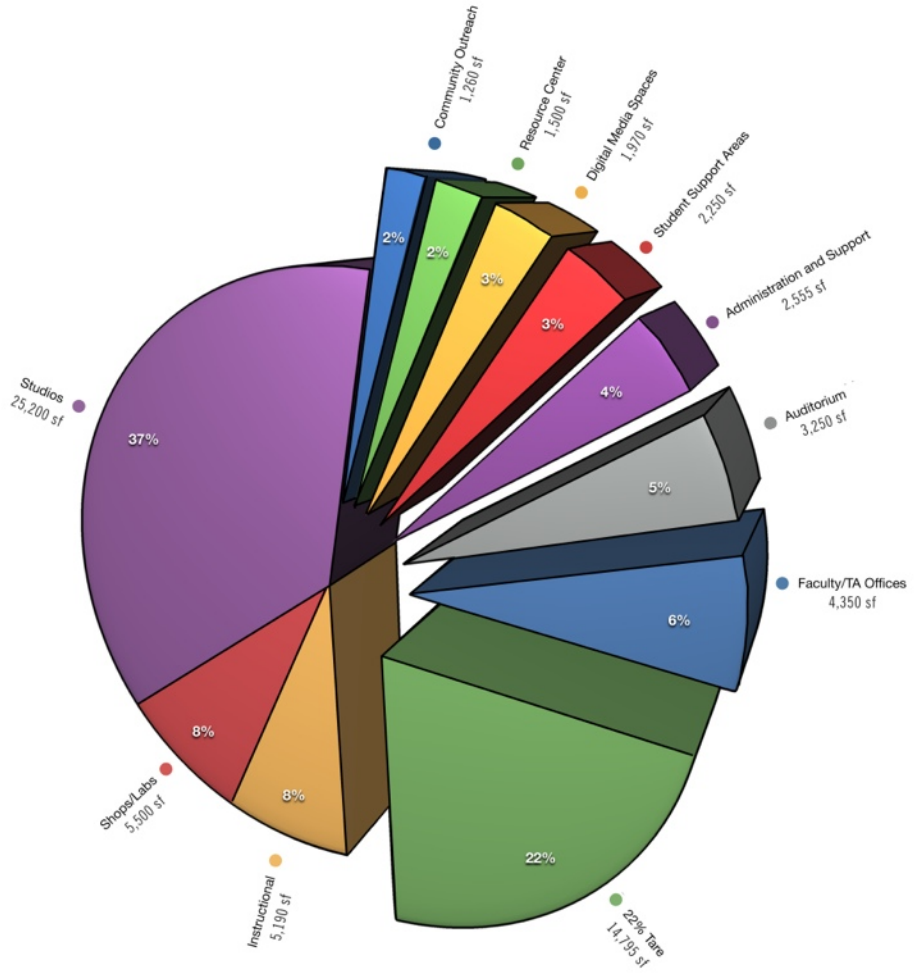

Figure 47: Program breakdown of the School of the Built Environment

Table 2: School of the Built Environment program requirements by sq.ft.

Program Summary									
				# rooms	# occupants	SF/ occupant	Size	Sub-total	**Category Total**
100			**Instructional**						**30390**
	101		Studios	21	15	80	1200	25200	
	102		Storage	1			80	80	
	103		Lecture Hall						
		103.1	Lecture Room	1	75	12	900	900	
		103.2	Projection Booth	1		60	60	60	
		103.3	Storage	1		80	80	80	
	104		Small Classrooms	2	30	20	600	1200	
	105		Seminar Rooms	8			350	2800	
	106		Storage	1			70	70	
200			**Digital Media**						**1970**
	201		Computer Lab	1			900	900	
	202		Remote Printers/ Scanners	3			80	240	
	203		Computing Classroom	1	1 5	40	600	600	
	204		Computing Manager's Office	1			100	100	
	205		Computing Equipment & Storage	1			80	80	
	206		Equipment Chock Out				50	50	
300			**Resource Center**						**1500**
		300.1	Archival Storage	1			440	440	
		300.2	Manager's Office	1			100	100	
		300.3	Reference Books	1			280	280	
		300.4	Media Work Area	1			200	200	
		300.5	Reading Area	1			480	480	
400			**Student Organizations**						**150**
	401		Office	1			150	150	
500			**Student Support Areas**						**2100**
	501		Student/Faculty Commons	1			500	500	
	502		Vending	1			100	100	
	503		Storage	1			100	100	
	504		Gallery and Exhibition	1			1400	1400	
600			**Shops/Labs**						**5500**

		601.1	Woodshop/FabLab	1			2000	2000	
		601.2	Structural Testing	1			1000	1000	
		601.3	Full scale testing	1			1500	1500	
		601.4	Lighting lab	1			500	500	
		601.5	Office	1			100	100	
		601.6	Secure Equipment Storage	1			100	100	
		601.7	Storage and Loading	1			300	300	
700			**Faculty/TA Offices**						**4530**
	701		Faculty offices	22		120	120	2640	
	702		Visiting/emeriti	3	2	65	130	390	
	703		TA offices	7	3	40	120	840	
	704		Part-time	1	22	30	660	660	
800			**Administration and Support**						**2555**
	801		School Head	1			180	180	
	802		Assistant to Head	1			120	120	
	803		Program Directors	3			120	360	
	804		Prog.Dir Assistants	3	1	80	80	240	
	805		School reception	1			150	150	
	806		Program reception	1			220	220	
	807		Conference	1			220	220	
	808		Office manager	1			120	120	
	809		Staff	3	1	90	270	270	
	810		Bookkeeping	1			100	100	
	811		Copy/storage	1			105	105	
	812		Mail/lounge	1			120	120	
	813		Development staff	1			120	120	
	814		Work studies	1			80	80	
	815		Files				150	150	
900			**Community Outreach**						**1260**
		900.1	Offices	3			100	300	
		900.3	Work area	1	15		960	960	
1000			**Auditorium**						**3250**
		1000.1	Seating	1	190	15	2850	2850	
		1000.2	Projection				100	100	
		1000.3	Stage				200	200	
		1000.4	Storage				100	100	
Net assignable (.78)									**53, 205**
Tare (.22)									**14,795**
Gross									**68, 000**

The tendency of most designers, using the standard design process, would be to begin with the program as it's outlined above and start planning the layout of the building's spaces according to relationships, adjacencies, etc. This process is normally done with bubble diagrams, which are a very loose and informative way of analyzing a program of this size. It's difficult to know how a building will function best without first exploring a series of iterations and hypothesizing about the outcome of each. Should the studios be next to the wood shops? Should the offices be in their own wing or should they be scattered throughout the building? Should the gallery be at the heart of the building, central to all the activities within or should it be off to the side, with a more public presence? All of these questions and more are asked and answers are attempted using the generative, sketchy process of diagraming.

Unfortunately, this process often results in building forms or building layouts that are designed solely for the immediate needs. When only the initial program of the building is considered, it leads to decisions being made about where to locate the structure, when to allow for a transparent envelope, etc. and all of these choices can result in design decisions that neglect the simple truth that buildings exist in time and are almost destined to change. For the purposes of this project, an intentional choice was made to design the entire building without a bubble diagram.

The question arose, then, "How do you design a flexible building without creating a generic form completely devoid of any attention to the needs of the program?" It was clear that a building, first and foremost, needed to function properly. There's no value in

designing a flexible building if it doesn't suit its uses effectively. To allow for this, a certain amount of scenario planning needed to be done.

Scenario planning is a process by which designers can think about the future use of a space without over thinking the possibilities. Effectively, it's a quick way to study the potential uses of a building and understand what the likeliest scenarios will be. That is to say, it's reasonable to assume that a building on an academic campus is not likely to become an auto manufacturing plant. Therefore, to over design the structure, the size of spaces, or the ceiling height to accommodate the program of an auto manufacturing plant would be unnecessary and unreasonable. It is safe to assume, however, that a building on a university campus could change its use to any number of university related programs. Residence halls, class rooms, offices, dining areas, laboratories, theaters, and recreation facilities are all programs that exist on a university campus and represent the vast majority of potential scenarios for the future use of a campus building. Therefore, the design process can keep these potential uses in mind, the initial program included, and design a building that's suited to accommodate just these use types.

At this point, it's important to consider the values and deficiencies of two approaches: Building as a designed system and building as a designed form. Modular design and form based design exist on opposite ends of an adaptability spectrum. A modular building with interchangeable parts can be an incredibly flexible building. With modular building components, spaces can change with a day's effort and the whole building can be transformed as needed. What this system gains in flexibility, however, it loses in character. A modular building is a machined building. It's an engineered

assembly in which the parts are all nearly identical. While some may argue that the flexibility of this system outweighs the loss of character, others would argue that humans prefer to live in structures that reflect their humanity.

Figure 48: Modular Construction
An example of modular construction by Pac-Van, a distributor and supplier of various products.*

This goes back to Stewart Brand's observations regarding why old buildings are loved. There's a certain personality that buildings adopt when they're created by the human hand and that personality is arguably lost on the machine fabricated regularity of modular structures. For that reason, this thesis proposes that modular buildings are, in fact, not the most effective means of realizing an adaptive architecture approach, however efficient and flexible they may be.

Conversely, however, form based design, although rich with character and personality, is potentially unchangeable. When a program or concept dictates the form of a building as the primary design driver, there's a strong possibility that that building will remain static throughout time. Wildly exotic and irregular forms can be difficult to fit a variety of spaces into. A museum designed in such an exotic way may function well as a museum, but could find it difficult to become a place of residence in the future. In this

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* Pac-Van. Website. Date of Access: April 20, 2012. <http://www.pacvan.com/>

way, form based designs can quickly stagnate and become static, though hat's not to say that form based designs are inappropriate for all landscapes. In many ways, form based, program based designs have become the icons of a modern world. The Sydney Opera House, in Sydney, Australia could never be anything other than an opera house, but in many ways it doesn't need to be. It stands as an icon, representing an entire city's population in the global landscape and there would no problem whatsoever if it stays exactly as it is for another 300 years.

Figure 49: Sydney Opera House
Sydney, Australia*

Recognizing that there are both inherent values and disadvantages to modular and form based design, a new goal for adaptive architecture develops: to prove that a middle ground exists between the two. By taking into consideration both the flexibility of the building as a system and the personality of a building as a form, there should, theoretically, be a place in between where adaptive architecture can exist. By seeking out this middle ground through the design process, the intention was to create a building that could be versatile and flexible without sacrificing the personality that concept or form based design affords.

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* Sydney Opera House. Website. Date of Access: April 20, 2012. <http://www.sydneyoperahouse.com/about/media/photo_gallery.aspx>

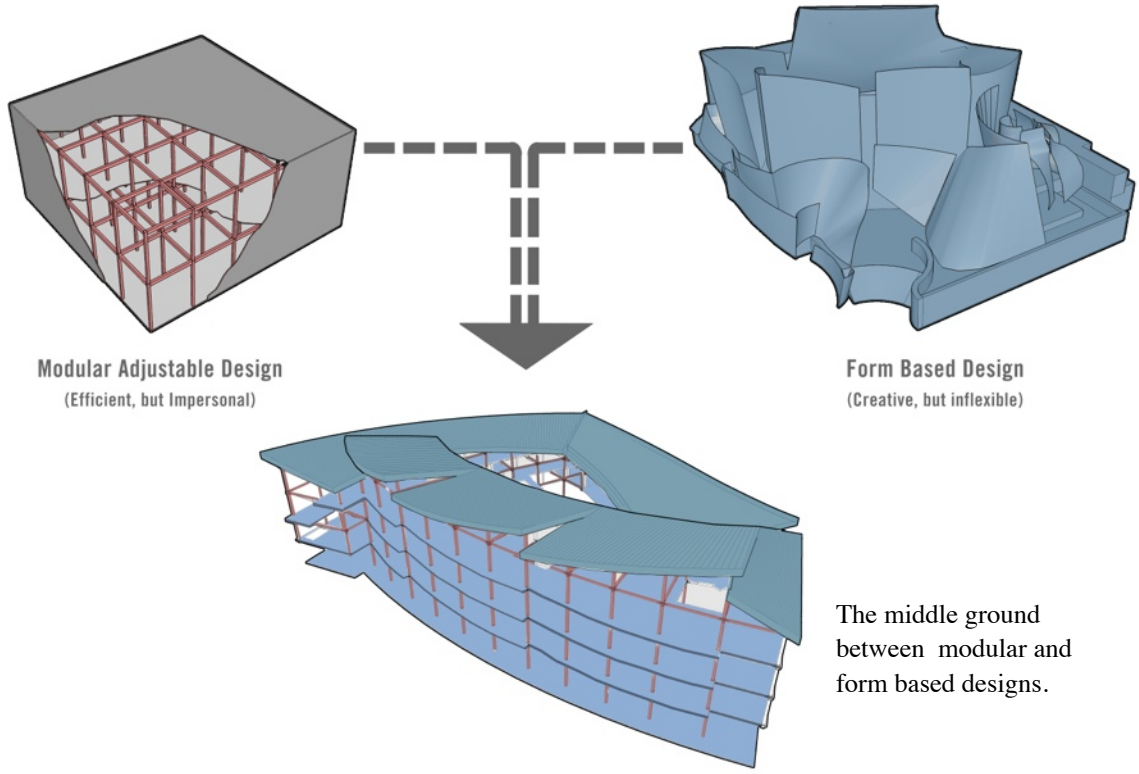

Figure 50: Modularity v.s. Form

The design approach for this project was then divided into two methodologies. One one hand was the design of the building as a system. This would lean heavily on the virtues of adaptability. On the other, was the design of the building with a concept driven form. In order to ensure that design decisions in the systems side weren't affecting or impacting decision made on the form side, these two approaches were investigated simultaneously and independently. This would ensure that the form of the building didn't drive the design of the system while the design of the system didn't inhibit the act of form making.

The process began by thinking about the layers of a building, going back to Stewart Brand's Six Shearing Layers of Change. By making the conscious choice to design with these layers in mind, the systems approach would be able to represent, in its purest form, the relationship between all of the layers of the building.

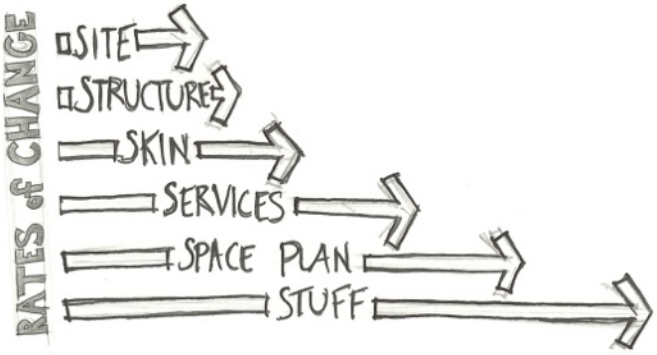

Figure 51: Rates of change

The exploration started in study model form. The goal was to think about the structure as something that the other layers of the building hung off of. Next to the site, the structure is the slowest layer of change. Although architects have some control over the site as a layer of change, structure really represents the slowest layer under their purview. As identified in earlier chapters in this thesis, Structure is, potentially, the most important layer of change. That's not to say that it's the most important because it's the slowest, it's also the most important because everything else hangs off of it. So not only is the designed structure of a building going to have to support the physical load of the other layers of change, it's also

Figure 52: Structural exploration model

going to have to support their temporal loads as well. If the envelope is likely to change every thirty years or so and it's integrated too closely with the structure of the building, the structure is going to have to withstand the metaphorical shearing forces of the skin layer. Pressure to change the skin will have to result in a change to the structure due to their tight integration into one another. The goal for adaptive architecture, in respecting these layers of change, is to prevent this kind of unnecessary metaphorical load. The above study model was one of many attempts at generically representing the relationship between these layers.

On the concept side of the process, some intense thought was given to the nature of building and how that might best be translated into a built form. Given that this building would be bringing together three related, but currently divorced departments, it seemed appropriate to explore concepts surrounding linkages, stitching, reconnecting, and repairing. In the end, a concept that would embody the nature of building was decided upon. Architecture, Landscape Architecture, and Building Construction Technologies - the three programs that would be occupying this structure - almost poetically describe the nature of buildings. Buildings begin in the ground with consideration of the landscape, the ground is broken and then the building begins to grow from it, studs, beams, and columns comprising the skeleton. It emerges, rising to the sky until it's capped by a roof, parapet, or pediment, completing the designed vision of the architect.

Thinking about the poetic nature of these forces, a concept of 'peeling the landscape' took form. The idea was that a building could grow from the landscape,

symbolically representing the process by which they're built. In the transition from ground to sky, there could be some formal changes that take place as it passes from Landscape Architecture to Building Construction Technologies and finally to Architecture.

Figure 53: The Peeling Landscape
The building seems to grow from the landscape, culminating in an architectonic gesture.

Although the intention was to keep systems thinking and concept thinking separate, the width of this formal expression ended up being driven by the desire for day lit interior spaces. As more of a principle than a design requirement, it felt important to recognize that a wide building has trouble getting light into interior spaces and the thinness of this concept study model was a response to that fact.

Having thought about the building as a formal, symbolic expression, the next step was to identify the potential for 'special' moments in the form - places in the building where it could deviate from the otherwise clear and powerful peeling form.

The result was a moment, about half way up the sloping roof form, where the continuous nature of the roof breaks and the two segments begin to slip past one another. This creates

an almost tangible relationship between two forms existing as one. The purpose of this expressed moment in the form was in response to the relationship architects often have with building construction professionals. That's not to say it's tumultuous and broken, but rather that two professionals coming at a problem with different mindsets can arrive at a solution that is both elegant and rich with the diversity that the two professions provide.

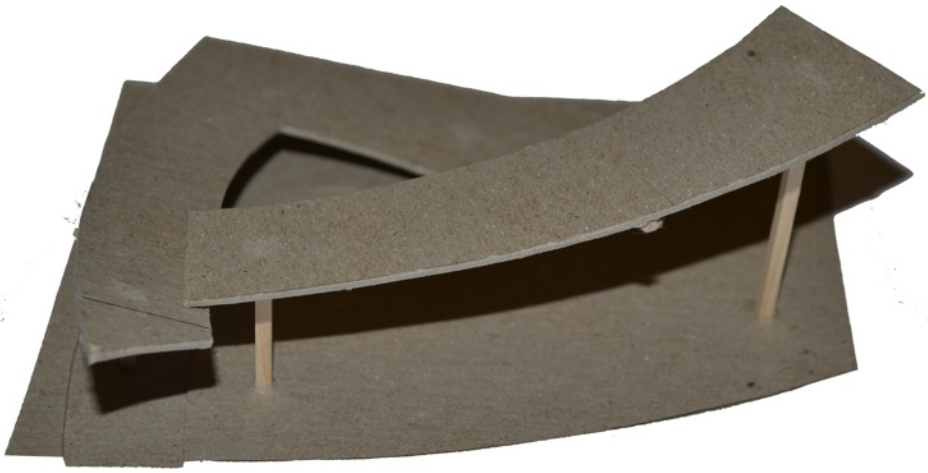

Figure 54: Peeling the landscape, second iteration

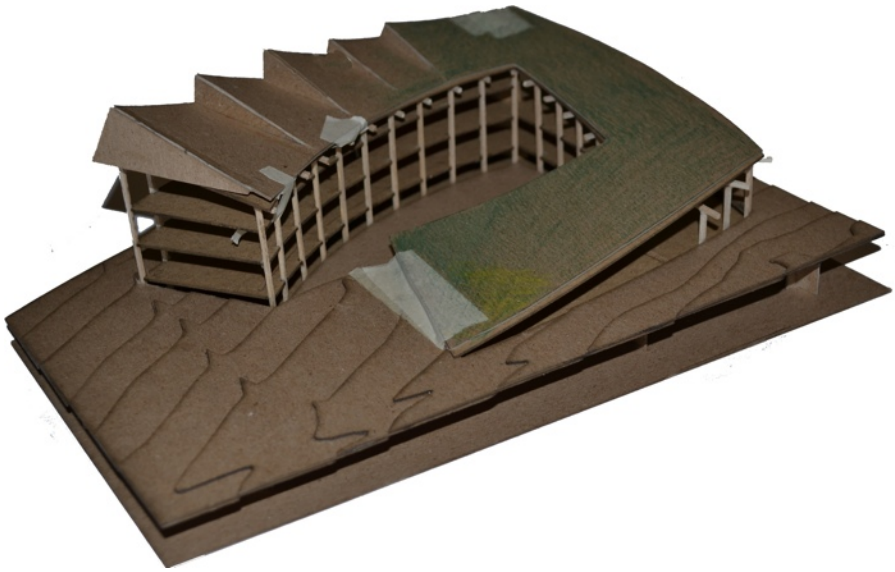

Figure 55: Initial study model

With a form developed and a systems approach established, it was time to combine the two trains of thought in one.

This study model began to explore the possibility of using a system of bents and bays where bents are like a structural cross section, repeated over the length of a building, and bays are the spaces between them. The goal was to start to explore the tectonic expression that a regular structural approach would have on an irregular form.

One thing that became apparent was the need to consider how the spaces would work within this combination form/systems thinking approach. One of the considerations was to leave the entire interior free of columns. By designing clear spans, the spaces within the building could exist wherever they needed to, without much limitation. The downside to that approach was that exceedingly long spans are not impossible to design, but are incredibly costly. The longer a span becomes, the more load a beam has to carry when spanning it. There are plenty of engineered products that can span long distances efficiently, but they're all very expensive and would add an exorbitant amount to the cost of a building this size, especially if none of the initial uses required an eighty foot clear span. A decision was made to consider the structural system of bents and bays as a two directional system. Where the bents and bays would otherwise be running parallel to one another, repeated along the length of the building, a new system of short span long span would be inserted to run in the opposite direction.

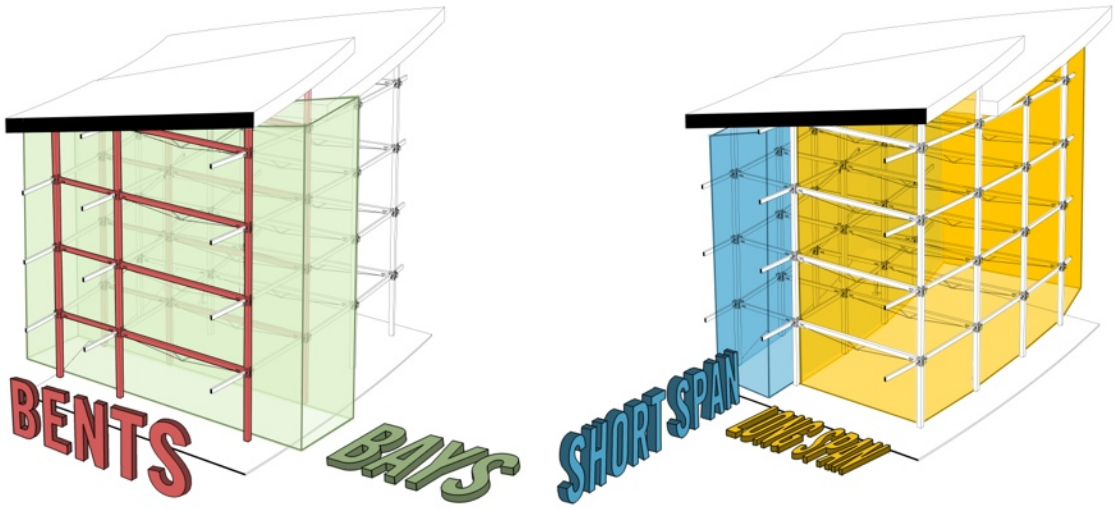

Figure 56: Organization of structural elements

This short span long span approach helps to organize the spaces within the building by their span requirements. Studios, class rooms, and wood shops would likely occupy the long span side of the building while offices, bathrooms, and seminar spaces could occupy the short side.

Having considered the structural and programmatic strategies and the concept and form development, the next thing to consider was how it all goes together. A choice needed to be made about the structural system and, more importantly, the materials it would be composed of. With a building of this size, the standard construction practice is to use steel. Steel I-Beams carry immense loads and can be design and constructed to meet virtually any size, span, and load requirements. Unfortunately, Steel has some significant disadvantages. The first and most recognized disadvantage is that steel is not fire retardant. In fact, steel acts horribly in a fire. It will literally melt, warp, and fall apart under the force of a blaze. For that reason, our steel buildings are often fire treated to

some degree. More than just sprinkler systems, the steel itself has to be covered with a fire rated material (typically a sprayed on pulp type product) in a certain thickness to prevent fire from reaching the steel. When it's not sprayed on, this fire proofing is done with sheet rock. Gypsum, a mineral mined from the earth, is incredibly fire resistant, so dry wall panels provide a good break between steel and exposed flames. This is why columns in steel buildings are often wrapped in these gypsum wall boards. The combination of spraying and gypsum coverings produces a net effect where the structure is essentially hidden. When it's buried under layers and layers of building components, a structure cannot be inspected and cared for as it should be. This is a big disadvantage for a building whose intention is to change over time by remaining flexible. Covering the most important layer is doing anything but producing flexibility.

The second disadvantage to steel is that when a building is constructed from it, the majority of the connections between members have to be bolted and welded together.

Having a welded frame increases the structural integrity of the building, but creates a condition where once the members are lifted in place and welded together, they're permanently fused with one another. It's not impossible to remove a steel member from a building, but it's an expensive and time consuming practice and requires the member to be cut off of the frame and then its corresponding welds have to be ground out manually. This means the member can never be used again and the frame suffers a bit of wear as a result of the continued fusing and grinding of material.

Figure 57: Standard Steel Frame Construction
This is a photo of the new Commonwealth Honors College Residence Hall project on the University of Massachusetts Amherst Campus. This steel structure has been mostly assembled and the corrugated steel decking has been laid in preparation for the concrete. (photo by author)

On top of the frame itself being fairly rigid, steel structures are also fairly inflexible due to the way that the other layers of change have to attach to them. Floors, for instance, are typically concrete, which requires a steel, corrugated decking system to be laid down on top of the beams and welded into place. Following the installation of this

tray, concrete is poured over it and allowed to set. So not only is the steel decking tray welded to the steel frame, the concrete covers up those welds making it completely impractical to tear out a floor in a building like this. Flexibility is not the primary consideration when designing and building a steel building. Efficiency and ease tend to be the reasons behind buildings of this type.

For these reasons and more, it was decided that the School of the Built Environment should be a wood building. Wood, being a manageably sustainable material, was also the more environmentally friendly choice for a project of this type as steel has an incredibly high embodied energy due to the mining and refining of ore and the smelting and manufacturing processes that produce steel members.

While the building could easily be built using standard wood construction (bearing walls, studs, and girders), it made more sense for the building to use an innovative and exciting wood system. Keeping with the bents and bays approach established earlier, timber framing was studied as a viable means of constructing a building of this size. Tedd Benson, who owns and operates a timber framing business out of Alstead, New Hampshire, is a leading authority on timber framing and its applicability to the modern world.* Although his work often deals with the timber-frame home, much of what he's discovering and inventing can be applied to construction on the large scale.

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* Benson, Tedd. The Timber-Frame Home: Design, Construction, Finishing. Newtown, CT: Taunton Press, 1997. Print.

In his book, The Timber-Frame Home, one of the things he explains is that timber frames are typically built as one solid unit. That is to say, they're not often built in the same way that a platform construction would be (where the floors rest on top of the walls below and the walls above rest on top of the floors so the levels are effectively sandwiched on top of one another). Timber frames tend to be built out of contiguous, connected members. A column wouldn't run from the first floor to the second floor, stop, have a beam on top of it, and then start a new column above that. Columns are typically continuous members from ground floor to roof. This helps ensure their stability, integrity, and reduces the need for excessive numbers of complex connections within the timber frame structure.

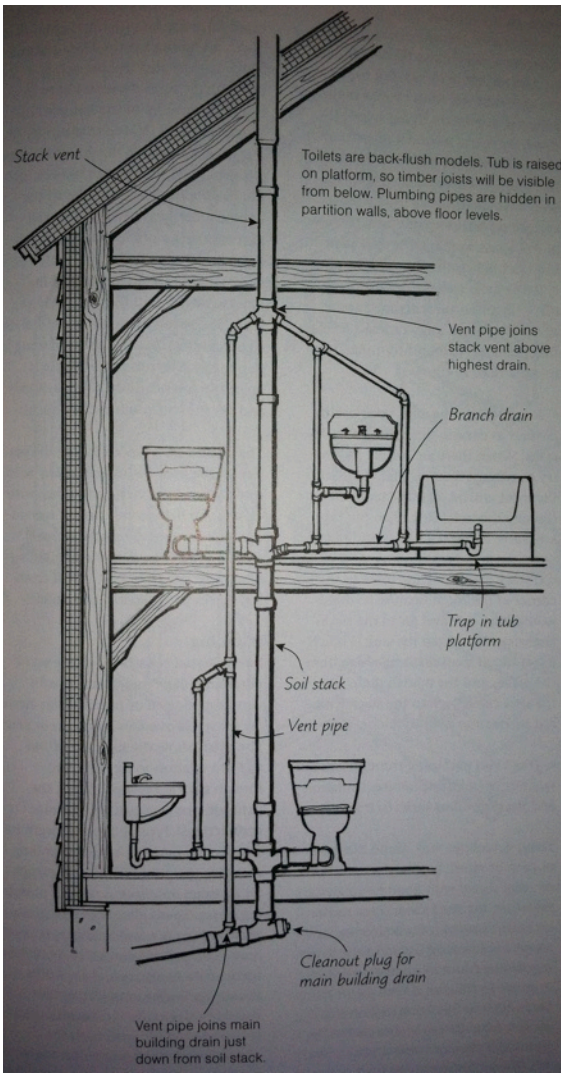

Figure 58: Standard Cross Section*

When designing a building with a 70,000 square foot program, however, it's nearly impossible to build less than three or four stories. That much space simply can't be spread evenly over a single or double story building. Having a 3-4 story timber frame

* Benson, Tedd. The Timber-Frame Home: Design, Construction, Finishing. Newtown, CT: Taunton Press, 1997. Print. (p159)

structure would mean columns in excess of 60' long. It would be unreasonable to assume that lumber of those lengths could be found at affordable prices which meant an alternative needed to be discovered.

By looking at the scarf joint in timber framing, which is effectively the process of taking two beams and splicing them together, it was proposed that perhaps the same could be done with columns. Maybe there was a way to make a single length continuous column out of many smaller segments. The scarf joint wouldn't work on the vertical axis, since it's designed to accommodate forces in the lateral direction, so there needed to be another way of combining wood members in the column assembly to one another.

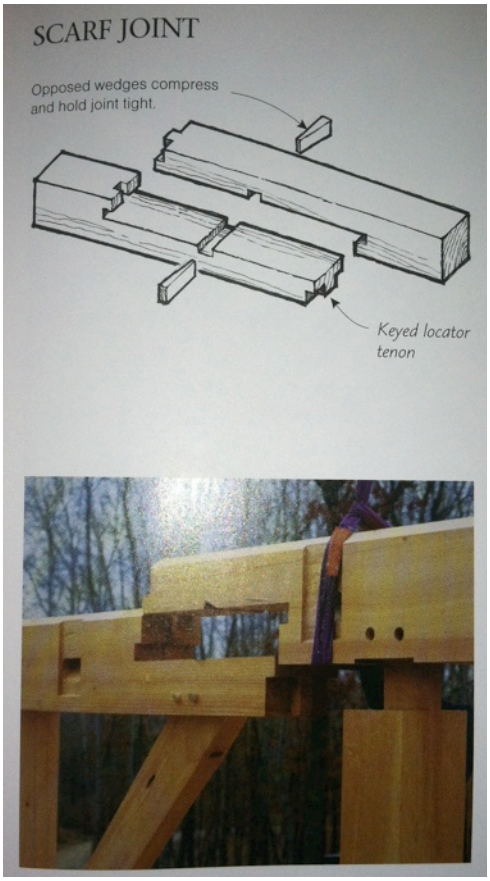

Figure 59: Scarf jointing to increase beam length*

Luckily, as heavy timber structures become more and more acceptable and gain popularity, designers around the world are beginning to experiment with ways of making them applicable to modern construction techniques. Most builders, when constructing a multi-million dollar facility, don't want to have to hand shape each joint in the structural system as Bensonwood sometimes does.

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* Benson, Tedd. The Timber-Frame Home: Design, Construction, Finishing. Newtown, CT: Taunton Press, 1997. Print. (p49)

There needs to be a more efficient, more appropriate way of bringing two wood members together that doesn't require such intense, specialized work.

In Germany, some designers have already begun to address this need. The project on the right, a high rise residential building with a glulam wood structure, found a creative and simple way to modularize the structural components in an effort to simplify their connections. On top of being fairly regular in design (consistent floor to floor heights, regular spans, etc.) this building also used a similar component at every wood-to-wood connection. The steel box, seen in the lower image, is an engineered component that joins the top of one column to the bottom

Figure 60: Combination Wood and Steel Construction
Esmarchstraße 3, Berlin, Germany
Architects: Kaden Klingbeil Architekten
Steel timber connectors are used to create a rigid frame without complex wood joinery.*

* pro:Holz. Website. Date of Access: April 20, 2012. <http://www.proholz.at/zuschnitt/33/bauinitiative-prenzlauer-berg.htm>

of another and accepts beams on the sides. All the connections are finger jointed, which effectively locks the structure in place once it's been assembled. The beauty of this system is that the steel connector allows for a certain amount of flexibility in the components of the structure. Beams and columns can be removed without severely impacting the remaining structural members. Although this building is in an urban setting and wouldn't likely be able to expand, replacing the steel connectors in key locations could allow you to grow the building horizontally and even vertically if they're sized appropriately. This is a smart and efficient response to an incredibly complicated problem.

For the purposes of the School of the Built Environment project, this system was adopted, with some minor changes. By incorporating a steel connection type at every structural joint, the building can remain flexible in the interior and exterior but can also start to remain flexible in other ways. If we consider this steel connection as the point on which all the layers of the building hang, it could even become the node that bridges between them. The envelope could hang off of this connection just as easily as beams do, for example. Also, by designing in this way, beams and columns can be replaced if need be. Should the system need to be resized for an exceedingly heavy program on a given floor, beams could be swapped out with newer, higher capacity ones. Incorporating this level of modularity truly gives the building an opportunity to be flexible.

One problem still existed, however. As seen in the pictures above, this type of connection can only be made modular if it's receiving members at ninety degree angles. Given that the goal of this project was to prove that adaptive architecture could exist

without sacrificing form, it was important to find away to incorporate the modularity seen in the German high rise with the form and concept developed for the project. This meant the connector needed to be adapted to a curved facade. Unfortunately, adapting an element like that to fit a curved facade could also only work if the curve were a regular, repeatable radius. The goal was to prove form wasn't limited, so the radius of the curves in the foot print of the building were made intentionally irregular.

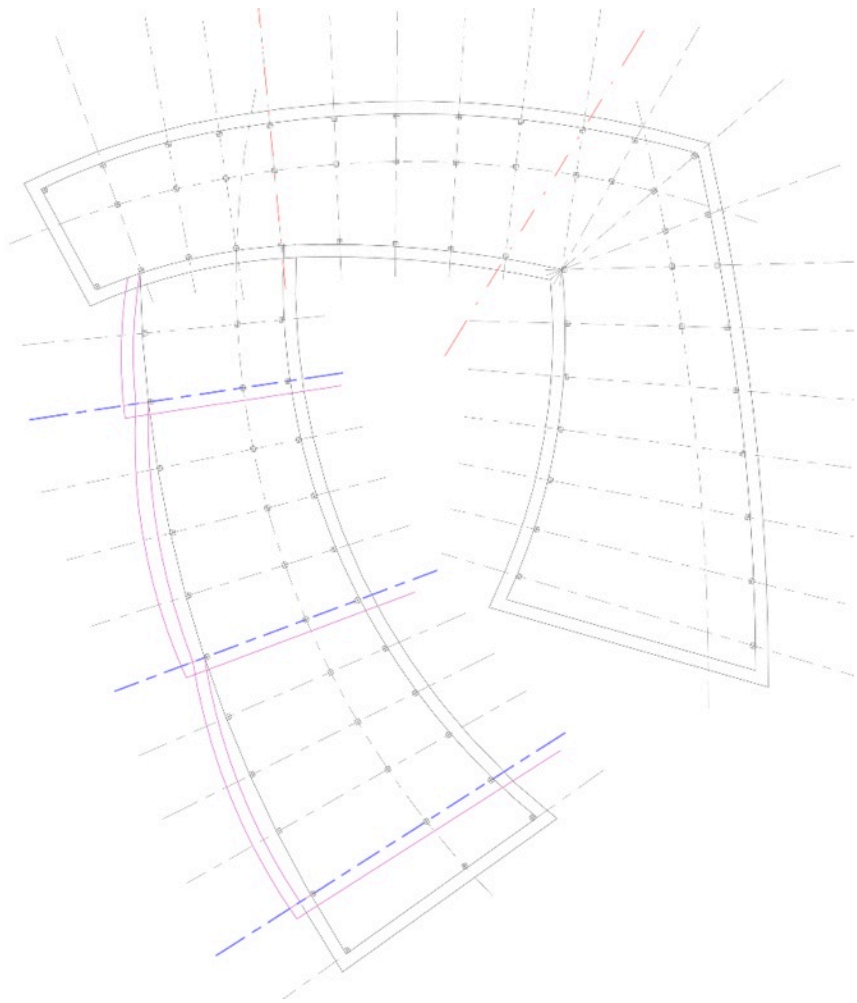


Figure 61: Establishing a structural grid

So the problem still remained - how to design a connector like the one in the high rise project that could accept connections in a timber frame inspired structure from any angle while still retaining its modularity? It came down to the connection types. By using pin jointed connections (connections that can rotate) in strategic ways, beams could run

into the steel timber connector from whatever angle they needed to. Continuing to maintain a system of bents and bays, the connection types began to develop.

In the bents, where the connections can all be at 90 degrees, a simple pin joint rotating along the vertical plane could provide an easy and efficient method of spanning the bent structural columns to form the short span long span approach.

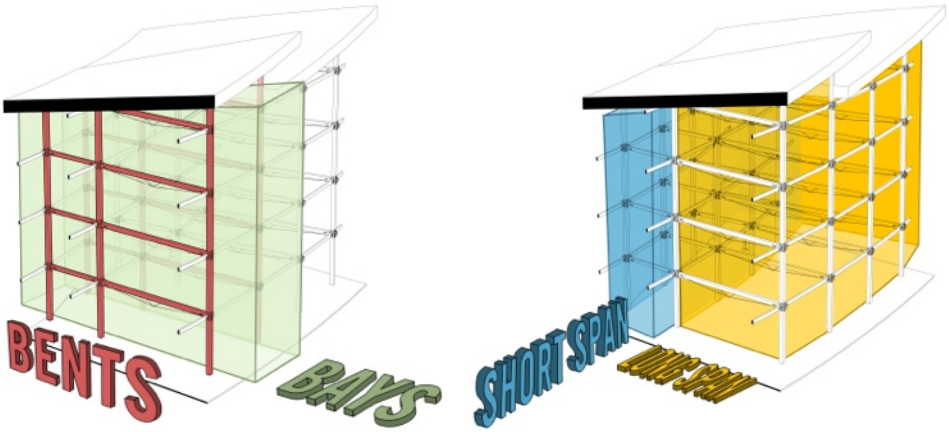


Figure 62: The benefits of smart structure

Where the curvature of the foot print could be compensated for was in the bays, where structural members would span from bent to bent, meeting the steel connectors at various angles. This connection type was made a pin joint that rotates along the horizontal plane, allowing it to meet the beam at whatever angle was required. Although in the redesigned timber connector, columns are still finger jointed at the tops and bottoms into the assembly, not using finger joints in the beam connections allows for increased flexibility in the beams themselves. The effect is that instead of the wood tying directly into the steel connector, a secondary steel member needs to be inserted into the beam in order to be received by the pin joint connections on the steel box. This secondary steel connection member can evolve with the beam if need be.

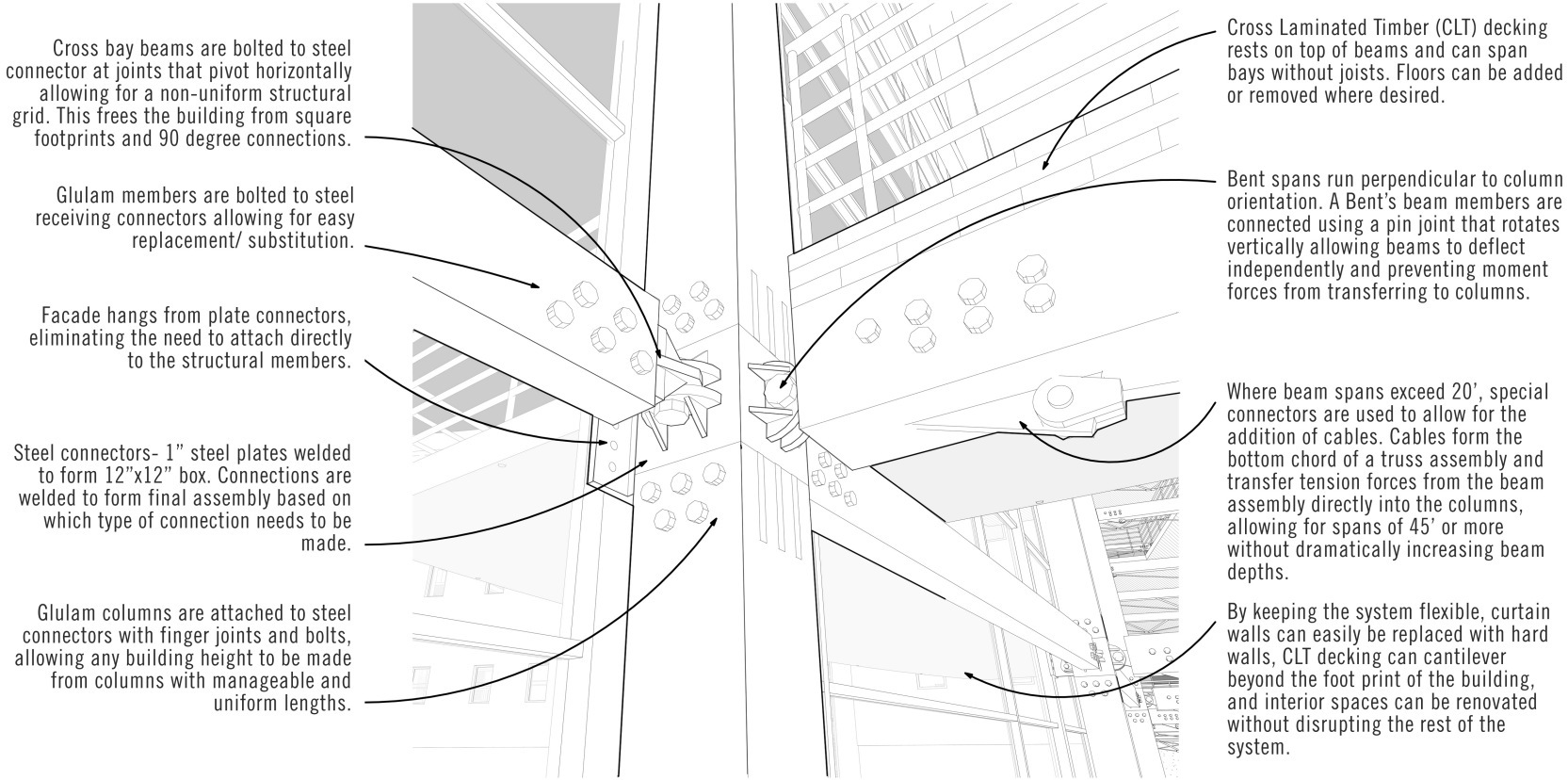


Figure 63: Design of a timber to timber connector

For example, in this design, long spans would require excessively deep beams. Initial calculations show a beam spanning the longest section of this building would need to be about two and a half feet deep. To remedy this issue, the beams were redesigned as combination wood beam-cable trusses. By incorporating a new type of secondary steel connector that would be inserted into the wood beam, a tongue for receiving cable ties can be added that will turn the long span beams into truss assemblies. At the center of the truss, the beam is still fairly deep, but the steel cable system allows the beam to remain light and airy, despite it's immense span. (See the lower right image on page 160)

Having developed a sensible, modular, and efficient solution to the problem of fitting an efficient and flexible structure into an irregular form, it was now time to begin crafting the building's design. What was discovered was that the flexibility which was intended to be designed into the future of the building was actually providing an incredible level of flexibility in the design process. The structural system was highly forgiving and allowed for floor plates to be removed wherever they needed to be. Also, having the facade hung from the steel connectors instead of being integrated into the structural system directly allowed for some expressive and unique moments to be created on the exterior of the building. The most flexibility, however, came in the vertical direction, where the slope of the peeling landscape was threatening to customize an otherwise modular building, the columns could be regularized and stacked on top of one another. Where the peeling landscape of the form conflicted with the regular height of one of the members, that member could simply become custom. (i.e. if the total column height from ground to roof at a given point was 40', and floor to floor height was 15', the

column assembly would be composed of a 15' column, a 15' column, and a 10' column reaching the roof.)

This helps to limit the amount of customized parts in the building while still maintaining the form established at the beginning of the design process. It also means that should a floor needed to be added in the future or should the peeling landscape of the building need to be turned into a full height 3 story building, the top most irregular columns could be removed and regular ones added. Like a kit of parts, this building could literally grow in any direction. Although it's unlikely this particular building would need to, the opportunity is there.

In keeping in line with the peeling concept, the facade of the building along with the roof of the building were designed to suggest that the growth of the building from

Figure 64: Final Design - Arial perspective rendering

ground to sky was an evolutionary process. The roof, which peels upward to allow light

to enter into the spaces within the building, also helps to speak to the evolution of form from ground to sky. The facade, which features a white, finished surface peeling away to reveal a rusted Corten layer beneath, begins to speak to the fact that buildings exist in time by showing the age of the building almost like an architectural footnote as it rests beneath the changing exterior finish.

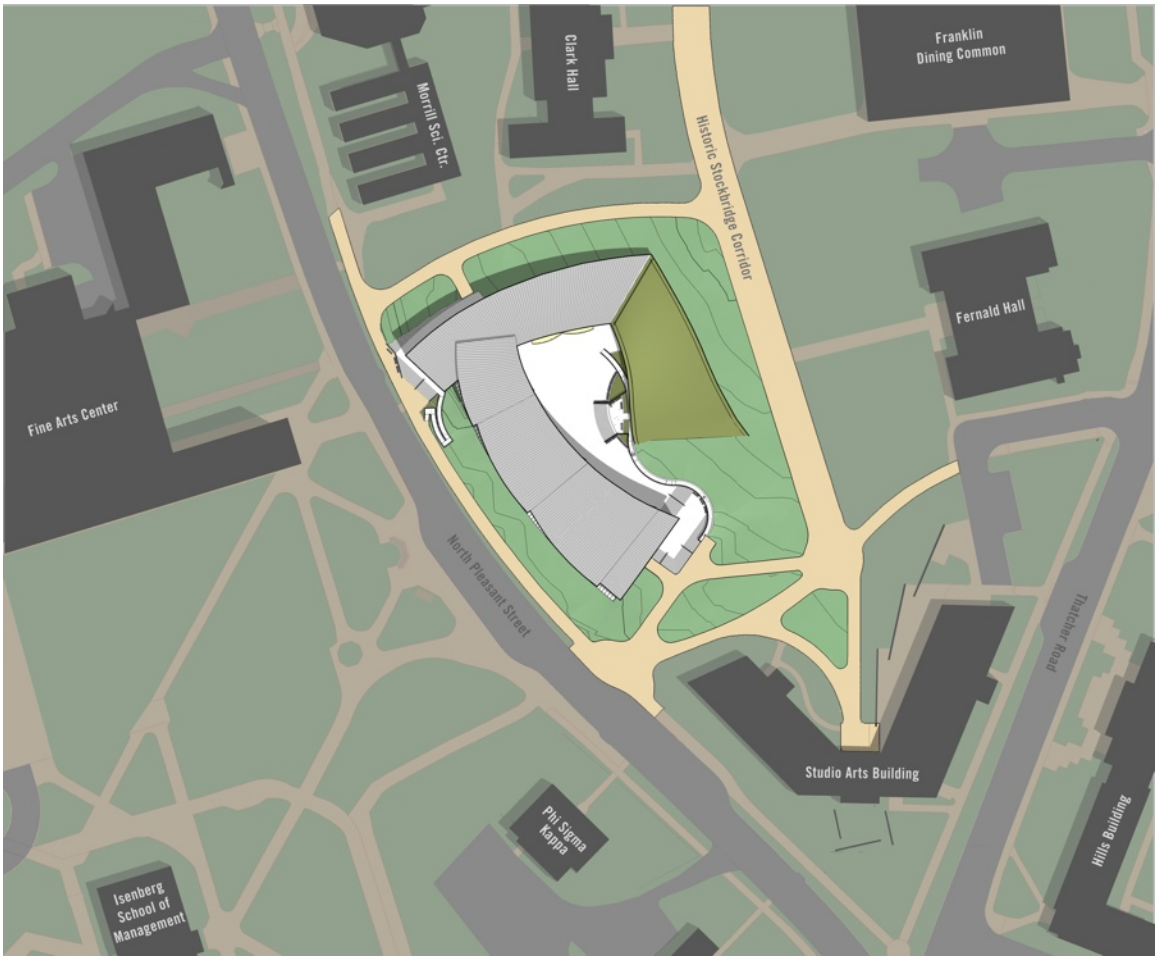


Figure 65: Final design - Site plan

Part of the consideration when moving from the sketchy study models of peeling landscapes was to consider how the building's siting would affect its form. Located on lot 62, a parking lot across from Umass' Fine Arts Center, this building had a unique

opportunity to help knit back together a disparate campus landscape. The site existed at the start of the historic Stockbridge corridor, a once vibrant and core academic area of the campus. In the current Campus Master Plan, there is a lot of discussion about revitalizing that corridor, as it's sole use has now become access for service vehicles.

By selectively siting the building, it was possible to create a structure that could help to shape and contain the campus space at the termination of this historic corridor and, in the process, re-urbanize the fabric of the university in this area of campus.

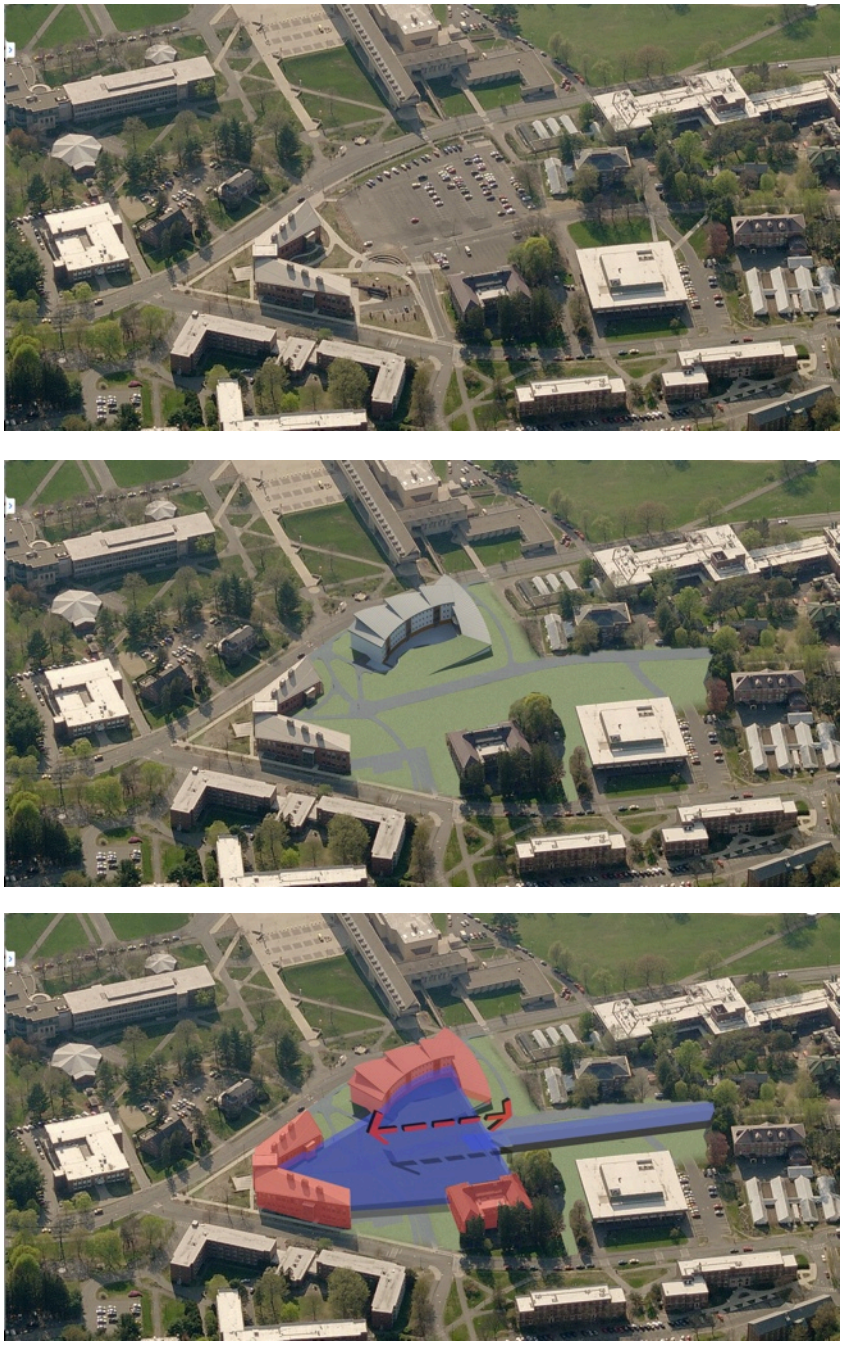


Figure 66: Enhancing the quality of outdoor space

Another concern, touched upon in the discussion about peeling roof layers, was getting light down into the spaces within the building. The first choice was to create a sunken courtyard in the center of the peeled landscape. Sinking this courtyard down to basement level allowed the basement spaces to gain access to light while creating a space where students could congregate, test truss assemblies, build full scale mock ups, etc. The basements house most of the wood shops and materials testing labs, so this courtyard can really serve as an expansion space for those uses.

Figure 67: Final Design - Courtyard perspective rendering

The roof was also a prime opportunity for capturing light, since the peeled layers of it were already letting a large quantity of daylight into the building, so a number of possibilities were explored for ways in which light could be passed from the roof to the basement beneath these peeled sections. The end result, was the design of a stair that could allow light to pass through its core, thus transforming the stair from a regular,

boring, utilitarian, switch-back fire stair into an exciting piece of the internal landscape.

Figure 68: Interior stair design

Much of the reason why this crafting of interior elements was so successful was the fact that the structural system allowed for a lot of things to happen on the interior of the building. The floor system, being a Cross Laminated Timber decking system, was able to span from bent to bent and beam to beam without the use of joists. This meant

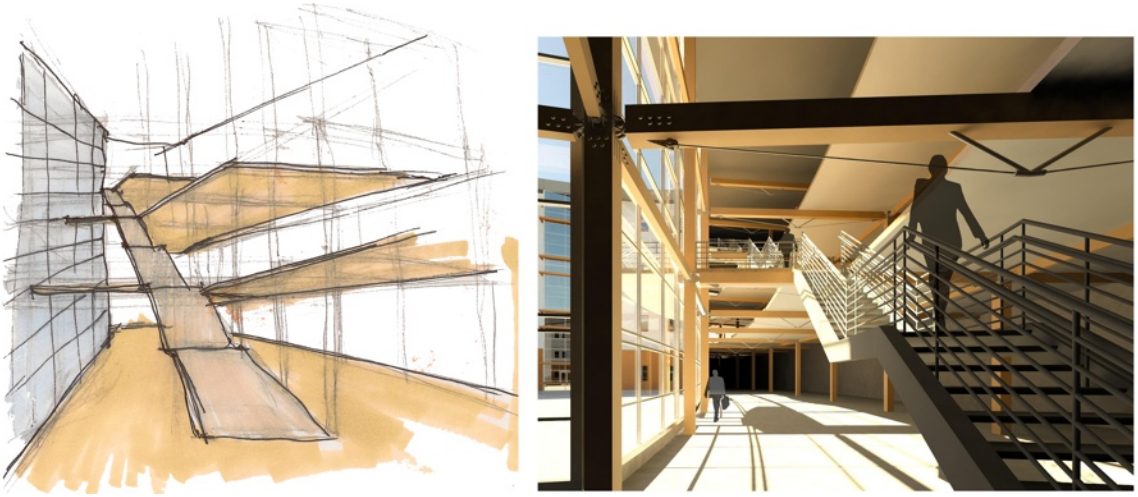


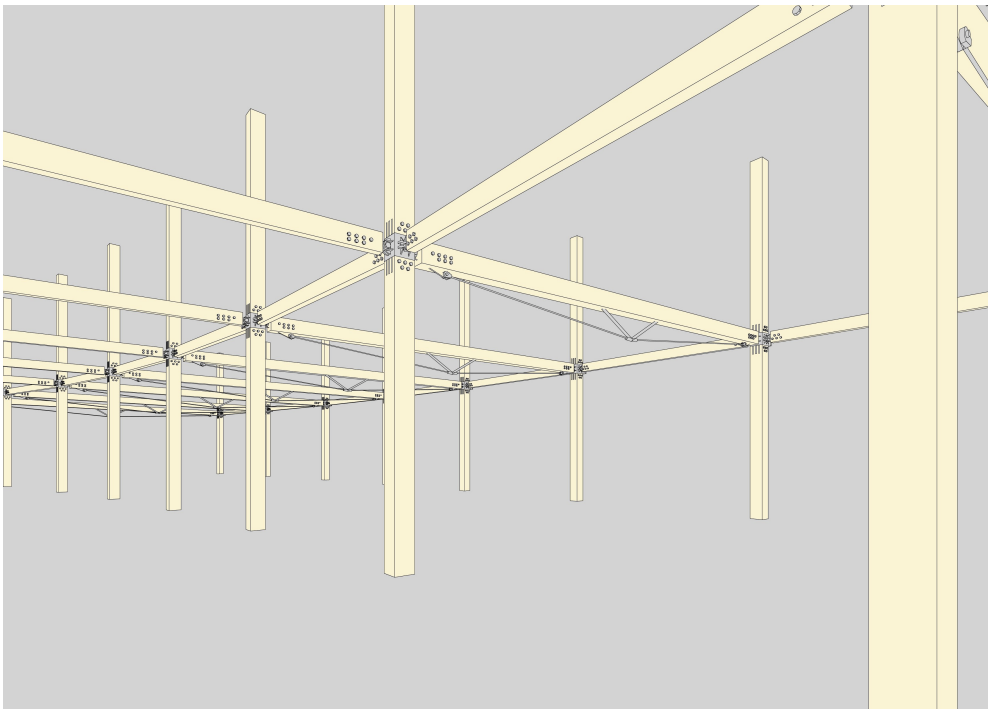
Figure 69: Interior stairs as a landscape

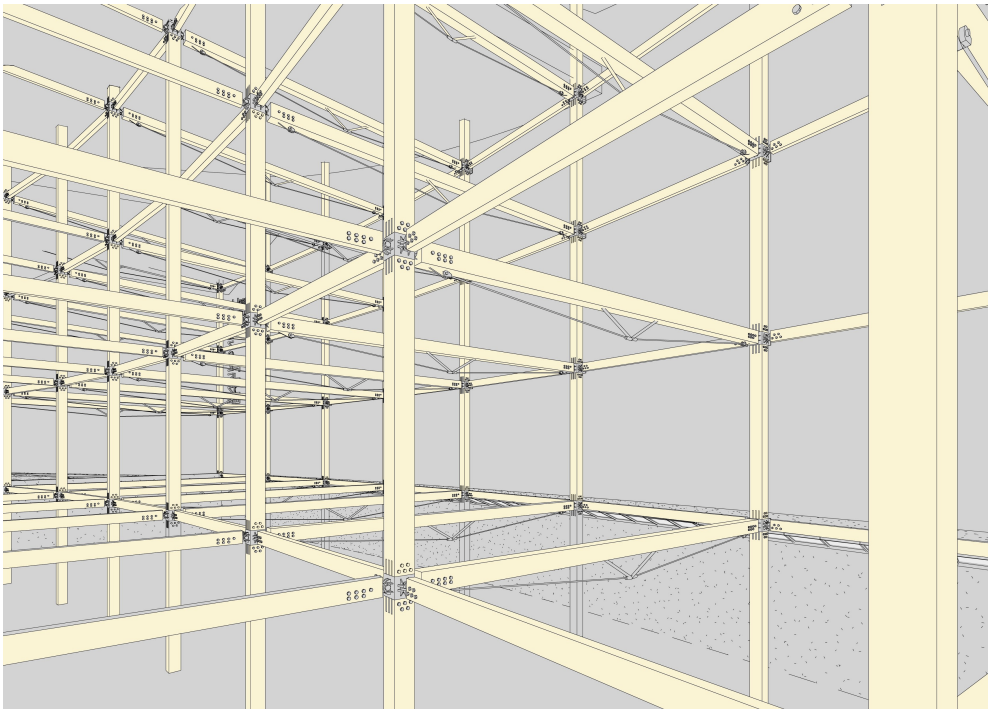
that openings could be created in the floor wherever they were needed without a ton of consideration into the secondary support systems. The floor itself was the support.

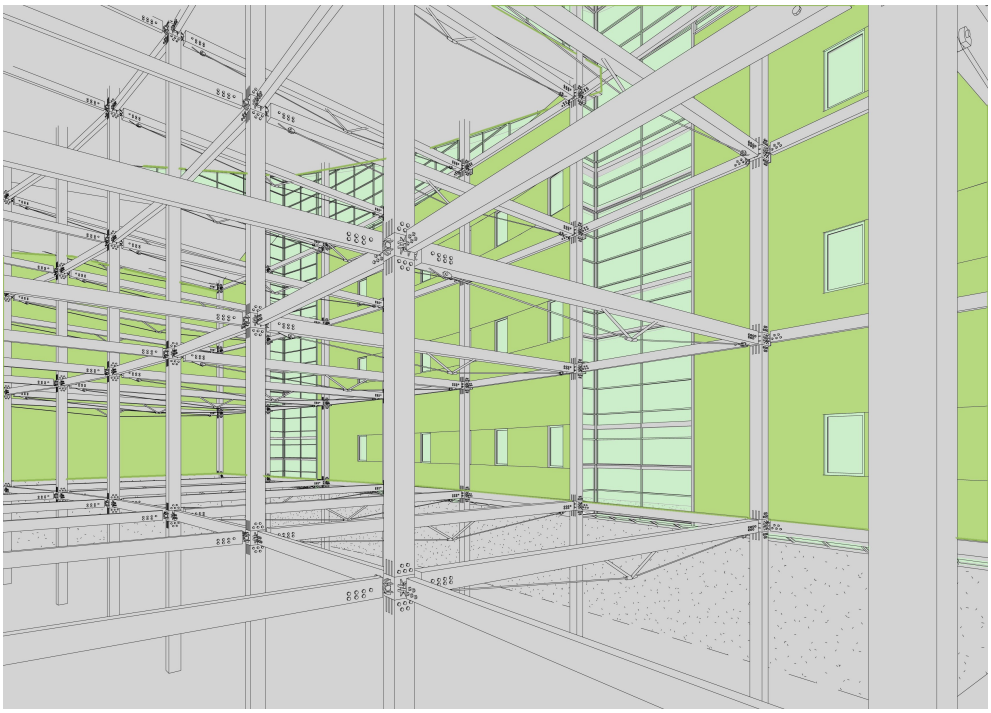
This allowed the design to adapt and change as the program was being fleshed out. The central stair was one such example of this. By using the structural grid as a framework and inserting design elements into it, the process of designing the interior became almost like renovating an existing building. There was an immense amount of problem solving, but it forced design choices to be more creative as a result. The central stair, which selectively removes portions of the floor and runs from the basement to the third floor in one continuous stretch, uses the curtain wall flanking the courtyard as a means of connecting the interior to the exterior. By reflecting the sloping, peeling form of the roof above, this stair creates a hill, of sorts, on the interior building. In this way, the interior landscape becomes just as exciting as the exterior landscape.

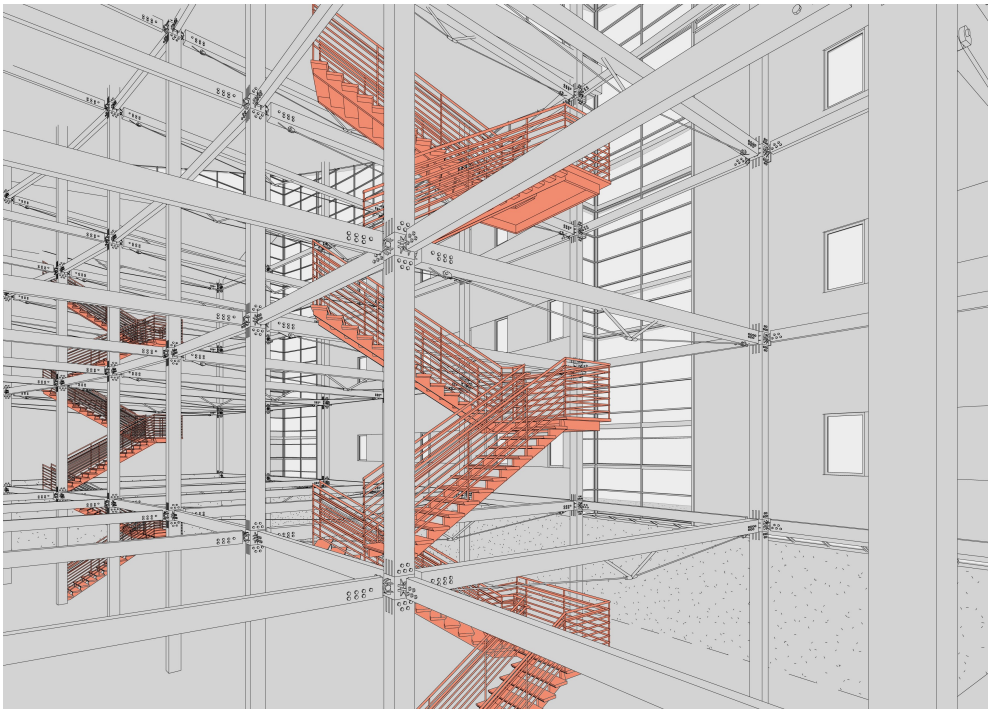
To conclude- the School of the Built Environment was a test against a theory. The objective was to prove that an adaptable building could be built with relatively conventional techniques that could have, at one time, the efficiency of modularity and the character of form based design. The end result was a building system that respected the six shearing layers of change through and, through an unconventional design process, succeeded at keeping them independent of one another. The following diagrammatic series outlines the process by which this building is assembled, layer by layer, until it's finally fitted out with program.

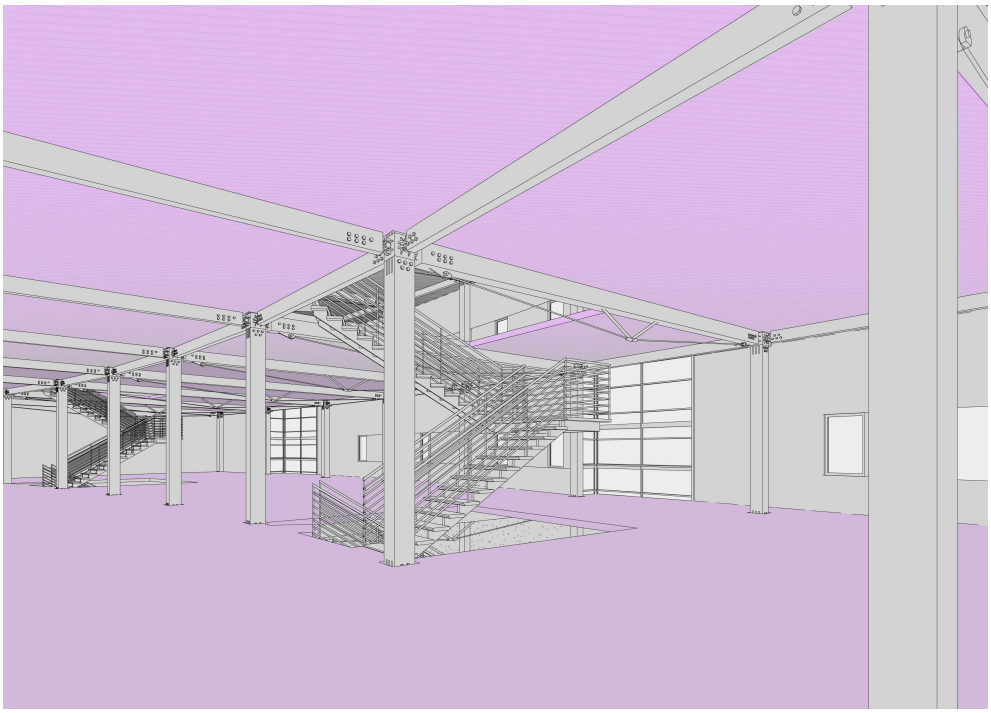
Figure 70: Building components and assembly sequence

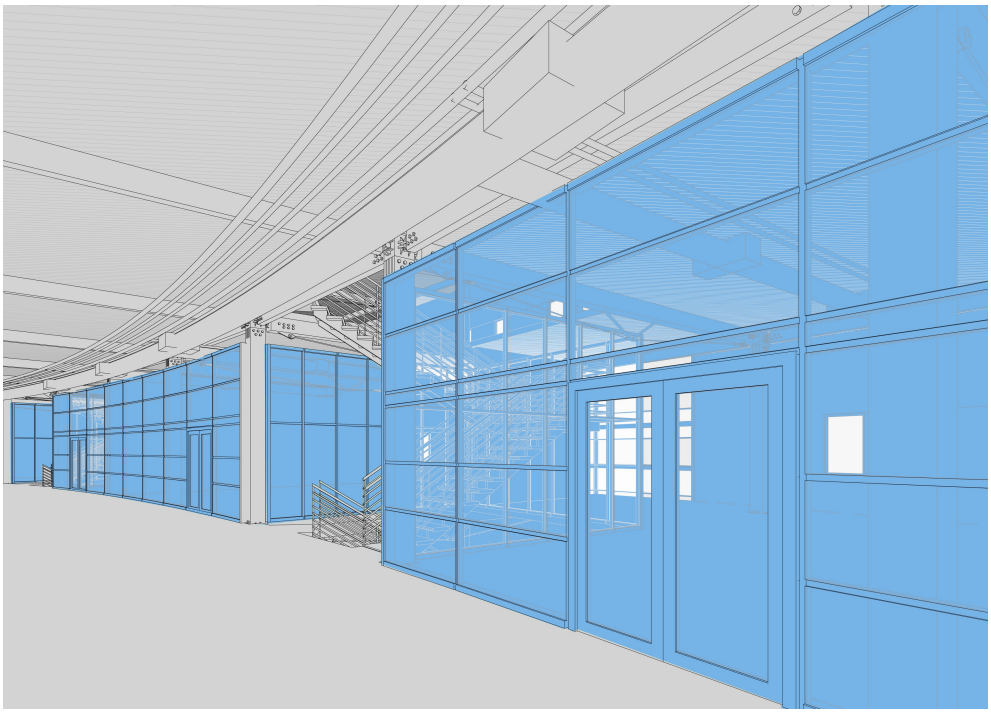












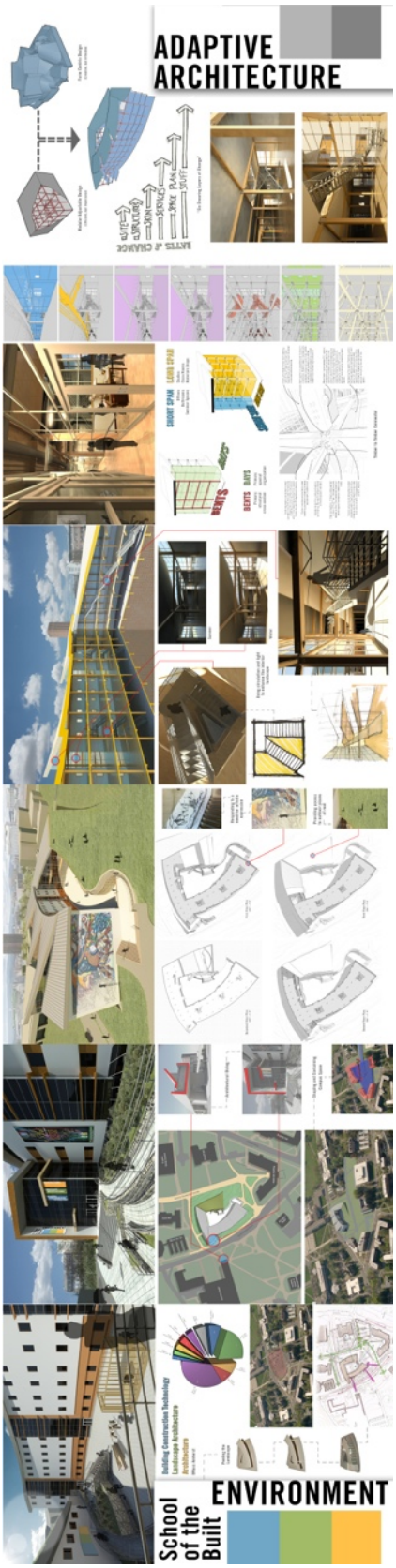

235
Architecture
Studio

Figure 71: Final Design - Main entry

The School of the Built Environment has the opportunity not just to be a place to house the Architecture, Landscape Architecture, and Building Construction Technology programs, but also to be a tool for learning. We can learn a lot about building from the structures we occupy, especially if those structures are meant to be tinkered with and altered over time. The building that houses students who will eventually be entering the design and construction fields needs to communicate the values and virtue of good, holistic design, not speak to the cheap, efficient, lowest bidder model that currently drives most design and construction choices. This building has an opportunity to be iconic not in its presence on the land, but in its presence in the temporal fabric. 150 years from now, this building should still be standing - visibly changed - and students and faculty everywhere should be able to praise its longevity and the careful attention that went into it.

Whatever building is actually constructed for this real university project, it is the aim of this thesis to address the design and construction community and say "We can do it better." By equipping our buildings to change through time, we can extend their lives. By carefully considering the possibilities, we can increase their usefulness. By crafting our buildings instead of producing them, we can enhance their charm. Through responsible, sensible, and holistic design, we can not only contribute to the building's future, but our own as well.

APPENDIX A:
FINAL PRESENTATION BOARDS

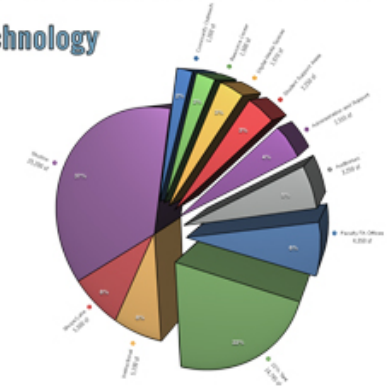


Final Presentation Boards as they appeared April 11th, 2012

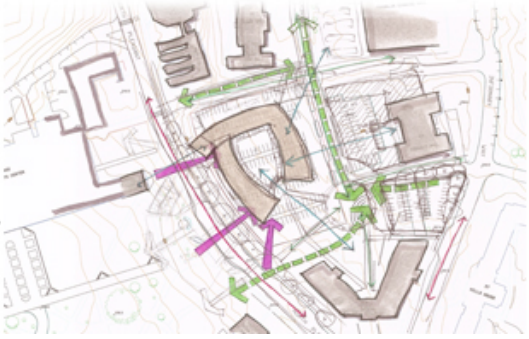
School of the Built ENVIRONMENT

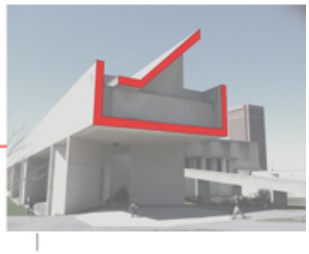
Building Construction Technology
Landscape Architecture
Architecture

UMass Amherst



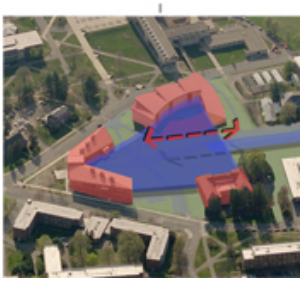
Peeling the Landscape

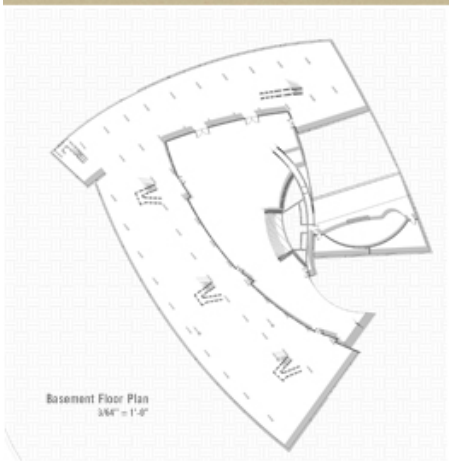


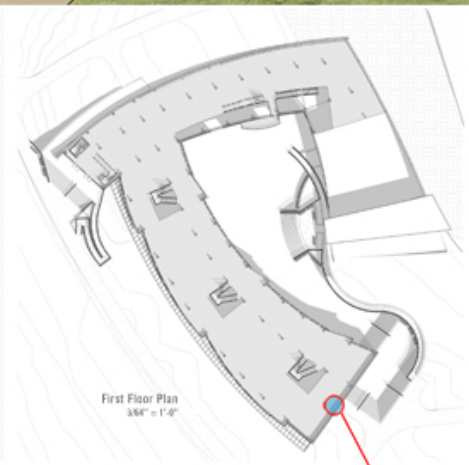


Architectural Dialog

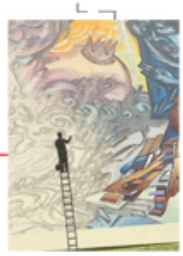
Shaping and Containing Campus Space

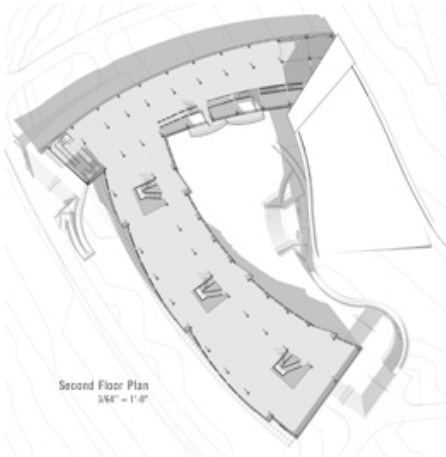






Responding to a need for artistic expression



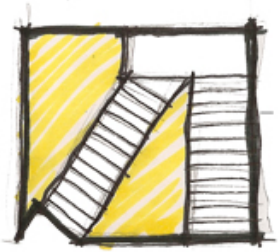


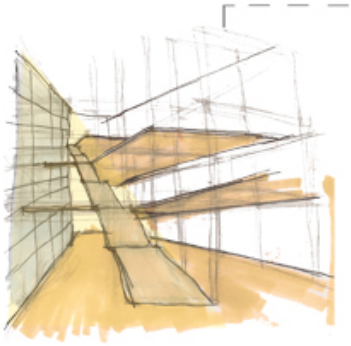
Providing access to outdoor places of rest

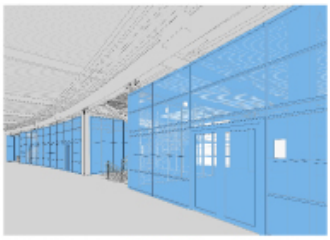
Summer

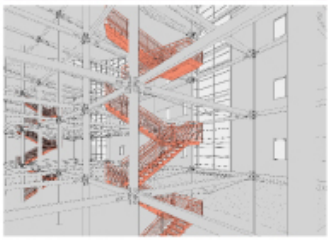
Winter

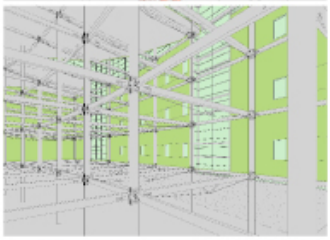
Using circulation and light to enhance the interior landscape

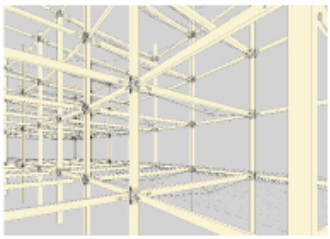


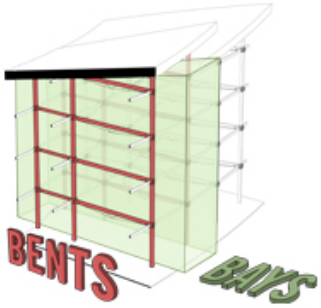










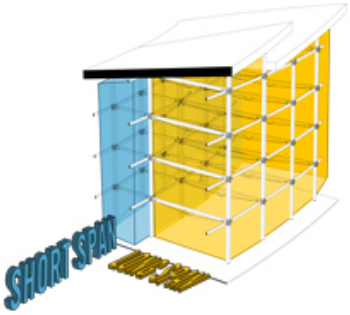


SHORT SPAN

Offices
Bathrooms
Seminar Spaces

LONG SPAN

Studios
Class Rooms
Materials Shops

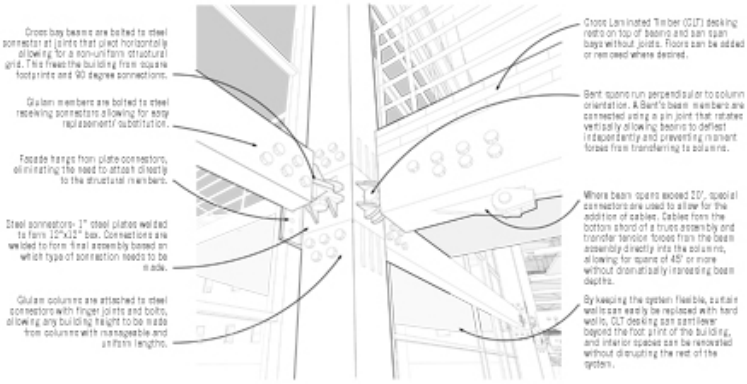


BENTS

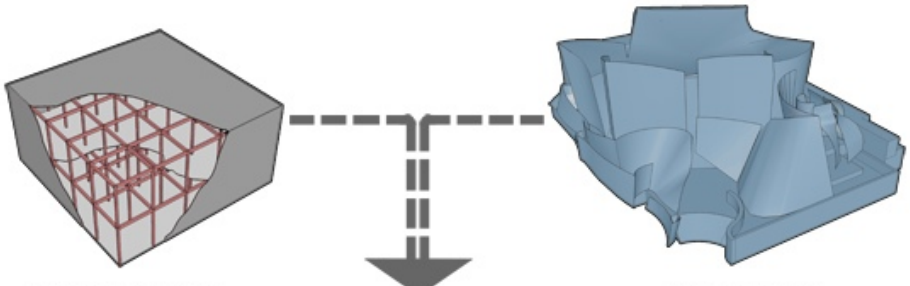
Primary structural cross section

BAYS

Primary spacial organization

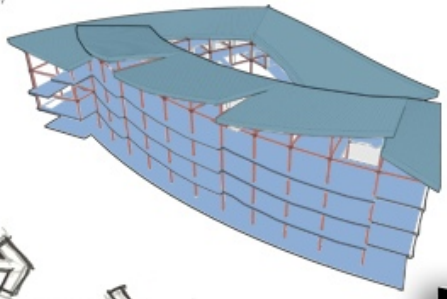


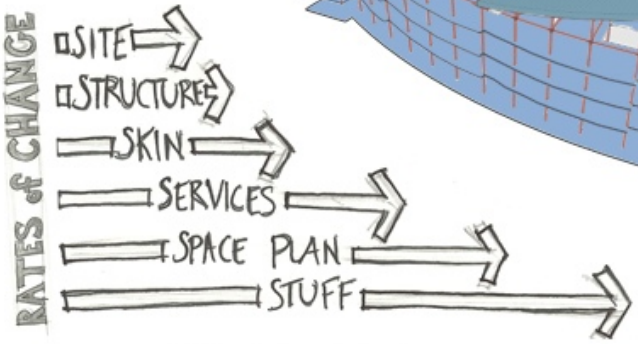
Timber to Timber Connector



Modular Adjustable Design
(Efficient, but Impersonal)

Form Centric Design
(Creative, but inflexible)





"Six Shearing Layers of Change"

ADAPTIVE ARCHITECTURE

APPENDIX B:
LITERATURE REVIEWS
& PRECEDENT ANALYSES

Justin Pelland

Literature Review

2011.02.01

The Peak of Oil: An Economic and Political Turning Point for the World

By C.J. Campbell

As a jumping off point for any research involving the subject of oil, The Peak of Oil is an informative and enlightening article that educates the reader on everything from the origins of oil to its regulation and, eventually, to its depletion. Although Campbell writes with a tone that has a clear bias, the article was very well balanced and stressed the importance of understanding the facts as opposed to word of mouth.

From the start, Campbell recognizes that the discussion of peak oil should not be centered around the discussion of global warming. He frames his thought process on the facts of oil consumption through trends, data, and observations without insinuating an increased pressure due to environmental awareness.

As a frame of reference, Campbell describes the process by which oil is created and the relative periods in which it was formed. According to Campbell, the youngest oil deposit currently being explored is no less than 90 million years old. That's not to say that oil takes 90 million years to develop, but rather that the

last time conditions on this planet were ripe to set the stage for oil was so very long ago. Specifically, he states, almost all of the world's supply of oil was created during a select few periods in which the planet's climate warmed. He then goes on to explain that the conditions within those conditions need to be just right in order to ensure the materials that form the oil (namely dead animal life) have the opportunity to do so. This is to say that without being trapped at the bottom of mostly stagnant water sources, quickly covered by sediment, and then stored in rock chambers undisturbed by fissures or other leaks as a result of tectonic activity, the oil would have never formed in the first place. This paints oil in a light that makes it seem almost as unique of a product to the planet as life in general is to the universe.

Campbell is unspecific as to the sources of much of his information, but his history as a renowned petroleum geologist and position of authority on predicting peak oil suggests that much of his knowledge is first hand. He claims, for example, that the nature of oil, its price, and its production is all the product of false reporting. There are charts and graphs inserted into the article (with no reference as to if they're official industry documents or not) that show the "industry insider" prediction of the production of a particular new oil well, or "wildcat", was much higher than the first reported figures. Campbell describes the relationship of the oil industry to the stock market is one that benefits from this under reporting as it provides the industry with a means to feign an increase in production and thus control the value of their business.

By sifting through the under reported numbers and finding the true value of our oil assets, Campbell describes that the discovery of oil actually peaked in the 60s and has since been on a steady decline. Considering that the notion of "peak oil" is one based on the idea that our oil will have "peaked" when the discovery of new oil ceases to exceed the rate at which we deplete the found oil. As Campbell describes, there are economists who feel that the understanding of oil and its origins is inaccurate and that the planet actually contains much more oil than is discoverable until such a time as it rises from the depths of the geology to fill the empty wells, but he brushes it off as ill informed industry controlling codswallop (without really giving any evidence to the contrary).

One interesting bit of history states that M.K Hubbert, using many of the prediction techniques described by Campbell in this piece, predicted in 1956 that the US domestic oil production would peak around the 1970s. This seems to stand as evidence that the three primary models of predicting peak oil are, indeed, fairly accurate.

Towards the end of the article, Campbell begins to dissect the complex and overwhelming relationship between politics and oil. Specifically because of the nature of how oil was created, it exists primarily within a few large regions of the globe; namely, Saudi Arabia, Abu Dhabi, Iran, Iraq, and Kuwait. These five countries are referred to as the "swing share" of oil. This article was written in 2003, so it's likely that Campbell was responding directly to current events, but he says that the likelihood of political tension is strong as the world begins to exhaust its domestic supplies of oil and the swing countries begin to produce the

majority of the world's oil. Specifically, he described, the relationship between the USA and Iraq is one of such bad blood that, as the US begins to depend more on their oil, an escalating conflict will arise which will likely result in "western military intervention." Whether Campbell wrote this before or after the start of the War in Iraq is irrelevant, however. It's clear enough, by the information presented, that the oil industry is one with severe influence over politics and the market designed around supply and demand. Sadly, however, it's impossible for the supply to meet the demand when the product is one of a finite nature.

Perhaps the most interesting thought that came out of reading this article was the one of understanding when, exactly, the loss of oil would result in serious consequences. Where once the impression was that when the last well of oil runs dry, the world will be forced to change, it is now understood that the peak of production is more likely to be the start of the weaning process. Campbell concludes that the process of dealing with a global shortage of oil will likely last around 10 years and will need to result in massive restructuring of everything from infrastructure to daily lives. He states that nuclear energy will likely be "rediscovered" and alternative energy sources are likely to gain ground. It's not likely that the world will be plunged into a new, energy-less dark age but rather will be reorganized and reeducated to handle new forms of energy. He does note, however, that airlines will "all but crash", public transportation will be the norm, town and city planning will have a renewed focus on energy efficiency, miniaturization, and self-sufficiency, and that building codes will begin to evolve.

What does all this mean for architecture? A change in the way we live demands a change in the way we design. Independent of the difficulty of transporting non-local materials, the human condition will demand reinvention. Campbell speculates that the process of adaptation will last around 10 years. This is an estimate likely based on the fact that complex systems adapt once a problem has been introduced, but if we know that oil is likely to peak between 2010 and 2020 and can understand the implications the following shortage will bring, then our architecture can begin prepare its inhabitants and allow the population to ride out the storm in comfort while the “free market” catches up.

Justin Pelland

Literature Review

2011.02.02 - How Buildings Learn

By Stewart Brand

As the book How Buildings Learn was written in 1995, it's no surprise that many of the concepts Brand describes as being lost in the design process have since become important facets of sustainability and the "green movement". The book begins with the observation that most architecture is built in the moment and at the same time for permanence. Two completely different values, it would seem. Brand passionately defends the position that building to solve a current problem or need will ultimately result in the death of the building long before its time.

Relating directly to my thesis topic, Brand mentions the 1973 oil crisis and how, for the most part, people change frequently but yet our buildings always seem to be struggling to keep up. In the case of the oil shortage, when energy became scarce, we frantically searched for technology or techniques to help reduce the stresses. This kind of building-as-a-response technique leaves us with monuments to the past that are seemingly useless to the present or future. Thus, Brand theorizes, a building is only as good as its combined history and ability to remain useful.

Brand mentions in one passage that buildings and the way they adapt can be summed up in three categories. Commercial buildings, which are ready to

adapt at a moments notice to keep up with market demands, are the most willing to change. Residential buildings, 2/3 of which are occupied by their owner, are not necessarily the most ready to adapt, but are the ones that change with the most consistency. And finally, Institutional buildings, be it because of their nature or their ruling bureaucracy, are the least likely to adapt and the most resistant to change. Although I would agree that commercial buildings have the tendency to change according to market forces, in the 16 years since the authoring of How Buildings Learn, I would argue that commercial buildings, more than any other, have pushed for increased cost efficiency in their construction (a good example being Trump Tower) at the sacrifice of good design choices. As a general observation, it would seem that the commercial and corporate architecture of the day is more likely to build a 30 year building than a 300 year icon and although that may contribute to their flexibility to change, it doesn't necessarily reflect Brand's idea of the adaptability of commercial architecture.

One particularly compelling area of thought that Brand explores is the adaptation of the 4 S's in creating the 6 S's which describes the layering structure of building components (structure, use, etc.) and lobbies for the design of architecture that responds to the frequency of change of each of the particular layers. Recognizing that structure has a certain permanence about it while end users are likely to change or reorganize their use of the building far more frequently is an idea that takes into consideration the element of time in construction and is, in and of itself, timeless. Brand mentions the perfect example as being the nature of a timber frame house and its ability to change and adapt to

new uses or organizations versus the nature of a standard balloon framed house that integrates the many systems and layers far too tightly. As Brand concludes, “a design imperative emerges: An adaptive building has to allow for slippage between the differently-paced systems of Site, Structure, Skin, Services, Space plan, and Stuff.”

On the topic of design processes, Brand writes, “All buildings are predictions. All predictions are wrong.” Although this is probably a great line to feed to a client in order to convince them that the best course of action is to plan for the scenarios you simply can’t predict, I would argue that not all predictions are wrong and that Brand’s logic is a little short sighted. A fortune teller, when grasping your palm, does not look at you and say “You will meet a rich and famous man by the name of Ben who will drop his wallet. You will find it and return it for a reward of $1,000.” They’re purposefully vague and would be more likely to describe your future in this way, “You will encounter someone of importance and your life will be the better for it.” Brand’s logic in the case of predictions in architecture suggests that architects are trying to make serious predictions. While this may be true and an interesting way to view the design process, I would argue that what brand means to say is that, “All buildings are predictions. Good buildings are the closest to being right.”

In conclusion, Brand’s book, although possibly slightly out-dated and in some places a bit dramatic, describes a solution to a very real problem in design. Humans, in general, live in the moment and tend not to think beyond their week, day, or even life time. Architecture, often the product of a large investment by a

person or organization, tends to reflect the needs of the clients in that moment and, as a result, the over-specialized and over-personalized buildings that come out of the process, develop a sort of half life, a poison that slowly brings about their death. For building to reflect the characteristics that people value, it will have to not only suit the needs of the moment, but continue to do so into the future. This, Brand argues, is the epitome of what makes our buildings loved.

I find his theories surrounding the different-paced layers of architecture to be thought provoking and generative. With regards to my emerging thesis topic, I found it hard to explain the primary goal of my research into peak oil and how it might affect architecture and realized while reading How Buildings Learn that this system of layers is exactly the theory I can use as a jumping off point. I'm not interested in hypothesizing the way in which architecture will change in response to increased oil prices and a lack of supply. I'm interested in developing a stratagem, a framework, a manifesto (if you will) that defines a new design process that's both accessible and adaptive. Peak oil is just one example of a "system shock" that I'm choosing to use but ideally, the principles I develop will, like Brand's 6 S's and scenario planning, prepare buildings for the unknown future and increase their durability, adaptability, and versatility.

Topics that could emerge from analyzing, critiquing and suggesting improvements to the theory:

- A better system of the 6 S's

- A prescriptive “how to” for combining the scenario planning theory with the 6 S’s theory in the actual planning and design process.

Theory from the text could be ‘tested’ by:

- Doing in depth comparison research on timber frame construction vs. balloon framing (i.e. Longevity, Durability, studies of how frequently they’re each torn down vs. renovated)

Theory from the text could be expanded to be applied or tested on:

- Expand Brand’s theories on scenario panning to extend beyond space planning and start “scenario planning” for the other layers of a building (structure, site placement, etc.)

Research topics could emerge from a comparison or contrasting with another text such as:

- Deep Economy, Bill McKibben- combine Brand’s theories with McKibben’s theories about human nature, local living, “stuff”, and happiness to develop a unified theory for architecture.
- Architecture of Happiness, Alain de Botton- Take de Botton’s theories regarding how architecture speaks to people and why we develop affinities for particular styles and compare/contrast with Brand’s observations of how buildings change with time. Maybe try to find a relationship between de Botton’s theories about how much of our happiness or misery stems from the buildings we live in and

Brand's theory of how people (the fastest-paced layer of the 6 S's) change their tastes and buildings over time?

Justin Pelland

2011.02.011

How Buildings Learn, Brand &

Taking Shape, Hagan - Comparison

Being 10 years old (but still younger than How Buildings Learn), Hagan's Taking Shape is an interesting, albeit overly personal, view of the architecture profession and its role in society. Hagan argues that within the realm of environmental architecture, there exist three parties; the arcadians, a backward looking camp intent on returning to pre-urban days; the rationalists, a forward looking group with an appreciation of technology, its ability to meet our needs, and maintaining the status quo; and the environmentalists, a smaller faction with an interest in marrying the former two lines of thought. Whatever the means, Hagan argues the camps are essentially all reaching for the same ends - environmentally responsible design.

Brand, in his 1994 piece How Buildings Learn, makes the case for the responsibility of architecture to acknowledge its existence within a temporal landscape just as much as it does the physical. His primary philosophy is that buildings change dramatically over time and often without much predictability, but that a building with the ability to adapt and maintain its usefulness long into its life is inherently far more successful at being an example good architecture than any other.

Although the two authors are arguing for seemingly unrelated theories in the field of design, under close scrutiny, their conclusions amount to very much the same thing. Brand, identifying the relationship between architecture and time, would likely agree overwhelmingly with Hagan, who postulates on the relationship between architecture and nature. Brand's theory, if applied in conjunction with Hagan's, would develop a new and influential four-dimensional approach to sustainability resulting in buildings that are not only economically, socially, and environmentally sustainable but whose demonstration of aptitude in these three fields would be reinforced with a strong, temporal web of time and history.

At the time of her publication, Hagan acknowledges that those people who belong to the rationalist's camp of thought hold utilitarianism in high regard and often consider art in architecture to be an expensive irrelevance. She goes on to describe not just the ability of architecture to act as an iconic, formally artistic representation of sustainability, but its necessity to. In such a role, Hagan theorizes that architecture, primarily in the transitory period between what architecture was and what it will become, has the power to enact change. Recognizing the overambitious failures of the Modern Movement, she claims that "there is a case to be made for [architecture] being able to contribute to social change by making its emergence visible. This visibility could encourage further or more rapid change, as self-conscious form is given to less conscious cultural shifts." While Brand may argue that donning a cloak of sustainability could result in the obsolescence of the built form, it is easy to see where his pro-adaptability

mentality could find a home in the arms of Hagan's proposition. Hagan, herself, acknowledges that once change is effected (or, alternatively, global warming kills us all), her theory will no longer be relevant. As a principle for cultivating the social change required, its applicability fades once that goal is reached. Essentially, Hagan suggests our architecture should begin to take on a visibility in the form of aesthetic and formal value that reflects its ability to coexist with nature and, in so doing, incubates and promotes the social change necessary to combat a coming climate crisis.

Now, usher in Brand's theory. As Hagan's cultivation of social change takes hold, the adaptability of the architecture is called into question. If our architecture is designed to reflect its environmental identity for the sake of enacting social change, and change has, in fact, been enacted, then Brand would argue that the architecture in question has a responsibility to adapt accordingly or face certain obsolescence. This is the point at which the two authors theories begin to coexist in an elegant dance that only the temporal landscape could observe. Hagan echos this sentiment in the conclusion of her theory where she states that, "in the built environment, this kind of [social change] can be furthered by architects, not only in specifying and designing the building's fabric and services in particular ways, but also expressing architecture's capacity to transform itself. This is the ideological message: not that architecture can transform society, but that it can transform itself, and as architecture does, so, perhaps, can other forms of production."

Where once there existed two theories of different but noncompetitive value, a union of principles has developed a manifesto, of sorts; an enhanced ideology for an age where change is an imperative and future considerations a necessity. Perhaps Brand said it best when he wrote, “A building is not something you finish, a building is something you begin.”

Justin Pelland

2011.04.02

Precedent Analysis

Timber Framed Construction

After doing an extensive outlining process to flesh out the major ideas comprising my thesis, I've finally developed a base of theory and fact enough to draw a clear line between the peak oil crisis and a need for more adaptive architecture. In the book, How Buildings Learn, Steward Brand alludes, a number of times, to timber framed construction. At first, he recognizes its mastery over the problem of keeping the differently paced layers of a building separate (not integrating the services into the structure like we do with stud walls, for example). Later in the book, when discussing the potential for buildings to have a much longer life than their typical 30 - 50 years, he brings up the subject of timber framed construction again, this time in reference to one of the oldest houses in New England and which is still owned and maintained by the original family that built it. The potential for timber framing, a historically tested, tried, and true construction method, is evident in Brand's love for the buildings alone, but the subject demands much more scrutiny.

It's true that timber framed buildings have been generally held as long lasting structures. This is in part due to the fact that their timbers are so massively overbuilt for any of the forces that would challenge them, but also in

part because the exposed wood structure allows for both constant visual inspection and the ability to dry. If it's such an amazing construction technique, then why is it we don't build all of our buildings this way? Upon further inspection, there are three major problems with framing; availability of resources, cost, and the untrained labor force.

Timber framed structures require massive volumes of wood. Although in most cases the amount of wood in a timber structure may not be too much more than the amount needed in standard stud construction, the members are far larger, which means the forestry required to supply the members must be chosen with greater care. Similarly, wood is not available everywhere. The southwestern United States, for example, would have to ship in all of the major components from regions that are heavily forested (not unlike what happens today, but with the sizes, weights, and non-standard nature of timber frame members, this means a premium on cost). This contributes to the second problem- price. The price of timber framing, both in labor and materials, exceeds the cost of stud construction dramatically. Timberpeg, a company which designs and builds timber framed homes, makes the distinction that comparing the cost of a timber framed home to the cost of a stud framed home is like comparing the cost of a two red cars. The value of the timber frame is almost entirely perceived and not experienced. A timber framed home feels no more secure upon move in than a stud framed home. They add no experienced value in regards to energy efficiency, except where wider cavities between members allow for more

insulation. In general, the value of a timber framed design is experienced over time. A building that can be passed down from generation to generation with little in the way of decay or obsolescence is a value not experienced by many stud framed occupants. Initial costs of timber framing exceed those of stud framing, but the longevity is where the value lies. Which brings us to the third problem with timber framing - an issue that also greatly contributes to the cost of the system - availability of skilled labor.

Stud construction is easy. It's been made easy by years of pressure from the free market capitalist system. Efficiencies and standards have not only contributed to the increased safety of our construction methods, but they've also homogenized our work force. Virtually anybody who's anybody in the construction industry has a back ground in stud framed construction. It's quick, easy to learn, cheap to assemble, and in very high demand because of it. To begin constructing entirely in timber framed construction would require a massive restructuring of the work force and their training. This means that timber framing is likely to be slow to catch on as it will take time for the market to provide the right amount of skilled labor to encourage competition and drive down the price. Similarly, as the method picks up steam, timber framing will likely develop similar efficiencies as that experienced by stud construction. Manufacturers will invent newer assembly components and streamline their production process to allow for the quick-trip-to-the-lumber-store kind of commercialism. In most cases, timber framed buildings have to be fully designed and then almost entirely fabricated so

that every member fits according to plan. This is a huge hurdle, but with time and popularity, it will not be as permanent a problem as the availability of resources.

The Loch Lomond & Trossachs National Park Headquarters Building is an example of an increased popularity and interest in timber framed construction. Located in Balloch, North Lanarkshire, the Headquarters Building was (as of 2007 data) the largest timber framed structure in the United Kingdom.

Using two carpentry teams, the Douglas Fir members were cut and assembled to form a massive (in size and strength) structure which served as the base for all the interior partitions. The building is composed of 24 cross frames laid out in a sweeping S plan nearly 75 [meters] long and spanning close to 20 [meters].

Although structures like this are beginning to promote the values of timber framed construction as an adaptable, long lived structural system, it will take a large concerted effort on both the part of the market as well as the consumer (who's pockets will feel much lighter after choosing to timber frame) in order to make this method of construction as common as stud framing.

A book titled Design of Wood Structures ASD/LRFD provides a 'here's what you need to know' reference manual for anyone interested in timber framed construction (be they architects or engineers). It's highly sophisticated and very

technical, but a few select details depict how a simple change in method will be as difficult as a complete change in mentality and understanding.

Although many of the important things to know when designing wood structures come directly out of understanding the basic material properties of wood, there are some clear examples of how typical construction details will no longer be applicable when used in timber framed buildings.

Justin Pelland

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Assignment 8 - Precedent Analysis

*To supplement the argument for redefining Vernacular and the differentiation between style and and purpose.

In the discussion of style versus purpose, where style is applied and purpose is inherent, these two constructions stand out as perfect examples of each. Taos Pueblo, the oldest Native American village still in existence, stands atop a plateau at the base of a series of mountains. It has been discovered, through archeological evidence, that this Native American pueblo town has been continuously occupied for over 1,000 years, though the taos indians had lived in this valley for much longer. Folklore and detailed oral histories that explain exactly how old the village might be are passed down from generation to generation, but have never been revealed to the public due to religious beliefs and hopes for privacy. What makes this pueblo so interesting for a discussion on architecture is that it satisfies two arguments at once. First, the people of this village, for thousands of years, have maintained, rebuilt, and added to it constantly. It is the epitome of adaptability and continues to grow and evolve as needed. In fact, some of the buildings still standing today are over 500 years old and still in perfect condition. The second point that makes this village so interesting is in the way it so honestly stands as Vernacular. Because it was originally constructed in an era not dominated by architects and stylists, its form,

materials, location, and organization are the direct result of the needs of the people and their available resources. The most plentiful material - desert sand - became the building block for almost all of the construction. Combinations of earth, water, and straw were packed into brick molds and allowed to dry under the hot desert sun. Wood members were used to create roof beams, but had to be harvested and carried down from the treacherous mountains, which made them very hard to acquire. This is why most desert dwellings were historically never made from wood. Earth had its own advantage, however. Adobe dwellings were incredibly well equipped to protect their occupants from the heat of the sun, disallowing the radiative heat from entering the dwelling throughout the day. This was not the only benefit, however. Deserts, while incredibly hot during the day time hours, could also host unbearably cold nights. Adobe walls, therefore, were successful in absorbing the sun's rays during the day - preventing them from entering the interior spaces - and then could release them at night and provide an incredibly efficient heat source. The result was an architecture that suited its occupants and climate perfectly.

Its counterpart in this argument would be the Santa Fe Style. This movement, as its title indicates, was a late 20th century attempt at replicating the attractive style of the iconic desert dwellings. The adobe house, because it was so efficient and so perfectly suited to its environment, became the standard historic dwelling type throughout the southwestern United States. Santa Fe Style attempted to replicate this visual harmony but neglected to acknowledge the

reasons that brought it into existence in the first place. What was once a tried and true method became a style - a commodity - to be applied in a cheap attempt at capitalizing on its value. The Hotel Santa Fe, in Santa Fe, New Mexico is the perfect example of this flagrant misuse of vernacular elements. Its no secret, when you observe the photograph above, that this building was designed to replicate the form and style of the Taos Pueblo village - and it does so insultingly. First, the “form” of the Taos Pueblo village was the result of existence in time. As the centuries progressed, individual members of this community would expand or retract the village as needed. When new homes were constructed, they were built on top of one another, forming an artificial mountain of sorts. This was not because they felt it was an attractive way of building, it was a direct result of the social relationships between families and village people. Their way of life dictated this construction and the culture it supported. Hotel Santa Fe ignores time and has been constructed only to look as if it is the product of it.

Compounding the issue is the simple topic of materials. At first glance, Hotel Santa Fe appears to be constructed using the same techniques that Taos Pueblo may have been, but this is not the case. Although Taos Pueblo was, in fact, covered in a thin layer of stucco or mud to protect the bricks from the elements, it was done using local sand and for very specific reasons. Hotel Santa Fe also uses a form of stucco, but in this case, it’s almost purely decorative. It does serve to protect the interior elements, but it does so with the same impact that vinyl or aluminum siding might have. Stucco of this kind is typically dyed to give it a particular color. It can be dyed to virtually any color required. In this

case, the architects chose a red, sandy color that mimics that found in the Taos Pueblo village. But mimicry is not flattery. Where the stucco or mud cover of the Taos Village derived its color from the sand of its environment, further connecting it to its landscape and its region, the stucco of Hotel Santa Fe uses technology and dye to fake it. It likely bears no resemblance to the sands and materials that surround it and, therefore, responds to its environment by rejecting it. To reject a reality and substitute its own is to insult the meaning and purpose that lie behind stucco. This is not vernacular, this is mockery.

The problem continues further. Although the design details could not be located for this building, it can be said - with probably accuracy - that this building is not made of adobe bricks, but is more likely made from some cheaper modern method. It's possible that it employs some form of steel or wood stud construction with an adobe wash on the exterior to hide it all, completely neglecting the purpose of adobe bricks in a desert climate that the Taos Pueblo village so acutely recognized. Furthermore, the round wooden beams seen in the Taos buildings, which were painstakingly dragged from the neighboring mountain to fill a roofing need, are replicated in the Hotel Santa Fe with likely no structural purpose at all. As this interior photograph shows, the construction that is so "evident" on the exterior is false. The interior, with the exception of some of the furniture and fabric patterns, is as generic as a Motel 6 in New Jersey. None of the wooden beams continue into the interior which suggests that they serve no structural purpose and merely live to emulate the beauty of a true pueblo dwelling.

Hotels might be the worst offenders to the subject of Vernacular. Because of their desire to provide an experience to visitors that places them in the region and makes their stay seem different from ordinary life at home, there's a pressure to build hotels around this experience and deliver a unique product to the consumer. The result, however, is a Disney World Dilemma where all of the experiences are false and there is no "Architecture" present. Vernacular only becomes Style when its mimicked without purpose. When we talk about Vernacular, we're talking about the reasoning and intention. that exists beneath it.

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