

# Sustainability and the Transformative Value of Repair

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"If the world is to contain a public space, it cannot be erected for one generation and planned for the living only; it must transcend the life-span of mortal men."  
Hannah Arendt – *The Human condition*

New, high performing building design and advanced green technologies are now leading all forms of our field, from residential construction mixed use and high rise buildings. As stewards of our planet, we know this is the right direction for our discipline, for according to the United States Building Council (USGBC) and the Pew Center for Climate Change, buildings are responsible for 65% of all electricity consumption, 55% of natural gas consumption, 30% of raw materials use, 43% of carbon emissions and 30% of greenhouse gas emissions. Focusing on sustainable building is effective; the USGBC reports that buildings qualified as 'green' use an average of 36% less energy, require fewer raw materials, and divert less waste to our landfills. Furthermore, the cost of green building is only one or two percent more expensive than a conventional building.

The word sustainability is heard often these days, and in many contexts. The word itself dates back to 1727 according to the *Merriam Webster Dictionary*. Today, it's meaning is vast and complex, and much of how we understand sustainability today, evolved in the mid 19th century when a few writers began evoking the power and awareness of the natural landscape and discussing a profound respect for nature. Well known American author Henry David Thoreau (1817-1862) published his seminal book *Walden* in 1848. It told of Thoreau's two-year living experiment in woods near Walden Pond, Massachusetts, where he spent his time walking around the woods and lake, reading books and growing his

own food. His intention in his manuscript was to then describe a harmony that humans can only experience when living with nature, written for - and at -an increasingly industrial world. A similar notion was shared by early conservationists such as naturalist and writer John Muir (1838-1914), founder of the nature conservation organization The Sierra Club which he established in 1892. Through his writings and the club, he successfully encouraged the US Government to protect some of the greatest natural landscapes in the country.

In the 1960s, light was shed not only on our natural ecosystems, but the effect that humans had on them, especially in the name of progress. *Silent Spring*, published by Rachel Carson in 1962, focused on industrial chemicals - previously considered to be a modern miracle -that were destroying the ecosystem of plants and soils, and therefore, humans who lived off of these plants. While Carson focused on pesticides and insecticides that poisoned wildlife and wrote about these chemicals like DDT that entered the human food chain through agriculture, and illustrated the progressive practices that were harming rather than helping our fragile ecosystems and those dependent on it. This type of writing unveiled a critical approach to understanding the full impacts of new technologies previously hailed as effective, and their larger impact on the fragile ecosystems of the planet.

The *Merriam Webster Dictionary* dates the root word 'sustain,' back to the 13th century and defines it as: "to give support or relief to"; "to supply with sustenance:nourish"; "keep up, prolong"; "to support the weight of : also : to carry or withstand

*(a weight or pressure)"; "to buoy up"; "to bear up under : suffer, undergo."*<sup>1</sup> This definition, both a transitive verb and noun, is clearly architectural in its language and meaning. It implies that anything - such as architecture, to be sustainable, must give support or relief to, supply with sustenance, structurally keep up and prolong the environment we live in. This is what the recent green building movement is all about. In fact, 'sustainability' has permeated our lives in many aspects; home recycling, urban agriculture and food production, composting, hybrid vehicles, and reusable, cloth shopping bags rather than the traditional paper or plastic. Yet, in a world where we dutifully reduce and reuse, we are disconnected with the idea that we should reuse our existing building stock. If we are so concerned with being sustainable, why aren't we considering the environmental consequences of demolishing buildings?

Reusing - not tearing down and recycling - existing buildings is the most sustainable practice in our built environment today. For the past several years the architecture and building industry has shifted most of its focus on new, higher performing structures that use less energy, more recycled materials and low volatility products to produce healthier interior environments. This is a good start, but unfortunately misses many of the basic values we idealize at domestic or individual scale. There has been little recognition given to the contribution existing buildings can make through adaptive reuse. As a result, the preservation and adaptability of historic and older buildings have been disconnected from the green revolution.<sup>2</sup> As a practice preservationists have been calling 'sustainable' for years, historic preservation and adaptive reuse must be considered a crucial component of any effort to promote green building practices, encourage environmental and cultural sustainability and counter the effects of global warming.<sup>3</sup> It has been said 'the greenest building' is that which already exists.

Existing buildings are our single most sustainable resource in the built environment, and in many cases, may out perform newer buildings in terms of energy consumption. Many older buildings were designed to take advantage of natural daylight, ventilation and solar orientation and utilize durable materials. In fact, according to a study by the US Energy Information Administration, our older commercial building stock - pre 1920 - performs at an

average of 80,127 Btu/sf while new green buildings from 2003 perform at 79,703 Btu/sf.<sup>4</sup> Yet with little economic incentive, and little federal, state or local regulations, problematic building codes and fears of cost overruns, we have established a culture that caters to teardown and waste rather than reusing and retrofitting.<sup>5</sup>

A recent study by the Brookings Institute says that by the year 2030, if we keep within current practices, we will have demolished and replaced 82 billion square feet of our current building stock in the United States. Since it is estimated that there is about 300 billion square feet of existing building space in the United States today, that means we anticipate demolishing nearly 1/3 of our building stock in the next 20-25 years.<sup>6</sup> The report also estimated that the energy it takes to demolish 82 billion square feet of space would power the entire state of California - and 36 million people - for a decade.

All types of buildings are susceptible to this continuing trend of valuing new construction over adapting existing buildings. The National Trust for Historic Preservation has been publishing surveys of residential tear down communities in the United States. State by state, they have identified communities suffering from a rapid rate of residential teardowns and what is frequently called the 'mcmansion' phenomena of tearing down older homes to replace with newer, larger (and therefore more have higher energy use) buildings. Not only are these teardowns creating tons of construction and demolition waste, but they are changing the historic character of neighborhoods. Denver alone has torn down 1000 residential structures to in the past 5 years, which is an average of 200 houses lost a year, replaced with larger - and not necessarily greener - homes.

One of the biggest issues with this unsustainable phenomenon is the enormous construction waste produced from demolition of buildings that is typically hauled off to distant landfills. In the United States, construction debris currently accounts for 25% of the municipal waste stream each year. This is both expensive and energy consumptive; municipal waste that must be loaded, hauled, transferred from trucks to trains, processed, and dumped into landfills which costs between \$50 and \$75 per ton. It's also polluting from the transportation; fuel use in the handling and disposal contributes significantly to environmental impacts and carbon emissions.

Additionally, landfills are filling up, and the sites themselves pose environmental hazards from loss of natural resource lands, leaching of toxic chemicals, and release of methane gas.

Currently in Seattle, known as one of America's "greenest cities," a one mile long train with 100 cars loaded with waste, travels six times a week to a massive landfill in Arlington, Oregon, near the Columbia River, - 25 of these filled with demolition waste from buildings.<sup>7</sup> With current estimates, this means that 7800 train cars a year filled construction debris are sent to a massive landfill, with an annual bill to the City of Seattle that extends to 225 million dollars for construction debris alone. Upstream, reducing this construction waste reduces the need for the extraction and processing of raw materials, product manufacture, and eventual disposal.

### THE PROBLEM WITH HISTORIC PRESERVATION

The term 'historic preservation' is problematic on many levels for architects, most certainly because of the limitations on design it suggests. Rather than new creative design, ideas of conservation suggest preservation of the past rather than designing for the future. While this type of traditional preservation design and restoration is needed, it only applies to about 5-10% of the existing building stock. This small percentage of buildings that are considered 'historic' through age, architectural value or historic importance are important to preserve and need assistance to remain in their original form for our collective cultural heritage. Building upon a cultural past and keeping our history preserved is part of our civic duty to maintain cultural continuity with the past and connections between generations. These buildings, generally landmarked either through the honorific National Register of Historic Places (can be altered or demolished) or through local, regulatory historic commissions (must get approval for alteration) are protected only after exhaustive review and justification of historic status. Designation usually follows national standards of 'significance' set within boundaries of exceptional architectural style or tradition, important moments in local or national history, or relationship to an historical character or group. In addition, what constitutes 'significant' historic and cultural value in a building is often hotly debated by owners, historians, politicians, community groups and other inter-

ested parties. At the end of the day, it is clear that some buildings are more historic due to their architectural style, the activities that occurred on site, or the important people associated with the site. In fact, if these things don't exist, then it's practically impossible to 'officially' declare something historic, and suddenly, the building lacks 'value'.<sup>8</sup>

This is a very narrow and limiting method of measuring cultural, historic and environmental value in a building; yet something non-significant and lacking in historic value is leading argument for anyone who wants to tear down an 'old' building. The word "historic" saves it, but 'old' or 'existing' does not. Considering these non-historic buildings comprise 90% of our building stock, we need to look at a broader definition of 'value' and how it relates to sustainability.

**Platform21's**  
**Repair Manifesto**

- 1. Make your products live longer!**  
 Repairing means taking the opportunity to give your product a second life. Don't ditch it, stitch it! Don't end it, mend it! Repairing is not anti-consumption. It is anti-needlessly throwing things away.
- 2. Things should be designed so that they can be repaired.**  
 Product designers: Make your products repairable. Share clear, understandable information about DIY repairs.  
 Consumers: Buy things you know can be repaired, or else find out why they don't exist. Be critical and inquisitive.
- 3. Repair is not replacement.**  
 Replacement is throwing away the broken bit. This is NOT the kind of repair that we're talking about.
- 4. What doesn't kill it makes it stronger.**  
 Every time we repair something, we add to its potential, its history, its soul and its inherent beauty.
- 5. Repairing is a creative challenge.**  
 Making repairs is good for the imagination. Using new techniques, tools and materials ushers in possibility rather than dead ends.
- 6. Repair survives fashion.**  
 Repair is not about styling or trends. There are no due-dates for repairable items.
- 7. To repair is to discover.**  
 As you fix objects, you'll learn amazing things about how they actually work. Or don't work.
- 8. Repair - even in good times!**  
 If you think this manifesto has to do with the recession, forget it. This isn't about money, it's about a mentality.
- 9. Repaired things are unique.**  
 Even fakes become originals when you repair them.
- 10. Repairing is about independence.**  
 Don't be a slave to technology - be its master. If it's broken, fix it and make it better. And if you're a master, empower others.
- 11. You can repair anything, even a plastic bag.**  
 But we'd recommend getting a bag that will last longer, and then repairing it if necessary.

**Stop Recycling. Start Repairing.** [www.platform21.nl](http://www.platform21.nl)

Figure 1: Platform21 Repair Manifesto

This new definition needs to come from the sustainable design community, and should be separated from the idea of historic preservation. As architects and designers, it's not generally considered as creative or 'cutting edge' to remodel or renovate. This is especially true when 'preservation' comes to play; building codes and restrictions complicate design; most designers would prefer the blank slate approach. Even though everyone can appreciate older buildings, well done adaptive reuse projects and charming historic neighborhoods, they are rarely thought of when discussing 'green' design.. Under the designation guidelines, the process of land marking older but undistinguished buildings simply to prevent demolition isn't possible; therefore extant buildings are quickly disappearing without consideration of their intrinsic cultural, community and environmental value. Many of these sites are associated with the everyday actions of human behavior and commonplace events. Culturally, they represent places people live, work, play and make community. They embody the culture of place, represent individual histories and promote continuity between generations. Physically, they represent sources of embodied energy (the amount of energy originally imbedded in the materials and expended through construction), which is a renewable source of energy. Creative adaptive design and reuse is the most sustainable approach to these sites; maintaining pieces of the past while creating a well designed, high performing use for the new and improved building for the future.

### THE VALUE OF REPAIR

In the architectural revolution of building new 'green' buildings, we have lost the value of repair at its most basic level; fixing things we have is the most greenest thing we can do. In the hope of spurring a reappraisal of repair, a Dutch marketing and textile design group, *Platform21*, has written a manifesto describing the benefits of fixing everyday items and calling upon designers and consumers to break the chain of throwaway thinking. The idea is that value can be placed on not only in the object itself (historic preservation) but its inherent qualities for cultural continuity (repair and adaptive reuse). Building on their idea promotes can inform a new culture of building reuse is based on creative design, originality, high performance, long life and sustainable practices.

Repairing has multiple meanings. Repair can be done at the material level - such as masonry repair, drywall replacement or system upgrades; building programs can be redesigned if the use is not needed and added on to or reduced to fit the next use. Sites can also be repaired; many buildings are torn down due to a much larger building program needing to fit in and the smaller existing building cannot fit the larger program. Perhaps at the repair level it becomes the responsibility of the owner to find a more suitable site for larger programs.

Rediscovering the value of repair and how it has devolved over the past century can be seen in an ordinary object such as the toaster. As seen in an article from *Popular Mechanics* from 1947, toasters commonly came with instructions that helped you understand their mechanics and construction to aid in the repair process if you may need it. If you weren't able to repair it yourself, it was often easy to locate a neighborhood repair shop. Today, if a

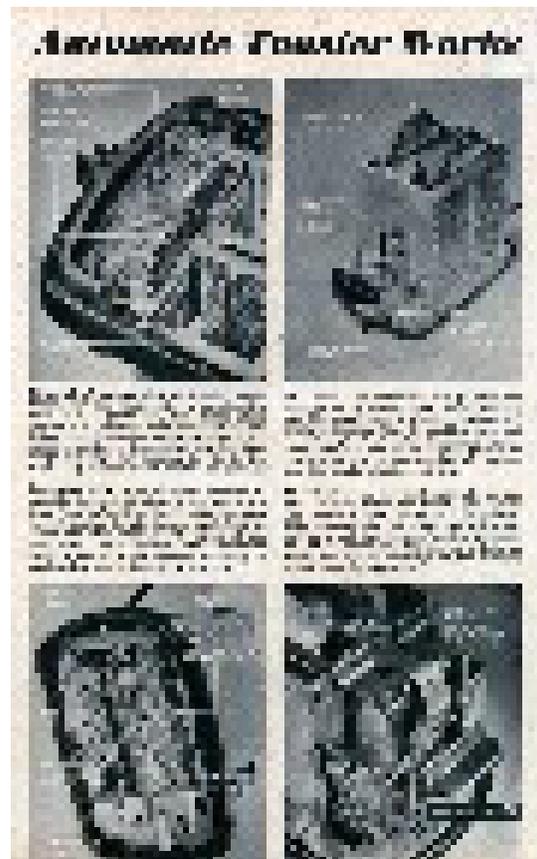


Figure 2: "How Your Automatic Toaster Works," *Popular Mechanics*, December, 1947.

toaster broke, it not only would be difficult and expensive to find someone to repair it, but it also less expensive to buy a new one at a local superstore. However, this new toaster would also have a shorter lifespan, and the waste cycle would continue. The idea of 'new is better, easier, and cheaper' has permeated into our building industry as well. Planned obsolescence is culturally accepted in many places in our culture; buildings aren't seen as something to repair or work around or with; they are seen as opportunities for replacement - something newer, trendier, more efficient and ultimately, disposable.

### THE VALUE OF THE EXISTING BUILDING

Recently Seattle City Mayor Greg Nickels kicked off a campaign he calls "Choose Reusable," promoting reusable bags over disposable ones. "Both paper and plastic disposable bags harm our environment, and every year, residents in Seattle throw out 360 million of them. That's simply unsustainable,"<sup>9</sup> said Nickels. The city is now on its sixth consecutive year of improving domestic and commercial recycling and sending less waste to our landfills. Although the city claims to have one of the best domestic and commercial recycling systems in the country - demolition and land filling of buildings seems to be completely acceptable. This is due to the fact that the saving of buildings tends to fall along the sidelines of preservation, rather than sustainability. Buildings -not just bags - should be reused in order to make an environmental difference.

Recently, the City of Seattle and Seattle Parks and Recreation submitted a SEPA Checklist and Determination of Non-Significance in order to prepare all the paperwork to demolish an early 20th century Naval Firehouse in a local park. The building is nothing remarkable on first glance; a common looking, three story, brick building in average condition. The building was slated to be considered part of the park's historic district, but the City argued that The Firehouse should not be considered for the National Register nomination because it "does not exhibit Art Deco architectural detailing found on other buildings in the District." It also stated that a 1993 Survey concluded that the building "is not significantly associated with the historic events of Sand Point Naval Station; establishment as a reserve base and then conversion to active duties in preparation for World War II."<sup>10</sup>



Figure 3: Building 18, "The Firehouse" at Magnuson Park.

The reason the city is considering demolition is they felt it would cost too much to repair. Officials argue the building had "years of disuse and neglect have left the structure unsound." In 2001, the City had slated 60k to repair the roof that was beginning to fall into disrepair; the money was pulled from the project due to budget constraints or disinterest. An estimate for "roof replacement including basic seismic strengthening improvements to tie roof to building exteriors" was estimated again in 2005, this time at 200k. Either of these acts would have sufficiently upgraded the building to await further improvements, and find interested tenants, but no action was taken. In fact, there were interested tenants, a design in place, but due to lack of movement by the City and increased costs, they fell out of the running and the building sat vacant. Currently, estimates to demolish the building are 200k. If this money was put toward the building in the first place, The Firehouse would have a future as a viable, vibrant place in the park rather than looking at demolition as it is today.

Earlier this year, it seemed like the city was going in the right direction in terms of reusing built resources. On March 25, Mayor Nickels announced an alliance with the National Trust for Historic Preservation for the Seattle Green Lab, recognizing the important connection between buildings and climate change. The Lab will be looking at connections between existing buildings and energy savings, and using these measures to promote building reuse and green adaptation. "Our buildings are our history," said Nickels. "We need to

preserve our past, but we also need to prepare for the future. By adapting the latest technology, we can renovate our historic buildings without toasting the planet.” (the toaster comment is completely coincidental here) It seems that the mayor was only referring to “historic” buildings - those that are laboriously put through a rigorous process at the City, County, State or National level to get the name “historic” or “landmark” after proven to have historic or architectural value.

In a similar situation, on the other coast, it was recently announced that one of the libraries at Yale University constructed in 1981 was slated for demolition and was to be replaced with a new Robert Stern designed residence hall. While the architects are trying to fight the decision, the problem is that the library stands in the path of the university’s plans for two new residential colleges. And despite the library’s superior design, sound shape and important function, the architects have been unable to convince Yale officials to preserve it and adopt it for new uses. The library has won awards from both the Connecticut Society of Architects and the American Institute of Architects, is one of a dozen buildings scheduled to be demolished, to the dismay of preservationist groups. From a design point of view, the library can be easily said to have architectural merit, and worthy of saving, yet also in material quality and quantity, the existing building could be argued on resources alone. Michael Morand, Associate Vice President of The Yale Office of New Haven and State Affairs issued this university statement: “Our architects and planners carefully considered reuse of existing structures. The Mudd Library cannot be practically incorporated in the residential college program, due to its mass, style and location.” The university will not budge on their master plan, even though the architects describe the building as being greatly adaptable for a variety of uses. The architects noted it will be a tremendous chore to take down the library, with all of its reinforced masonry and concrete. Ironically, Morand said Yale is committed to sustainability. “We will be diverting from the landfills more than 90 percent of the building material, either through salvaging notable architectural elements or recycling the material.”<sup>11</sup>

The U.S. EPA reports that “In 2006, US residents, businesses, and institutions produced more than 251 million tons of municipal solid waste, which is

approximately 4.6 pounds of waste per person per day.”<sup>12</sup> Using the Firehouse at Magnuson Park in Seattle as an example, if it were demolished - an average three story solid brick and steel building of approximately 14,013 square feet - 1212 tons of C&D would be put into a landfill. That’s as much waste as it would be for a single person putting his or her 4.6 pounds per day into a landfill for 1,444 years.



Figure 4: Seely Mudd Library, Yale University.

Every building is a storehouse of non-recoverable energy and can be considered by its “embodied energy”. This is the energy that has been spent in its construction, manufacture and transportation of materials. When a building is torn down, more is lost than the built resource (and its associated heritage)— embodied energy is lost, and more energy is expended for the demolition, loading and hauling of the debris. The amount of gasoline this represents in a singular building can be helpful to understand the impact - for Building 18 alone the embodied energy is the equivalent of driving your (fuel efficient) car every day, 24 hours a day, 365 days a year, for over 200 years. If Building 18 is demolished, have now wiped out the entire environmental benefit from the last 1,972,830 aluminum cans that were recycled. We’ve not only wasted perfectly good building, we’ve wasted months of diligent recycling by the people of Seattle. In addition, it is also equivalent to carbon sequestered by either 427 tree seedlings for a decade or 3.8 acres of pine forest annually.<sup>13</sup>

Embodied energy only tells us part of the story. As the National Trust for Historic Preservation says;

While knowing the embodied energy in a building enables us to understand how building construction and demolition compares to other energy intensive activities, such as auto use, it doesn't help with much else. It doesn't tell us anything about toxins that are released as a byproducts of extraction, manufacturing, construction and demolition – or the natural resources consumed in the process.<sup>14</sup>



Figure 5: The Ecotrust Building, Portland

It is currently understood that embodied energy is the energy alone lost and expended. These numbers say nothing of the vast amount of waste created by demolition—on average, a combined 115 lbs/sq. ft. for all residential structures. Although not the entire picture, it is helpful to use embodied energy to confront the avoidable loss of a scarce resource.<sup>15</sup> Other tools, such as Life Cycle Assessment (LCA) provides a means to do just this. LCA quantifies the energy and materials usage and environmental releases at each stage of a product's life cycle, including extraction of resources, manufacturing of goods, construction, use and disposal.

Reusing buildings can be as green as new building design as well as have the advantages of being sustainable through reuse. One of the best examples is seen in the Ecotrust Building in Portland, Oregon. The building, a century old 70,000 square foot brick and timber warehouse, both maintains the historic urban grain of the Pearl District and uses bold, green technologies in building; enough earn the first LEED™ Gold Rating of an existing building in the country. The building used 75% of the existing shell and recycled 98% of any materi-

als either on site or to a nearby construction site. Daylight is available to 75% of the indoor spaces; electric lighting is rarely used in these locations. FSC certified wood is used throughout the project where new wood was used; on the outdoor terrace, in construction plywood and in new window and furniture. Rainwater is filtered through the green roof and the bioswales in the parking lot; this landscape is not only functional but creates a beautiful atmosphere both at the ground level and at the roof deck. New steel stair towers on the back of the building provide circulation and seismic reinforcement as well as a contemporary architectural expression. Most of all, the building is popular by both users and visitors and the building continues to be well cared for, a decade later.

Reinvestment in, rather than replacement of older communities, repair and reuse of existing buildings are important components of a new preservation ethic – one that is environmentally and culturally more sustainable. We need to be true to our commitment to sustainability. Landfills should no longer be an option for used but otherwise clean and durable building materials. Policy makers, preservationists and architects need to push green building practices into the 21st century by promoting the environmental, economic and community benefits of building reuse and recycling at all levels. State and local governments should establish working guidelines, programs and incentives to promote the reuse, retrofit and reinvestment of older buildings, including valuing a new energy models of performance-based codes rather than prescriptive codes, which are designed for new buildings design. In this way, the new preservation ethic can be our "greenest" tool of sustainability.

In order for design professionals to claim a 'green' status, they need to embrace the reuse of older buildings as a creative endeavor that is equal to, and in many cases, preferable to new construction. The value of repair and transformation must be considered as a creative process as much as a practical one. Reusing buildings promotes a sustainable practice of environmental and cultural sustainability, for we need old buildings, not just historic ones. We need texture, age and variety in our cities, not just new buildings, for as Jane Jacobs wrote in her *Death and Life of Great American Cities*, "newness, and its superficial gloss of well-being is a very perishable commodity."<sup>16</sup> Repair and reuse promote

an idea of cultural sustainability as well as environmental sustainability, for as Jacobs also said, "old ideas sometimes can use new buildings; new ideas use old buildings."<sup>17</sup>

*The author would like to thank Jessica Miller for her research on repair, and the idea of toasters.*

## ENDNOTES

1. Merriam Webster Dictionary, p. 487.
2. LEED™ 2.0 gave few points for existing buildings, yet the new LEED™ 3.0 incorporates more metrics relating to existing buildings especially according to Life Cycle Analysis Indicators that are higher in extant structures. LEED™ 3.0/2010 will look at adding additional social, cultural and preservation metrics that will increase ratings for existing buildings.
3. The National Trust has been promoting this idea for decades. See more at <http://www.preservationnation.org>.
4. U.S. Energy Information Administration, 2003 Commercial Building Energy Consumption Survey. More building ratings are: 1920-1947: 90,234 Btu/sf; 1946-1959: 80,198 Btu/sf. The numbers then begin to rise until the highest level during the 1980s where Btu/sf use is 100,077.
5. For more information on the economic side of historic preservation and adaptive re-use, see Donovan D. Rypkema's second edition of *The Economics of Historic Preservation: A Community Leader's Guide* (National Trust for Historic Preservation, 2005). Rypkema argues that preservation of existing building is not only good for the environment, but it creates local jobs, provides affordable housing, creates cultural sustainability and revives downtown cores for livability and tourism.
6. National Trust for Historic Preservation, "Sustainability Initiative," *National Trust for Historic Preservation*, January 6, 2008, <http://www.preservationnation.org/issues/sustainability/> (accessed April 26, 2008). The initial study was conducted by the Brookings Institute in 2004. Also see the National Trust's recently published survey of tear down communities in the United States.
7. Kathy Mulady, "Where your Seattle trash ends up: And you thought taking out the garbage was a big chore," *Seattle PI* (Seattle: Hearst Newspapers, July 2007).
8. Since 1973, the City of Seattle has designated more than 350 individual sites, buildings, vehicles, vessels, and street clocks as landmarks subject to protection by city ordinance. On average, this is about ten nominations per year that are protected under city ordinances. Last year in an unprecedented move the Seattle City Council, after embarking on a city inventory for buildings that might qualify under current Seattle City landmark status, suggested a total of 37 buildings from the inventory should be slated for landmark status. Looking to preempt the chance of losing these buildings to demolition, the group nomination suggests that preservation of our existing buildings should be considered in the broader sense to maintain city fabric and character. It also suggests that current preservation
9. City of Seattle, "Mayor and Grocers: Choose Reusable Bags: New Campaign Promotes Reusable Shopping Bags in Stores and Food Banks," *Office of the Mayor Press Release*, 2009.
10. "Determination of Non-Significance, Sand Point Fire Station Demolition," dated May 28, 2009 by Seattle Parks and Recreation.
11. [http://archrecord.construction.com/yb/ar/article.aspx?story\\_id=135797558](http://archrecord.construction.com/yb/ar/article.aspx?story_id=135797558) (accessed 9-28.09)
12. <http://www.epa.gov/epawaste/nonhaz/municipal/index.htm>, (accessed July 14, 2009).
13. <http://www.epa.gov/cleanrgy/energy-resources/calculator.html> These are based on initial calculations of embodied energy from [www.thegreenestbuilding.org](http://www.thegreenestbuilding.org), (accessed July 14, 2009)..
14. <http://blogs.nationaltrust.org/preservationnation/?p=438> (accessed July 14, 2009).
15. <http://www.thegreenestbuilding.org/embodiedenergy.html> (accessed November 14, 2009).
16. Jane Jacobs, *Death and Life of Great American Cities*. (Random House, Inc. New York, 1961) p. 193.
17. *Ibid*, p. 194.