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Post-disaster Building Deconstruction

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Post-disaster building deconstruction

by

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ABSTRACT

In a major disaster such as wildfire or earthquake, large numbers of buildings will be damaged. One central theme of the research is the reality of building deconstruction as a green approach for post-disaster waste management and recovery. As a green approach to demolition, the deconstruction of a building is applied by disassembling building structures and segregating the materials for reuse or recycling with the goal of increasing the amount of components to be reused or materials to be recycled and minimizing the amount of materials going to landfills.

This study of post-disaster building deconstruction begins with background and implication of building deconstruction and research questions. Chapter two is a review of scholarly and non-scholarly literature and the current practices in the deconstruction field to provide a snapshot of the emerging industry. With the research question of whether the governments of USA, PR China, and Japan are different in initiating and leading related areas under their unique political systems and political cultures, Chapter three discussed the most representative cases in each country, followed by the analysis of important factors such as political system, funding issue, and insurance systems, etc..

The green deconstruction best practice recommendations are made in Chapter four, including planning issues, techniques, and job creation. Summary and conclusions are drawn in Chapter five.

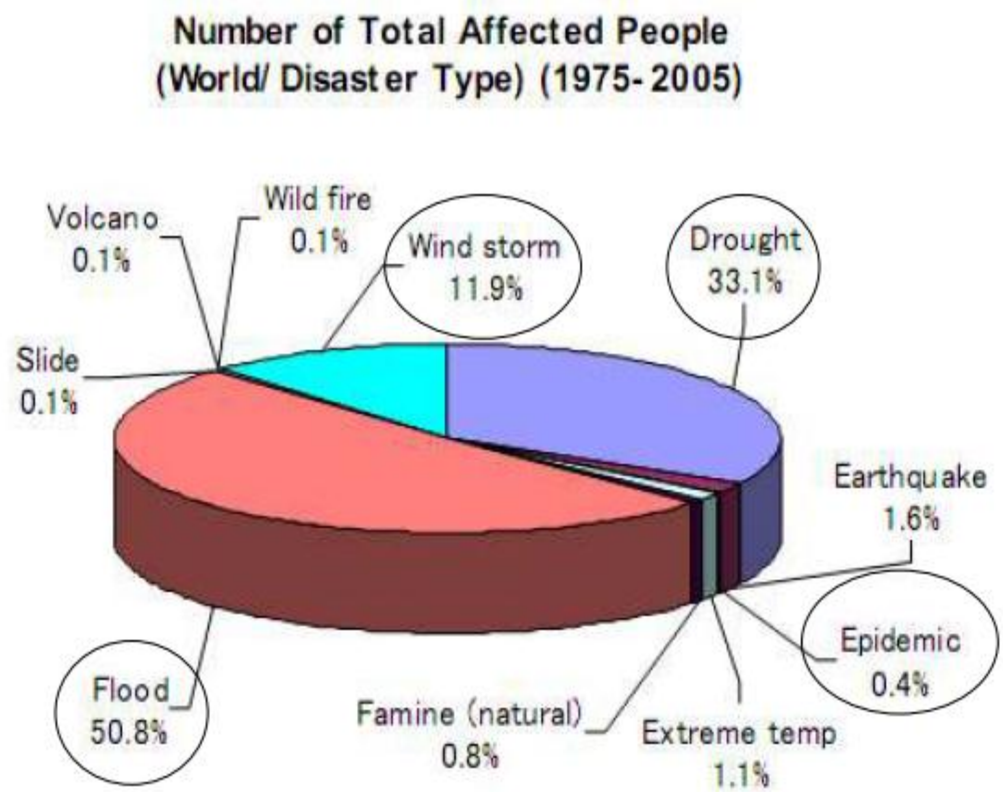
CHAPTER I

INTRODUCTION: THESIS FORMATTING

Background and Implications of Building Deconstruction

Natural disasters are sudden events brought about by forces other than the acts of human beings, such as hurricanes, earthquakes, floods, tsunamis, volcanic eruptions, and tornadoes, and those negatively impact society, causing widespread destruction, human loss and financial loss, as well as profound environmental effect. Do you remember the deadliest natural disaster ever recorded—the Central China Floods that submerged China in 1931 and caused as many as 4 million people perished and nearly 30 million individuals displaced? Who can forget the plight of more than 250,000 deaths, nearly 1 million left homeless, and about 300,000 structures either severely damaged or collapsed completely, in the 2010 Haiti Earthquake? Even as this research is being carried out, Typhoon Haiyan, one of the worse natural disasters in history just hit the Philippines on November 10th, 2013, claimed untold lives and flattened countless buildings.

Natural disasters have happened for millions of years, and will continue to occur in the future as well. Humans can do very little to stop them, and will hardly be safe from these natural calamities. But when we look at some of the worst disasters that have taken place, we can learn how to lessen the damage and reduce the loss of life, how to remedy for the loss of property damage, and how to enhance our ability to recover from the calamity.



Source: CRED-EMDAT, Université Catholique de Louvain, Brussels, Belgium, 2005

Figure 1 Number of Total Affected People (World/Disaster Type) (1975-2005)[1]

Figure 1 shows the number of total affected people in the pie chart divided by disaster types in the world from the year of 1975 to 2005. Flood, drought and wind storm are the three types of disasters that most affected human beings in the history, following which earthquake is placed the 4rd. In a major disaster such as wildfire or earthquake, a great deal of buildings will be severely damaged or greatly collapsed, leaving a large amount of residents homeless. As the most important part of post-

[1] CRED-EMDAT, 2005, figure cited by Cheng, *Flood Management: the experience of P.R.China, IKSFFM 2012, Bangkok*

disaster reconstruction efforts, the topic of how we could possibly help the afflicted population to rebuild their homes by utilizing their disaster-affected building materials to the most degree has been brought up by policy-makers, researchers, post-disaster workers & volunteers, and disaster affiliated communities. Deconstruction of a building is proposed as a green approach to demolition, applied by disassembling building structures and segregating the materials for reuse or recycling, with the goal of increasing the amount of components to be reused or materials to be recycled and minimizing the amount of materials going to landfills. In other words, deconstruction contrasts with demolition, as deconstruction involves taking a building apart while focusing on carefully preserving valuable elements for re-use.

As part of the waste management of post-disaster recovery planning, building deconstruction has many implications:

Rehabilitation of Properties

Since emergency shelters may be expected to close within a certain weeks (in the United States, three weeks) after the event, rehabilitation of the disaster area is an urgent need. However, the reality is that repair and permanent replacement of lost housing stock can take several years. The method of deconstructing and reusing of building components and materials can be a great boost to the rehabilitation process.

Economic Impact

The advantages of the deconstruction of buildings also include an increased diversion rate of demolition debris from landfills, and ‘sustainable’ economic development through reuse and recycling (Chini & Bruening, 2003, p. 1). With proper planning, this approach has resulted in landfill diversion rates that exceed 90 percent of an entire building and its contents in some cases[2]. The Center for Construction and Environment at University of Florida has compared the total cost of deconstructing six single-family homes versus traditional demolition methods, and found in each case that deconstruction was less expensive (Guy, 2000).

An excellent example of how deconstruction can reduce the demands made upon our natural resources to provide raw materials for new construction is the recovery and reuse of lumber from deconstructed buildings. On a national level, the timber industry is the single largest user of land in the United States. Timber production exceeds even agriculture in terms of sheer acreage. Reducing the consumption of new lumber reduces the amount of land needed by this industry to meet demand. According to the Deconstruction Institute, the deconstruction of a typical 2,000 square foot wood frame home (the average American home) can yield 6,000 board feet of reusable lumber. This is equivalent to 33 mature trees, or the yearly output of 10 acres of planted pine (7 football fields). On the contrary, the 2,000 square foot wood frame home, if demolished, would produce about 10,000 cubic feet of debris[3].

Green Jobs Opportunities

Because deconstruction takes more time and requires professional skills, deconstruction creates more employment and training opportunities for low-skilled workers than does demolition--there is a 5 to 1 ratio of workers in deconstruction

[2] Our Waste Calculations, Bentley. Retrieved 01/04/2014

[3] Deconstruction Institute Benefit Calculator data cited by Eric Hangen, AICP, *United Villages: A Case Study on Building Materials Reuse in Portland, Oregon* Retrieved 01/04/2014

verses demolition. The jobs and career opportunities that deconstruction provides include attracting and growing green businesses, fostering green job creation, growing local green workforce, and promoting green practices.

Building deconstruction offers such an opportunity to cooperate with local government's green job promotion program. This brings jobs and career opportunities into the community, which stimulates the local economy. It has been estimated that for every landfill job created, resource recovery creates ten jobs. As pointed out by Chini and Brueing (2003), the skills learned in deconstruction are marketable in the construction industry. In showing workers how to take a building apart, they learn how the building is put together.

Environmental Sustainability

"Each timber that is reused is one less timber to be landfilled" (Chini & Bruening, 2003, p. 9). Without a doubt, the most important benefits provided by the reuse of deconstructed building materials are those they provide to our environment. In the hierarchy of actions required for closing the materials loop, protecting the environment, and conserving resources, deconstruction and materials reuse ranks above recycling and just below minimizing the mass of materials used in the built environment (Chini, 2001, Preface).

Psycho-social Impact

Benefits such as economic and environmental impacts of deconstruction in post-disaster areas have been studied by many researchers. Besides its significant implications for environmental sustainability and post-disaster rehabilitation, studies also show that building deconstruction had a positive psycho-social impact in post-disaster areas. As Denhart (2009) pointed out, deconstruction allowed participants to reclaim wealth that would have been scrapped for landfill waste by government mandate. Participants reported a sudden psychological shift from despair to enthusiasm as they regained control of their property and then discovered value out of the ruined buildings.

Health and Safety

Damaged houses need to be taken down because they pose an imminent threat to public health and safety. Old dilapidated buildings may become methamphetamine labs and drug houses. Children or pets maybe injured playing in these buildings. The lead paint in old buildings causes brain damage in children. Mold in old buildings causes chronic breathing problems for seniors.

Research Questions

One central theme of the research is the reality of building deconstruction as a green approach for post-disaster waste management and recovery. While most previous studies solely focused on introducing the implementation of building deconstruction without picturing it on a specific background such as post-disaster recovery, this research examines building deconstruction on a smaller scale--as a green approach to post-disaster waste management and recovery.

Among various countries where green deconstruction is being practiced, to what extent do governments initiate building deconstruction related policies and incentives, and what are the results of different governmental approaches to post-disaster building deconstruction, in terms of the process of decision making, responsiveness, and financing for deconstruction? What are the lessons learned as well as the ongoing challenges and live issues, and how can we imagine the future by analyzing current practices? This research aims at answering the questions above, by collecting data through case study in three different regions and developing alternative strategy plans and recommendations.

Case Selection

This research attempts to conduct a case study of current practices of post-disaster green deconstruction in the countries of the People's Republic of China, Japan, and the United States. To justify the selection of regions, Table 1 demonstrates the factors of economic system, population, and overall environmental condition (by EPI Ranking) in the targeted three countries.

In the 2012 Environmental Performance Index (EPI, 2012, p. 10), the United States places 49th, with strong results on some issues, such as water and air pollution management, but weak performance on others, including greenhouse gas emissions and renewable electricity generation. This ranking puts the United States significantly behind another industrialized nations Japan (23rd). In addition, the U.S. places 77th in the Trend EPI rankings, suggesting that little progress has been made on environmental challenges over the last ten years. Of the emerging economies, China ranks 116th reflecting the strain rapid economic growth imposes on the environment.

Full report of the 2012 EPI Ranking can be found in APPENDIX D.

Table 1. Selection of Regions

	P.R.China	**Japan**	**United States**
Economic System	Socialist market with economic system (State Capitalism)	Capitalism	Capitalism
GDP[4]	US $8,939,327 billions (2nd); $6,071,472 per capita	US $ 5,007.203 billions (3rd); $39,321.185 per capita	US $ 16,724.272 billions (1st); $52,839.162 per capita
Population	1,350,695,000 (1st)[5]; Density: 373/sq mi (83rd)	126,659,683 (10th)[6]; Density: 873.1/sq mi (36th)	317,312,734 (3rd)[7]; Density: 88.6/sq mi (179th)
EPI Ranking[8]	Ranked 116th place	Ranked 23th place	Ranked 49th place

Six cases were carefully selected from each country that best fit into the research of building deconstruction. The cases chosen from P.R. China are the 1998 Yangtze River floods and the 2008 Great Wenchuan Earthquake. For another targeted region Japan, the 2011 Tohoku earthquake and tsunami and the1995 Great Hanshin-Awaji Earthquake were selected. The 2008 Midwest floods (Iowa) and the 2005 Hurricane Katrina are the two cases picked from the United States. These cases will be studied in

4 "Report for Selected Countries and Subjects". *International Monetary Fund 2013 data*. Retrieved 1/2/2014.
5 2012 data from Population (Total). *The World Bank Data.* Retrieved 1/4/2014.
6 2012 data from Japanese population decreases for third year in a row, *JDP*. Retrieved 1/4/2014.
7 U.S. and World Population Clock. *U.S. Census Bureau* (figure updated automatically, retrieved 1/4/2014 18:31pm)
8 2012 Environmental Performance Index and Pilot Trend Environmental Performance Index Full Report, p.10. *(EPI Website)* Retrieved 01/04/2014

detail in Chapter three, followed by a couple of Chapters that discuss outline of the research and the justification of the regions and cases selected for the research.

CHAPTER 2

REVIEW OF THE LITERATURE AND CURRENT PRACTICES

Recycling Hierarchy in Building Deconstruction

According to Growther (2001), a proposal of recycling hierarchy in building deconstruction involves four different levels:

- building reuse or relocation;
- component reuse or relocation in a new building;
- material reuse in the manufacture of new component;
- material recycling into new materials.

Building Reuse

The first scenario is that of relocation or reuse of an entire building. This happens when a building is needed for a limited time period but can later be reused elsewhere for the same or similar purpose. A good example of this is the Crystal Palace of 1851. This modular exhibition building designed by Joseph Paxton was based on a simple system of prefabricated structural and cladding units that could be easily joined together (Crowther, 2001, p. 17).

Component Reuse

The second scenario is the reuse of components in a new building or elsewhere on the same building. This may include components such as cladding element or internal fit out elements that are of a standard design. A recent example of this is the IGUS factory by Nicholas Grimshaw. The cladding of this building consists of panels that are interchangeable and can be easily moved by just two people. This allows the buildings cladding to be altered to suit changes in the internal use of the building. It is also possible for these components to be used on other buildings of the same design. This scenario of reuse saves on resources, waste disposal, and energy use during material processing as well as energy use during component manufacture and transport (Crowther, 2001, p. 18).

Material Reuse

The third scenario, that of reprocessing materials into new components, will involve materials or products still in good condition being used in the manufacture of new building components. Direct reuse and upcycling of building materials generally requires that they be recovered in good condition. A good example of this is the re-milling of timber. In most parts of the world that use timber as a building material, there is a strong vernacular tradition of constructing buildings so that members may be removed and reused or re-processed into smaller members. Even today we still see the reuse of old timber in this way. As well as the waste disposal advantages of the recycling scenario, this reprocessing also reduces the energy required for material processing (Crowther, 2001, p. 18).

Material Recycling

The final scenario, recycling of resources to make new materials, will involve used materials being used as a substitute for natural resources in the production of manufactured materials. One of the most common current examples of this is the crushing of reinforced concrete to make aggregate that is used for road base. While this scenario does reduce the solid waste stream, other environmental issues may actually not be so positive. While the natural resource use and waste disposal problems are alleviated, the total energy use, and the resultant pollution, may actually be greater than if new resources were used (Crowther, 2001, p. 18).

These scenarios are arranged in a hierarchy, in which reuse is generally considered as more environmentally beneficial than recycling or disposal.

Theory of Layers

Some other researchers have also recognized the importance of the theory of layers regarding building deconstruction for material recovery. Craven, Okraglik and Eilenberg place the model of time-related layers within a system of life cycle assessment (1994, pp. 89-98). In a life cycle assessment the cumulative effects of a building over time are made evident, and within this model the importance of material and component recovery are highlighted. The concept of buildings as a collection of time related layers is fully consistent with the approaches of life cycle assessment in which the life span of the building becomes an important multiplying factor for all other environmental considerations. Failure to separate the layers will result in total building failure at that point in time when the first layer fails. The resulting need for total building replacement defies all environmentally sustainable principles.

Although Craven highlights the importance of the theory of layers using a life cycle assessment model, he also stops short of suggesting how this theory might be used. While he recognizes the strategy of design for deconstruction, no attempt is made to link it with the theory of time related layers to design buildings in a way that will improve the current rates of material and component recovery.

Crowther (2001) believed that in a life cycle assessment, the cumulative effects of a building over time are made evident, and within this model the importance of material and component recovery are highlighted. These theories of building layers have a major impact on the design of buildings for deconstruction.

Deconstruction Techniques and Methods

The first decision to be made in the deconstruction planning process is whether or not the target building is a good candidate to be deconstructed. Not every building consists of the right components and is in the right physical condition to be disassembled for material salvage. Chini and Bruening (2003) have examined current practices of building deconstruction and materials reuse in the United States.

In the report, Chini and Bruening (2003, p. 5) discussed various forms that deconstruction can take. According to Chini and Bruening, a building is a candidate for complete structural disassembly when a large portion of the materials have potential for reuse. A deconstruction project could fall within the category as below:

a. a complete structural disassembly;

b. a small soft-stripping project;

c. an individual assembly project.

Soft-stripping involves the removal of specific components of the building before demolition. For example, in a structurally weak building that does not have much salvageable material, only a few items may be desirable enough to salvage before demolishing the remainder of the building. Good candidates for soft-stripping include: plumbing or electrical fixtures, appliances, HVAC (heating, ventilation, and air conditioning) equipment, cabinets, doors, windows, hardwood, and tile flooring.

While the entirety of the building may not be worth deconstructing, certain assemblies within the building may be. For instance, earthquake design often requires monolithic structures which are more difficult to deconstruct. Perhaps the rafters in an old building are of high quality heavy timbers and thus command a high salvage value. In scenarios like this, particular building assemblies may be targeted for removal before the building is demolished. Rafters, floor joists, wall framing members, and sheathing materials may be of size and condition to warrant salvage.

Favorable Characteristics of Deconstructable Buildings

The decision whether or not to deconstruct can be facilitated by a detailed inventory of the building's components. According to Chini and Bruening (2003, p. 16), the favorable characteristics of highly deconstructable buildings include:

1) Wood framed buildings using heavy timbers and unique woods such as Douglas fir, American chestnut, and old growth southern yellow pine. These components are often found in buildings that were constructed before World War II.

2) Buildings that are constructed using high value specialty items such as hardwood flooring, architectural moldings, and unique doors or electrical fixtures.

3) Buildings constructed with high-quality brick and low quality mortar. These will be easy to break-up and clean.

4) Buildings that are generally structurally sound and weather tight. These buildings will have less rotted and decayed materials.

Chronology of Deconstruction

In the same report, Chini and Bruening (2003, p. 5) commented that the chronology of the deconstruction process is of utmost importance. The proper sequence of disassembly increases jobsite safety and efficiency and protects salvageable materials from unnecessary damage. By citing from California EPA (2001), Chini and Bruening (2003, p. 5) proposed that whole building deconstruction can be broken down into the five basic steps listed in Table 2.

Table 2
Basic Steps to Building Deconstruction

1) Remove the trim work, including door casings and moldings.
2) Take out kitchen appliances, plumbing, cabinets, windows, and doors.
3) Remove the floor coverings, wall coverings, insulation, wiring, and plumbing pipes.
4) Disassemble the roof.
5) Dismantle the walls, frame, and flooring, one story at a time.

In addition to Chini and Bruening, there is another brief guide to deconstruction put together by Guy (2003) as an introduction and cogent overview of deconstruction, including its components, its benefits, case examples, and how to make it part of a community revitalization strategy. It is used as series of checklists to provide guidance to deconstruction managers, supervisors and workers for conducting a deconstruction project. In this report, Guy (2003) examined the issues of safety, survey, environmental issues, contracts, permitting and utilities, organizational plan, and the deconstruction process. As showed in Appendix A (Guy, 2003, p. 52), the deconstruction for one-story wood framed building can be distributed into a 20-day process. Appendix B (Guy, 2003, p. 65) lists a complete inventory of basic tools that should be done prior to deconstruction. Another checklist for deconstruction can be found in Appendix C (Guy, 2003, p. 88).

An Evaluation of Building Deconstruction Feasibility

Robert H. Falk, a research engineer at Forest Products Laboratory documented a study of evaluation of the feasibility of using wood-framed building deconstruction at the Badger Army Ammunition Plant (BAAP) to salvage for resale and reuse building materials during 2000 to 2005. In the report, deconstruction was defined as "a building dismantlement method based on the separation and recovery of building materials and components for reuse and recycling" (Falk, 2005, p. 1).

The targeted buildings at the Wisconsin BAAP were built in the early years of World War II wholly or partially from wood. The standing timber in these and other military structures is some of the last remaining of the United States' once vast old-growth forests. The complexity of the project required a collaborative effort of government, university, military, and community groups. The USDA Forest Products Laboratory (FPL) provided overall management for the project and expertise on the lumber evaluation. United States Army staff at BAAP and the U.S. Army Corps of

Engineers, Olin Corporation staff, and Construction Engineering Research Laboratory provided information on the plant infrastructure and expertise on the current disposition and condition of the evaluated buildings. The Civil Engineering Department at the University of Wisconsin–Madison assisted in the actual lumber quantity surveys. And deconstruction experts from the Center for Construction and Environment, University of Florida, and the Austin, Texas, Habitat for Humanity rated candidate buildings for deconstruction feasibility. Finally, WasteCap Wisconsin, Inc., helped find reuse and recycling markets for the materials recoverable at the BAAP.

To determine the feasibility of using deconstruction for building removal at BAAP, two deconstruction experts from the University of Florida and the Austin, Texas, Habitat for Humanity ReStore surveyed a representative sample of building types. They first looked over the principal building types and made a qualitative assessment. They then conducted a quantitative analysis on the more highly rated buildings using detailed materials take-offs, assigned dismantling methods to building assemblies based upon the building type, and estimated salvageable materials. Techniques for building dismantling by assembly ranged from hand deconstruction to mechanized demolition and hybrids of mechanical and hand deconstruction techniques. Only buildings with a 0 or 5X rating were analyzed.

This report included a description of the methods used for the deconstruction feasibility analysis, the assumptions for the analysis including costs, a description of each building considered in the study along with a proposed method for dismantling, and the detailed deconstruction and salvage cost and quantities estimates for each building. In this study, a survey of representative building types was made to (1) determine the feasibility of using deconstruction for building removal, (2) quantify the volume of recoverable lumber and timber, and (3) identify markets for the recovered and recyclable materials. Twenty-eight building types were examined for deconstruction potential.

Results of this study indicated that many of the buildings at BAAP contain a wealth of materials with strong potential for recovery and reuse, including wood, concrete, brick, asphalt roofing shingles, metal and other reusable items such as signs and fixtures. Falk (2005, p. 24) concluded that nearly 200 wood-framed buildings can be deconstructed immediately and could yield over 4 million board feet of recoverable wood products, excluding the buildings that do not lend themselves to deconstruction because of their small size, contamination or other factors. The buildings most feasible for deconstruction in general are those that have minimal interior partitions and finishes or larger wood members. The buildings surveyed can reasonably yield from 40 percent to 70 percent wood salvage using deconstruction. However, a strong commitment by the new owners, contract language promoting reuse, involvement and buy-in from the local community, diligence in pursuing reuse and recycling markets, and close work with regulatory agencies on regulatory issues surrounding lead-based paint, asbestos, and chemical contamination will be key to ensuring a successful reuse and recycling program at BAAP.

The Powell Center for Construction and Environment (PCCE) at the University of Florida is primarily a research organization dedicated to the resolution of environmental problems associated with planning, architecture activities and the determination of optimum materials, and methods for use in minimizing environmental damage. The mission of the Powell Center is to foster the implementation of sustainability principles into the creation of the built environment internationally. From 2000 to 2005, PCCE organized and coordinated annual meetings for the International Council for Research and Innovation in Building Construction (CIB) Task Group 39 on Deconstruction and the Used Building Materials Association of North America (UBMA).

Task Group 39 (deconstruction) of CIB was formed on May 5th, 1999 in Gainesville, Florida (University of Florida), with a mission of producing comprehensive analysis of worldwide building deconstruction and materials reuse programs that address the key technical, economic, and policy issues needed to make deconstruction and reuse of building materials a viable option to demolition and landfilling. The CIB Task Group 39 on Deconstruction is specifically concerned with research into the disassembly and deconstruction of buildings to achieve higher rates of material and component reuse and recycling. This group has identified a number of research projects dealing primarily with the deconstruction of existing building. Publications of the CIB TG 39 Deconstruction are listed as follows:

- "Overview of Deconstruction in Selected Countries," CIB Publication No. 252, 2000;

- "Deconstruction and Materials Reuse; Technology, Economic and Policy," CIB Publication 266, 2001;
- "Design for Deconstruction and Materials Reuse," CIB Publication 272, 2002;
- "Deconstruction and Materials Reuse," CIB Publication 287, 2003;
- "Deconstruction and Materials Reuse - an International Overview," CIB Publication 300, 2005.

The first meeting of TG 39 was held on May 19th, 2000 in Watford, England (BRE) and the group's first product is the fully electronic CIB Publication 252, "Overview of Deconstruction in Selected Countries," which addresses the subject of deconstruction in eight countries: Australia, Germany, Israel, Japan, the Netherlands, Norway, the United Kingdom, and the United States.

The second publication of TG 39 is the CIB Publication 266, "Deconstruction and Materials Reuse: Technology, Economic, and Policy." The electronic proceedings include ten fully reviewed papers presented at the second annual meeting of TG 39 that took place in conjunction with the CIB World Building Congress in Wellington, New Zealand on 6 April 2001. The papers address the technical, economic, and policy issues related to deconstruction and materials reuse in eight countries: Australia, Germany, Japan, the Netherlands, South Africa, Sweden, the United Kingdom, and the United States.

The third product of the group is the Proceedings of the third annual meeting of TG 39 that took place in Karlsruhe, Germany (DFIU - University of Karlsruhe) on 9 April 2002. This Proceeding (CIB Publication 272) includes eighteen fully reviewed papers discussing design for deconstruction and other collateral issues such as recycling potential and materials reuse in eleven countries: Australia, Germany, Italy, Japan, the Netherlands, New Zealand, South Africa, Turkey, the United Kingdom, the United States, and Venezuela.

The final meeting of TG 39 took place in Gainesville, Florida on 8 May 2003 in conjunction with the 11th Rinker International Conference on Deconstruction and Material Reuse, brought together 160 experts from around the world to discuss the key technical, economic, environmental, and policy issues needed to make deconstruction and reuse of building materials a viable option to demolition and land filling. The CIB Publication 287 is the electronic Proceedings of this conference and includes 36 fully reviewed papers discussing different issues of deconstruction and materials reuse in fourteen countries: Australia, Canada, Germany, Italy, Japan, the Netherlands, New Zealand, Poland, Spain, Sweden, Turkey, the United Kingdom, the United States, and Venezuela.

CIB Publication 300 "Deconstruction and Materials Reuse - an International Overview," is the final report of TG 39. It is a state-of-the-art report on deconstruction and materials reuse in ten countries: Australia, Germany, Israel, Japan, the Netherlands, New Zealand, Norway, Turkey, the United Kingdom, and the United States.

CHAPTER 3

CASE STUDIES OF POST-DISASTER BUILDING DECONSTRUCTION

Outline of the Research

China, Japan and the United States are often recognized as the three most important countries in the world, in terms of its political, economic and cultural impacts. I have been fortunate enough to have opportunities of completing higher education in all of the three countries in the past several years. With an understanding of corresponding cultural, political, economic, and social aspects of the targeted regions, coupled with my multiple language skills, I was able to collect sufficient information on post-disaster building deconstruction in these three countries. By evaluating the selected cases and practices, I would like to ascertain the common practices and different methods in initiating and leading related area under the unique political systems and political cultures of each country. This and the following chapters will try to answer following research questions:

1. To what extent do these three governments initiate building deconstruction related policies and incentives?

2. What are some results of different governmental approaches to post-disaster building deconstruction, in terms of the process of decision making, responsiveness, and financing for deconstruction?

3. What are the lessons learned as well as ongoing challenges and live issues, and how can we imagine the future through examining current practices?

4. What recommendations and conclusions can we make?

Selection of Regions

Japan

Due to harsh natural conditions, Japan is one of the world's countries most prone to natural disasters, particularly earthquakes, typhoons, and floods. Japan as of now has taken a much more proactive approach to waste management. In particular, Japanese city and prefectural authorities have focused on the reduction of solid waste going into landfills. In addition, there has been a long-established culture of reuse and recycling of building materials in Japan. Materials such as stone, slate, timber, thatch, and mud were used, and these were allowed to decay naturally or could be easily reworked into newer buildings. Old materials tend to have aesthetic, authentic, and antiquarian value, and have always been considered as elements that add value to a property. Designing for disassembly has been utilized for traditional Japanese farmhouses, which were constructed without nails and could be disassembled and reassembled like a puzzle (Balachandran, 2002, p. 2).

As the waste generated from constructional industry is causing a serious social problem in Japan, related organizations and groups had started new projects to reduce the production of waste and to promote the reuse and recycling of construction and demolition waste. In 2000, the former Ministry of Construction (currently the Ministry of Land, Infrastructure, and Transport) announced officially the law that stipulates the deconstruction process and promotes the recycling of construction and demolition waste. At the same time, the Building Research Institute and the National Institute for Land and Infrastructure Management started a joint national research and development project to develop technologies to reduce waste and to promote the reuse and recycling of construction and demolition waste throughout the lifecycle of timber buildings. The final targets of this project were to develop demountable and recyclable wooden buildings, to develop new technologies for recycling building waste and residue and to develop information transfer systems to disseminate the developed technologies. The second year's results can be found in their report (Nakajima & Futaki, 2001).

There are three methods for selectively dismantling wooden houses in Japan: by hand, by machine, and in a composite way by machine and hand. Selective dismantling by hand traditionally has been used in Japan. Most demolitions are carried out selectively by hand when a suitable machine cannot be used for reasons of road condition, lot condition, neighborhood environment, preferences of the owner, or the type of house undergoing reconstruction. Selective dismantling by machine is available to use when a suitable machine can work without the restrictions of road condition, lot condition, neighborhood environment, and other delimiting considerations (Futaki, 2005, p. 101).

Much of the research to date on green deconstruction has focused on the country of Japan, where people are most prone to natural disasters due to harsh natural conditions and where there has been a long-established culture of reuse and recycling of building materials. However, Japan is known with its apparently contradictory attitudes toward nature and the environment. On one hand, traditional Japanese value system is suffused with a profound aesthetic appreciation of natural environment. On the other hand, as an industrialized nation, Japan has a long history of efficiently exploiting the environment and degrading the natural world to meet human needs and the demands of industry. Japan is the world's leading importer of exhaustible energy resources and the world's fifth largest emitter of greenhouse gases. It is a signatory of the Kyoto Protocol and also the country which hosted the conference in 1997.

People's Republic of China

Government efforts appear to be less extensive in the People's Republic of China, although there is rising awareness of environmental issues and sustainable development in China. Since the founding of the P.R. China in 1949, more than 50 extraordinary floods and 17 widespread severe droughts have occurred[9]. Two-thirds of the land area in China is prone to flood disasters, where most of the areas also suffer from drought. The areas most severely threatened by floods concentrate in the economically developed eastern and southern regions, where two-thirds of the national industrial and agricultural outputs are produced and over fifty percent of the national population is contained. Listed in Figure 2 below are the data on the flood-prone areas where the major social and economic activities occur in China.

[9] Flood control and drought relief in China, *Ministry of Water Resources, the People's Republic of China*. Retrieved 1/4/2014.

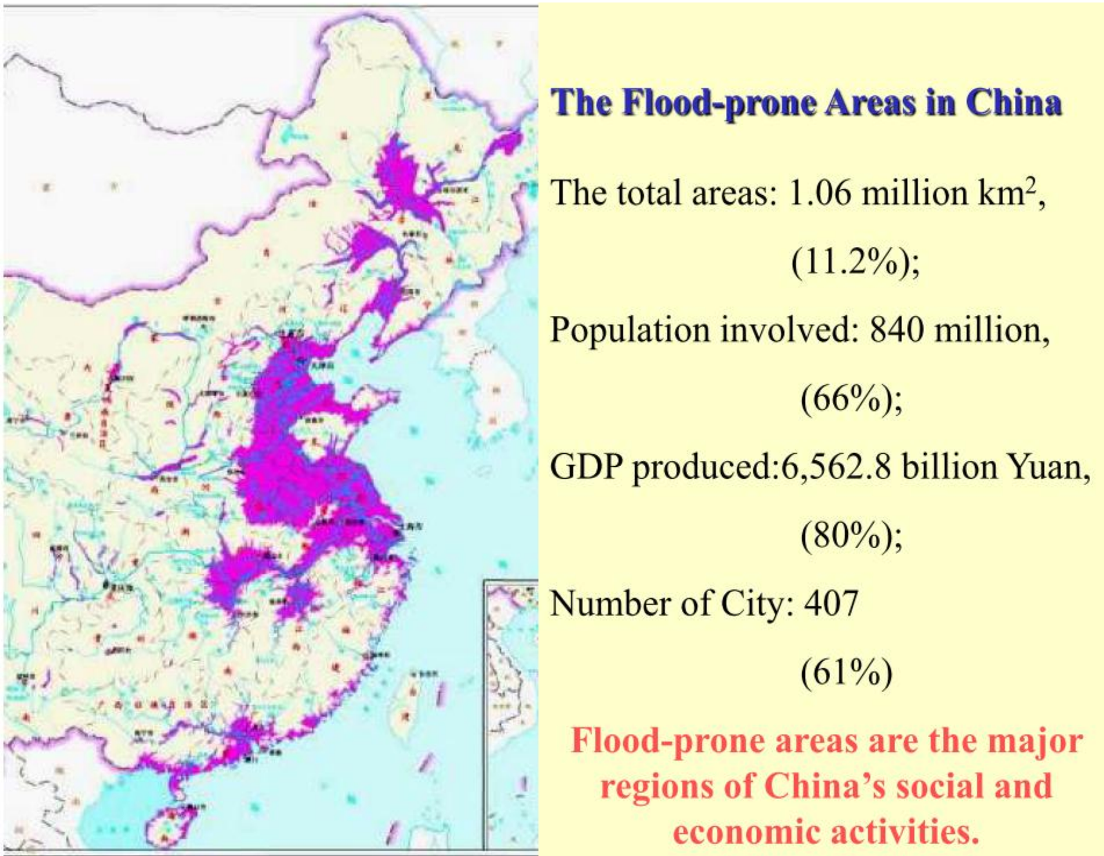


Figure 2. The Flood-prone Areas in China[10]

Earthquakes and other natural disasters often have severe impacts on flood structures. For instance, in 2008, the Wenchuan earthquake damaged 2473 reservoirs and 1229 km of embankment, and endangered 822 hydropower stations. Landslides resulted in 105 dammed reservoirs.

As the world's largest emitter of greenhouse gases and with the impact its rapid economic growth has had on its environment, China has been widely criticized for continually emerged pollution problems. Recycling of building materials is still at an

[10] Cheng, Flood Management: the experience of P.R.China, *International Knowledge Sharing Forum on Flood Management, January 2012, Bangkok,* 19-20.

early stage in China, while the P.R.China has continuously gained experiences in the area of green building deconstruction after severe natural disasters in the past several decades.

The United States

According to Gallup Poll[11,] Americans tilt toward the view that the government is doing too little to protect the environment -- at 47 percent, while 16 percent say it is doing too much. Another 35 percent say the government's efforts on the environment are about right. Results of Gallup poll are based on telephone interviews conducted during March 7 to March 10, 2013, with a random sample of 1,022 adults, aged 18 and older, living in all 50 U.S. states and the District of Columbia.

In the U.S., construction and demolition (C&D) waste is about 143 million metric tons (MMT) annually that is for the most part landfilled (Chini & Bruening, 2003, p. 1). In fact, wastes from new construction and renovation account for between 15 percent and 20 percent of landfill space in this country. Each year in the United States more than 42 billion board feet of lumber is dumped into landfills. Meanwhile, with an overall recycling rate of nearly 68 percent, the steel industry of North America is one of the most efficient industries. Each year, steel recycling saves the energy equivalent to electrically power about one-fifth of the households in the United States for one year, and every ton of steel recycled saves 2,500 pounds of iron ore, 1,400 pounds of coal, and 120 pounds of limestone (Chini, 2005). Figure 3 is the pie chart of U.S. construction and demolition waste generation in 2000.

[11] Frank Newport, Nearly Half in U.S. Say Gov't Environmental Efforts Lacking, *Gallup Politics, April 1, 2013*. Retrieved 1/4/2014.

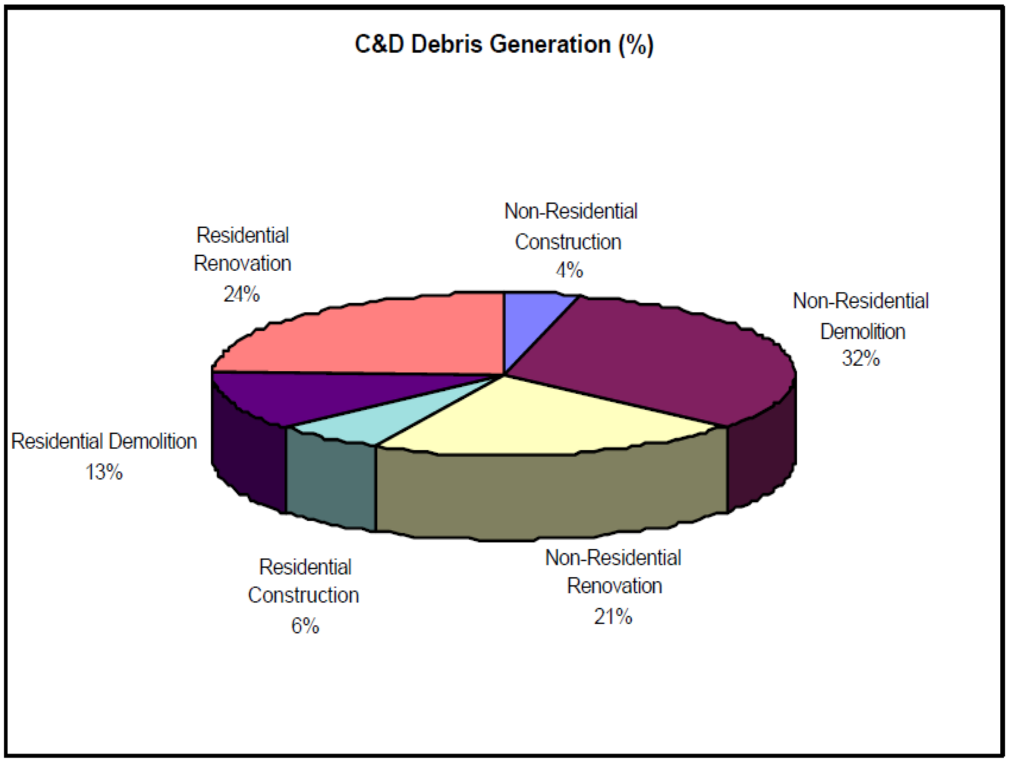


Figure 3. U.S. Construction and Demolition Waste Generation in 2000[12]

Created to stop construction's harmful effects on the environment, green building programs are springing up throughout the states. Currently there are over 10 major U.S. green programs that allow residences to be rated and receive a green designation for fulfilling minimum requirements (Tinker and Burt, 2003, p. 386). Each of the programs allots a percentage of the total points available to waste management issues.

But in the United States, deconstruction has confronted challenges. Most existing buildings in this country have not been designed for dismantling, and the majority of building components have not been designed for disassembly. Tools for

[12] Chini, Introduction: deconstruction and material Reuse, an International overview, *CIB Publication 300, 2005,* p.20.

deconstructing existing buildings often do not exist. Disposal costs for demolition waste are frequently low compared to dismantling methods. Additionally, dismantling of buildings requires extra time. Moreover, building codes and materials standards often do not address the reuse of building components. Unknown cost factors arise in the deconstruction process. Buildings constructed before the mid-1970s often contain lead-based paint and asbestos materials. Though these barriers often can be overcome by design and policy modifications, the economic and environmental benefits of deconstruction are not yet well established in the United States.

Cases Selected

China

2008 Great Wenchuan Earthquake

Recycling of building materials is a relatively new concept in China. It was only after the devastating earthquake of 2008 in the Wenchuan region that some attention was drawn to the vast amount of building debris that resulted from damaged and collapsed buildings.

The Great Wenchuan Earthquake measured 8.0 magnitude (on the Richter scale) in 2008 resulted in at least 69,222 deaths and a huge amount of collapsed buildings, generating a large amount of construction waste. It is reported that 125,975,000 square meters of buildings were ruined (around 6.8 million houses collapsed and 23 millions were reported seriously damaged), and the quake left about 5 million people registered homeless (Shi, Den, & Lin, 2008, p. 1). Some cities and towns were almost completely razed. The total economic loss is reported at US$120 billion.

Figure 4. 2008 Great Wenchuan Earthquake in P.R. China

Following the event, the Chinese government had been working to rebuild the afflicted areas by formulating a comprehensive plan for reconstructing and retrofitting public facilities and infrastructure such as schools, hospitals, bridges, and reservoirs. After the Wenchuan Earthquake, Chinese State Council issued and directed the "Counterpart Support Program", with a slogan of "one province to support a severely afflicted area", to raise the awareness and to better support the afflicted areas' post-disaster recovery effort.[13]

Figure 5. Collapsed Building in 2008 Great Wenchuan Earthquake

Government directed "Counterpart Support Program" with 20 provinces in the South and central China as supporters to assist corresponding 20 affected cities with post-disaster recovery needs:

1．Shandong Province——Beichuan, Sichuan

2．Guangdong Province——Wenchuan, Sichuan

3．Zhejiang Province——Qingchuan, Sichuan

4．Jiangsu Province——Mianzhu, Sichuan

[13] baike.baidu.com search result (in Chinese language), retrieved 4/1/2014.

5．Beijing——Shihao , Sichuan

6．Shanghai——Dujiangyan, Sichuan

7．Hebei Province——Pingwu, Sichuan

8．Liaoning Province——An, Sichuan

9．Henan Province——Jiangyou, Sichuan

10．Fujian Province——Pengzhou, Sichuan

11．Shanxi Province——Mao, Sichuan

12．Hunan Province——Li, Sichuan

13．Jilin Province——Heishui, Sichuan

14．Anhui Province——Songpan, Sichuan

15．Jiangxi Province——Xiaojin, Sichuan

16．Hubei Province——Hanyuan, Sichuan

17．Chongqing——Chongzhou, Sichuan

18．Heilongjiang Province——Jiange, Sichuan

19．Shenzhen——Gansu Province affected areas

20．Tianjin——Shanxi Province affected areas

Specialists on earthquake engineering field and government officials set up field missions surveying the damage to buildings, providing lifelines, and observing geotechnical failures. Many observations and recommendations for building deconstruction and reconstruction have been attained. For example, a team of seismologists, with earthquake engineering and geotechnical specialists, participated in the Earthquake Engineering Field Investigation Team (EEFIT, part of the UK Institution of Structural Engineers). The field mission presented a summary of the team's preliminary observations and recommendations to be considered during reconstruction (Free, Zhao et al., 2008). A full set of recommendations for the different types of construction can be found in the EEFIT Report on the Wenchuan Earthquake[14].

1998 Yangtze River Floods

The 1998 Yangtze River floods was a major flood that lasted from middle of June to the beginning of September 1998 at the Yangtze River in PR China [15].

Despite a series of dikes along the Yangtze, the overflow of the world's third-longest river affected 29 provinces and cities and 223 million people--one in five Chinese citizens, or a population comparable to that of the United States. It was reported that China flooding forces evacuation of 500,000 people. This event resulted in a reported total loss of 4150 people, a total amount of 6.85 million collapsed building, and US $26 billion (China yuan￥1.666 trillion) in economic loss[16]. Some non-governmental groups estimate casualties are even higher. About 14 million people were left homeless by landslides, mudslides, and toppled buildings, and an estimated 65 million acres of crops - or one-sixth of China's farmland -have been damaged or

[14] Downloadable from EEFIT Website. Retrieved 01/04/2014
[15] The 60 Events that Affected China: 1998 Floods, Chinanews.com.cn (in Chinese language). Retrieved 1/4/2014.
[16] 1998 Floods, baike.baidu.com (in Chinese language). Retrieved 1/4/2014.

destroyed, according to Fan Bojun, former vice minister of Civil Affairs (1987.7—2001.5)[17]. Six provinces were particularly hard hit.

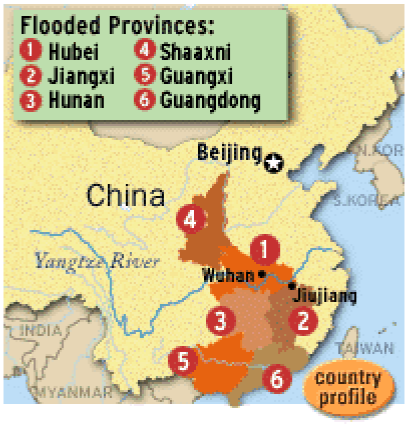


Figure 6. 1998 Yangtze River Floods –Map of Flooded Areas[18]

Figure 7. 1998 Yangtze River Floods – Flooded Buildings[18]

After the 1998 flood in the Yangtze River Basin, China established flood control systems at national, basin and local levels. The national Vice Premier Jiabao Wen was designated as commander in chief of the State Flood Control and Drought Relief

[17] China flooding forces evacuation of 500,000 people, *The Boston Globe, Indira A.R. Lakshmanan, Aug. 8th, 1998.* Retrieved 1/4/2014.
[18] http://anu.andong.ac.kr/~soongu/climate/yangtze.htm Retrieved 01/04/2014

Headquarters. The People's Liberation Army, the People's Armed Police Forces and the militia were greatly involved in performing duties of flood fighting and emergency operations entrusted by the state. Local governments at different levels have developed flood control responsibility systems, requiring the respective governors to assume full responsibility for flood activity. Expenditures for flood actions are funded primarily by the central government, and are supplemented by partial local counterpart funds.

Japan

Great Hanshin-Awaji Earthquake of 1995

Figure 8. The Epicenter of the 1995 Kobe Earthquake

Among the main historic hazard events occurred in the history of Japan are the Great Hanshin-Awaji Earthquake of 1995, which was most devastating for the city of

Kobe.

Figure 9. 1995 Kobe Earthquake – Collapsed Buildings

In Hyogo Prefecture, due to the 1995 quake approximately 41,527 were injured and 6,400 people lost their lives; about 4,600 of them were from Kobe. In Kobe, 67,421 structures were collapsed, and 6,965 structures were destroyed by fire, for a total of 6.9 trillion Yen of economic damage.[19]

2011 Tohoku Earthquake and Tsunami

In 2011, a 9-magnitude earthquake struck near Sendai, with over 500 aftershocks in just a matter of 10 days after the main quake. More frighteningly, a resulting tsunami struck Japan causing widespread destruction. 35 feet high waves slammed into Japan and flooded as far as 7 miles inland, causing large-scale damage on the way. The earthquake and the following tsunami also severely resulted in radiation leaks. As for now, Japan is still underway with its damage control and rebuilding measures due to this calamity.

From the 2011 Tohoku Earthquake and Tsunami, according to the November 8th, 2013 report[20], the Japanese National Police Agency confirmed 15,883 deaths (not including the 6150 people injured or the 2651 missing), 126,602 buildings totally collapsed, a further 272,426 buildings half collapsed, and another 816,241 buildings partially damaged or flooded. Substantial earthquake damage of wooden buildings and structures, including collapse or other heavy damage to houses, occurred over a wide swath from Tohoku down to northern Kanto, although in only a fairly limited number of clusters. The type of damage is extremely diverse due to differences in site amplification of the ground motion characteristics (Koshihara, Isoda, & Tsuchimoto, 2012).

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[19] Kobe, Japan Disaster Risk Management Profile, 2006

[20], Japanese Policy Agency 11-08-2013 Report (in Japanese language). Retrieved 1/10/14

Figure 10. Map of 2011 Tohoku Earthquake

Figure 11. Picture of 2011 Tohoku Earthquake and Tsunami

The United States

2005 Hurricane Katrina

Hurricane Katrina was the deadliest and most destructive Atlantic hurricane of the 2005 Atlantic hurricane season. It is the costliest natural disaster, as well as one of the five deadliest hurricanes, in the history of the United States. The storm started forming near the Bahamas, and actually hit the US coast only as a level-1 hurricane. However, as it strengthened in the Gulf of Mexico and turned into a level-3 storm, water moving around 10 miles inland caused massive destruction. Cities severely affected in its path included Florida, Texas, and worst of all, New Orleans in Louisiana. As a result of Hurricane Katrina, more than 80 percent of the city was flooded, and nearly 2,000 people perished. The economic loss was a whopping $100 billion, making it the most expensive natural disaster in the history of the United States. Eight years after this event much of New Orleans still had not been redeveloped, and the repairs and upgrades to the protection in place at the time of the hurricane still not completed, according to the UNESCO (2010). Figure 9 shows the 2005 Hurricane Katrina affected areas.

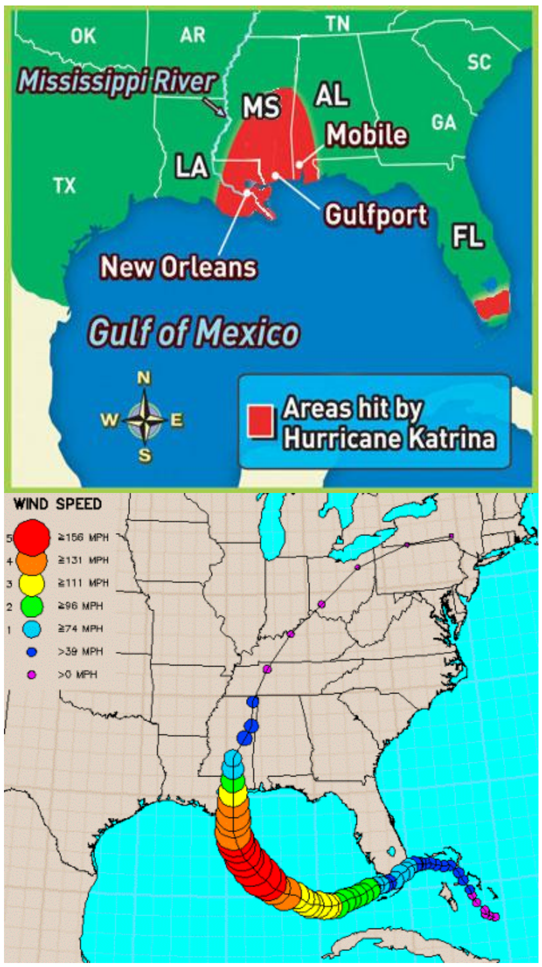

Figure 12. Hurricane Katrina Affected Areas[21]

[21] Source: [Lesson 3 - MEDC case study: Hurricane Katrina, New Orleans, USA](), *Worldlywise Wiki*. Retrieved 1/10/14

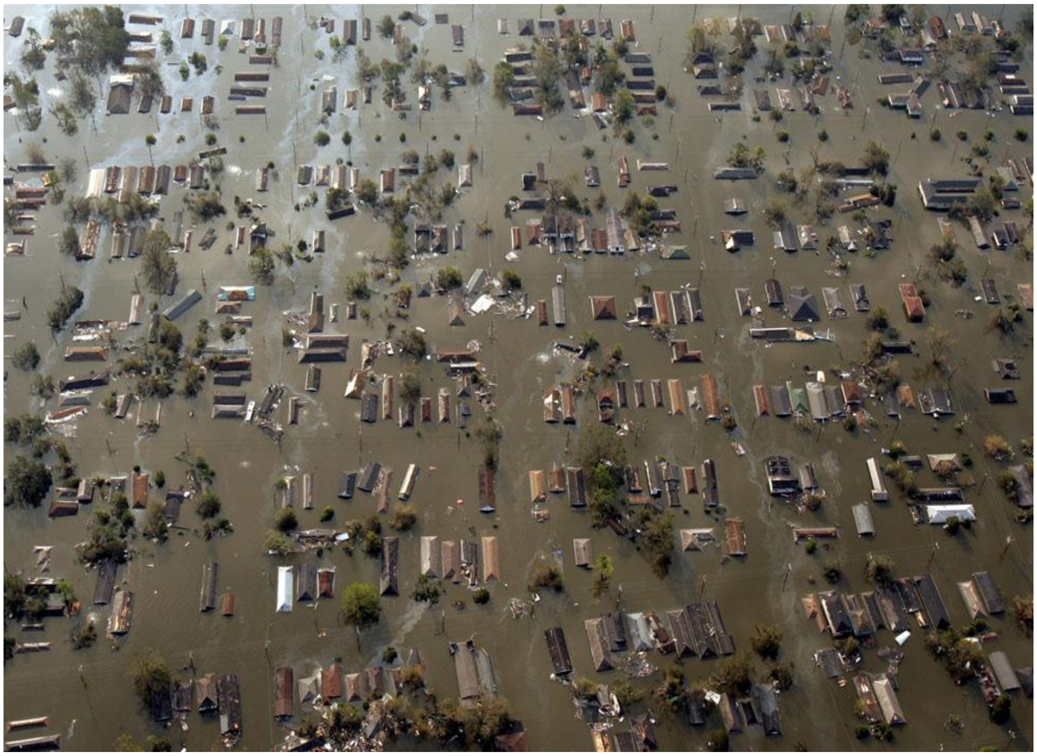

Figure 13. Water Surrounded Downtown New Orleans After Hurricane Katrina[22].

<u>2008 Midwest Floods (Iowa)</u>

Compared to the $2 billion in damage caused by the 1993 Iowa floods, the damage in the June 2008 Midwest floods was as high as $10 billion in Iowa—among the most costly natural disasters since Hurricane Katrina. In August 2010, the U.S. Department of Housing and Urban Development (HUD) announced that $312 million from the Disaster Recovery Enhancement Fund (DREF) had been awarded to 13 states in response to each state's flood mitigation efforts. Iowa was awarded the largest grant ($84.1 million) due to the state's commitment to flood mitigation efforts.

[22] The Dallas Morning News, *Smiley N. Pool, Aug. 30, 2005*

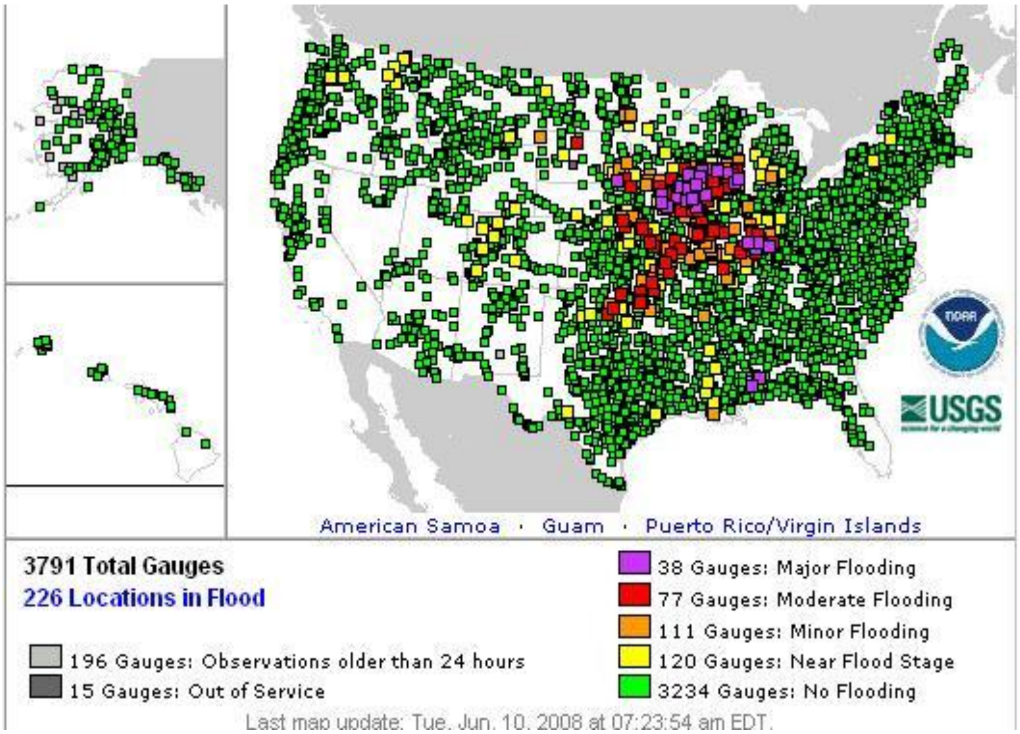

Figure 14. US Flood Map 2008-06-10

In the state of Iowa, nearly a third of the damage from the 2008 Midwest floods was to agricultural buildings, acreage, stored grain and equipment, that is a number between $2.3 and $3 billion. In the 2008 floods, out of the 99 counties in Iowa, 85 counties were declared disaster areas, some were whole towns covered in water, including Palo, northwest of Cedar Rapids, and Oakville, in southeast Iowa. It has been reported that hundreds of houses in Cedar Rapids remain abandoned, similar to the way they were on June 13, 2008, when the Cedar River crested. Some have been gutted down to their stilts, awaiting repair but lending entire neighborhoods the feel of a ghost town (Saulny, 2009).

Figure 15. 2008 Midwest Floods-Flooded Area

Analysis of Selected Case Studies

Impacts of the Cases Studied

Table 3
Impact on Thinking, Policy and/or Practice

Event	**Impact on thinking, policy and/or practice**
1995 Hanshin-Awaji; 1998 Yangtze River; 2005 New Orleans	A rethinking of post-disaster issues—how to carry out disaster-mitigation approaches more efficiently and effectively.
2008 Iowa; 2008 Wenchuan;2011 Tohoku;	Promoted the need for post-disaster building deconstruction.
All 6 cases studied	A need for national and local responsibility and regulatory of post-disaster building deconstruction.

How have natural disasters studied above influenced the country and even the world in shaping policy and practice in the area of building deconstruction? Above Table 3 is a brief summary of the impacts of the cases we discussed.

Political Background of Each Country

The PR China is one of the five remaining officially Communist states in the world. The government of the PRC has been variously described as communist and socialist, but also as authoritarian. The country is ruled by the Communist Party of China (CPC), whose power is enshrined in China's constitution. The Chinese electoral system is hierarchical, whereby local People's Congresses are directly elected and all higher levels of People's Congresses up to the National People's Congress (NPC) are indirectly elected by the People's Congress of the level immediately below. The political system is partly decentralized, with limited democratic processes internal to the party and at local village levels, although these experiments have been marred by corruption.

Japan is a constitutional monarchy wherein the power of the Emperor is very limited. Power is held chiefly by the Prime Minister of Japan and other elected members of the National Diet, while sovereignty is vested in the Japanese people. Japan's legislative organ is the National Diet, a bicameral parliament. The Diet consists of a House of Representatives with 480 seats, elected by popular vote every four years or when dissolved, and a House of Councillors of 242 seats, whose popularly-elected members serve six-year terms. The Prime Minister of Japan is the head of government and is appointed by the Emperor after being designated by the Diet from among its members. The Prime Minister is the head of the Cabinet and appoints and dismisses the Ministers of State.

The United States is the world's oldest surviving federation. It is a constitutional republic and representative democracy, "in which majority rule is tempered by minority rights protected by law"[23]. The government is regulated by a system of checks and balances defined by the U.S. Constitution, which serves as the country's supreme legal document. In the American federalist system, citizens are usually subject to three levels of government--national, state, and local, although local government does not have a separate constitutional existence except as granted by each state; The local government's duties are commonly split between county and municipal governments. In almost all cases, executive and legislative officials are elected by a plurality vote of citizens by district. There is no proportional representation at the national level, and it is very rare at lower levels.

Under three different political systems, U.S., China and Japan each has a unique policy cycle within which the main tool for building deconstruction—laws and regulations are generated.

As a centralized organization, all major policy decisions in China are made at the top by the Politburo and the Central Committee. Also, instead of allowing for diversity of solutions to meet different local needs, Chinese government stimulates policy

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[23], Your Government, *California Federation of Republican Women.* Retrieved 01/04/2014.

decisions based more on technical issues and less on narrow local self-interests. Chinese government allows for standardization of policy in all jurisdictions.

In Japan the government—particularly the bureaucracy—has been considered infallible, but actually this attitude has led to problems such as the failure of the medical care system for the elderly and miscalculations in estimating demand for expressways and airports.

The U.S. federal system disperses governmental power between national and state governments. Authority over environmental issues inherently is fragmented among a multitude of different governmental entities. Almost all new national regulatory programs since 1970 require implementation by the states. Congress passes laws that govern the United States. To put those laws into effect, Congress authorizes government agencies, including EPA, to create and enforce regulations through rulemaking. Proposed and final rules are published in the Federal Register. Once promulgated, regulations are printed in the Code of Federal Regulations.

Problems and Difficulties in Practices of Post-disaster Building Deconstruction

<u>Funding</u>

Among the common challenges that all three countries confronted in the promotion and practices of post-disaster building deconstruction, there is a pressing need for more funds in support of the building deconstruction process. National, state and local funding supporting deconstruction can be the difference between success and failure for the industry. However, disaster-affected areas and communities are too strapped for funds to pay for dismantling, demolition and landfill fees.

<u>Other Challenges</u>

As pointed out by Abdol R. Chini and Stuart F. Bruening (2003, p. 1), the challenges faced by deconstruction are significant but readily overcome if changes in design and policy occur. These challenges include:

- existing buildings have not been designed for dismantling;
- building components have not been designed for disassembly;
- tools for deconstructing existing buildings often do not exist;
- disposal costs for demolition waste are frequently low;
- dismantling of buildings requires additional time;
- building codes and materials standards often do not address the reuse of building components;
- unknown cost factors in the deconstruction process;
- lack of a broad industry identity with commensurate standardized practices;
- older buildings (in the U.S., usually built before the mid-1970's) with lead-based paint and asbestos containing materials;
- the economic and environmental benefits that are not well-established;
- lack of design for deconstruction strategies;
- lack of tools and training;
- lack of markets for used components.

Outline of Laws, Regulations and Incentive Programs for Building Deconstruction

A key issue in an economic assessment of a particular region's deconstruction potential is the level of involvement of the public sector. Kibert and Chini (2000, p. 190) explained the rationale of linking deconstruction and incentives: The nation's economy is, and always will be directed by regulated incentives and subsidies. Subsidies for recycling efforts pale in comparison to the hundreds of billions of dollars in subsidies provided to virgin-resource processors over the past century and which continue today. The virgin-based forest products, mining, and energy industries all benefit from both direct and indirect subsidies and tax breaks. Some examples of these tax breaks and subsidies include percentage-depletion allowances, which are intended to promote resource exploration and below-cost timber sales from Federal lands. Other subsidies include U.S. Forest Service research donated to industry, write-offs for timber management and reforestation costs, and below-cost mining leases based on an 1872 law. These subsidies do not include the many exemptions from environmental laws that the virgin-resource industries enjoy, allowing them to externalize costly burdens to the environment.

Government programs supporting deconstruction can do wonders in getting the ball rolling, which is quite possibly the most difficult step in the deconstruction development process (Chini and Bruening, 2003). One such support is the development of policy that promotes deconstruction activity. Policy support can take one of two forms (Macozoma, 2001, p. 33):

Direct Support for Deconstruction

Local authorities can formulate policies aimed specifically at the promotion of deconstruction and material salvage. For instance, the city of Portland, Oregon in the US undertook a program to aggressively support deconstruction, salvage, reuse and recycling. Driven by C&D waste statistics, Portland set targets for waste diversion from landfill sites, demanded recycling programs from construction projects, increased landfill tipping fees and enforced regulations.

Indirect Opportunities for Deconstruction

Government can develop various policies, in different sectors, that are driven by the common goal of achieving sustainability. Such policies can where appropriate, present a window of opportunity for the use of building deconstruction.

It is surprising to see that there is a lack of direct regulation or no regulation specifically for building deconstruction and related green job incentives at both local and national levels of governments in the three countries, among which Japan appears to be the most sufficient in policies supporting deconstruction effort.

Japanese Construction Material Recycling Law

Current Japanese environmental policy and regulations were the consequence of a number of environmental disasters in 1950s and 1960s. For example, cadmium poisoning from industrial waste in Toyama Prefecture was discovered to be the cause of the extremely painful “itai-itai disease” (ouch ouch sickness). In another case, people in Minamata City in Kumamoto Prefecture were poisoned by methylmercury drained from the chemical factory, known as the Minamata disease.

Enacted on May, 2000, the Construction Material Recycling Law[24]was issued by the Japanese Ministry of Land Infrastructure and Transport Division, aiming at recycling and reuse of prospected construction materials (especially for building materials including concrete, asphalt/concrete, and wood) in view of ensuring efficient use of resources.

The Construction Material Recycling Law requires to contractors to sort out and recycle wastes generated in demolition work of a building that the specified construction materials, such as concrete (including pre-cast plates), asphalt/concrete and wood building materials are used or construction work using the specific construction materials and is above certain scale (hereinafter referred to as the “designated construction work”). The criteria in terms of scale for the obligation of sorting demolition wastes or recycling of the construction wastes are; (i) in case of demolition work of building, the total floor larger than 80 ㎡; (ⅱ) in case of construction work or enlargement work, the total floor area is larger than 500 ㎡; (ⅲ) in case of repair work or remodeling, contract fee exceeds 100 million yen; or (ⅳ) in case of demolition work or construction work other than building, contract fee exceeds five million yen.

Also, as a procedure being enhanced in implementing designated construction work, the orderer is obliged to submit a work plan for sorting demolition wastes, etc. to the prefectural governors seven days prior to the launching the work, and in concluding

[24] Construction Material Recycling Law (Japanese), *Japanese Ministry of Land Infrastructure and Transport Division homepage*. Retrieved 1/4/2014.

the contract of the designated construction work, expenses for demolition or recycling should be specified.

A registration system of demolition operators to the prefectural governors has been introduced to ensure appropriate demolition works.

In addition to the above, in order to accelerate recycling of construction wastes, the law stipulates that the Minister in charge should develop the fundamental policy of the government which was decided on January 17, 2001. In line with this fundamental policy, roles of concerned parties and fundamental direction were stipulated along with the basic principles of promotion of sorting specified construction materials and recycling of specified construction.

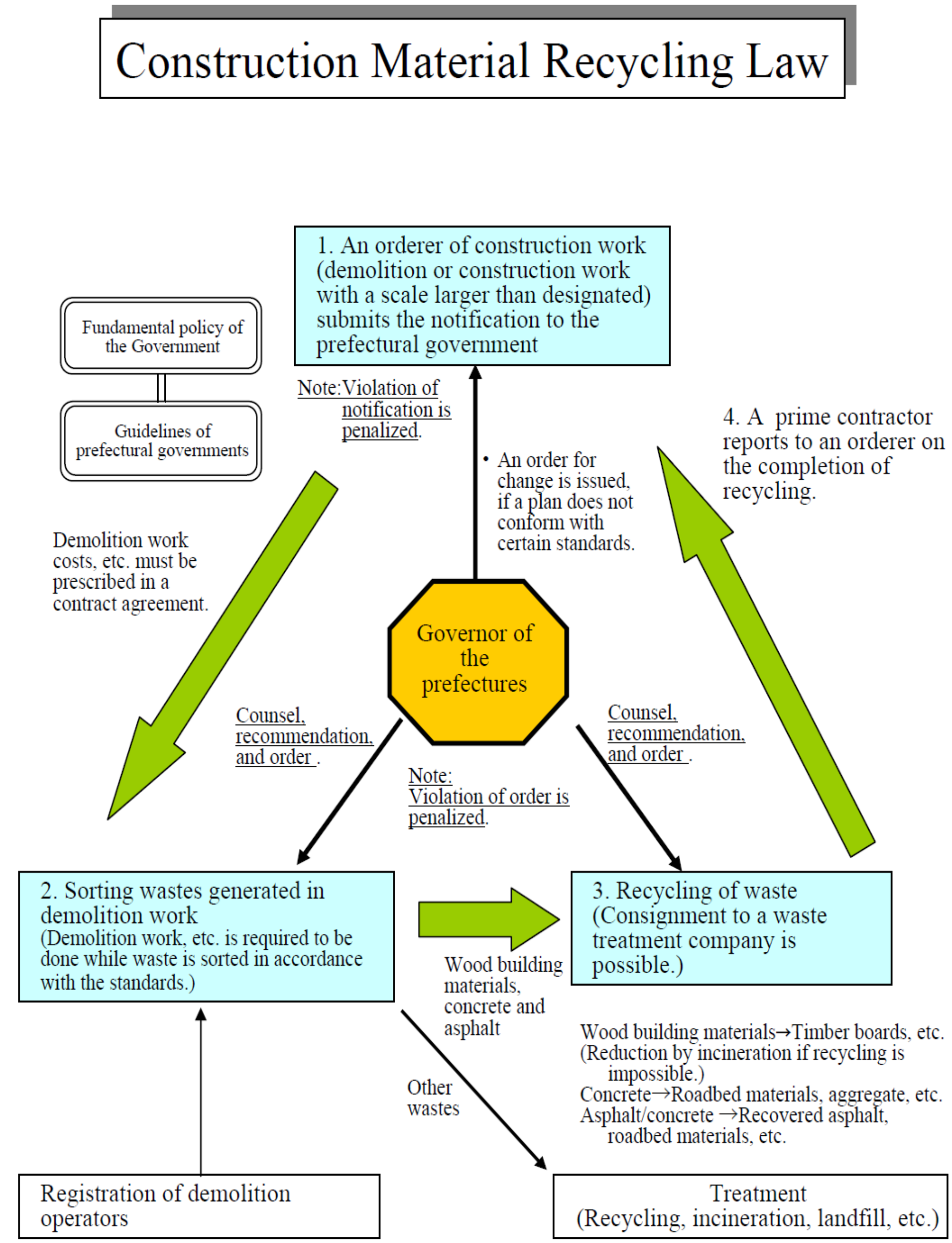

Figure 16 Outline of Japanese Construction Material Recycling Law[25]

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[25] Outline of Construction Material Recycling Law (Japanese). *Ministry of the Environment.* Retrieved 1/4/2014.

In P.R. China, direct regulations or law on building deconstruction is hard to find. In 2008, in order to guide the transitional settlement sites in earthquake-stricken areas to safely dispose domestic wastewater and garbage, the Ministry of Environmental Protection released the Technical Guidelines on the Treatment of Domestic Building Garbage in Transitional Settlement Sites of the Earthquake-Stricken Area[26].

For the case study of United States, Table 4 listed the incentives encouraging deconstruction versus demolition as well of green jobs policy in the State of Iowa. The search[27] summarized in the table below covers the Iowa Code, Iowa Acts, Election Laws, Iowa Administrative Rules, Iowa Court Rules, Current Bills & Amendments, and Senate/House Journal (The Iowa Legislature).

Table 4
Existing Building Deconstruction Regulations and Incentive Programs in State of Iowa

Resources	Citation of Relevant Regulation
Iowa Administrative Code; Environmental Protection Commission [567] Ch. 210, pp.1-2 "Beautification Grant Program" Iowa	• 567—210.1(455E) Beautification grant program. A beautification grant program is established in the department, with funds provided pursuant to 2009 Iowa Code Supplement section 455E.11(2)"a"(1) as amended by 2010 Iowa Acts, House File 2525, section 24. Each fiscal year for the fiscal period beginning July 1, 2010, and ending June 30, 2014, not more than $200,000 will be awarded to one entity that meets the eligibility criteria pursuant to rule 567—210.5(455E). • 567—210.2 (455E) Purpose. The purpose of the program is to provide financial assistance to a single eligible entity for the development and implementation of a public education and awareness initiative designed to reduce littering and illegal dumping. In addition, the successful applicant

[26] Calendar in Jun. 2008, *Ministry of Environmental Protection, the People's Republic of China.* Retrieved 1/4/2014.
[27] The Iowa Legislature Retrieved 1/4/2014.

Table 4 continued

Administrative Bulletins/2010 Administrative Bulletins/06-16-2010/Bulletin	must use the moneys to establish a community partnership grant program designed to support community beautification projects, including the **deconstruction**, renovation, or removal of derelict buildings. • Pursuant to the authority of Iowa Code section 455E.9, the Environmental Protection Commission hereby adopts new Chapter 210, "Beautification Grant Program, " Iowa Administrative Code. The purpose of the program is to implement 2010 Iowa Acts, House File 2525, section 24, which provides financial assistance in the form of a grant each year not to exceed $200,000 to a single eligible entity that meets the eligibility criteria set forth in the legislation. The grant is to be used for the development and implementation of a public education and awareness initiative designed to reduce littering and illegal dumping. In addition, the successful applicant must use the moneys to establish a community partnership grant program designed to support community beautification projects that include the **deconstruction**, renovation, or removal of derelict buildings.
83rd General Assembly/83rd GA – Session 2/Session 2/Other/Amendments/Senate/S5382 2010 House Journal Archives/03-26-2010	• Page 3, line 4, after <projects> by inserting <including the **deconstruction**, renovation, or removal of derelict buildings. Eligible communities are limited to cities of five thousand or fewer in population. Eligible costs shall include but are not limited to asbestos abatement and removal, the recovery and processing of recyclable or reusable material from derelict buildings and reimbursement for purchased recycled content materials used in the renovation of buildings. Special consideration may be given to communities that hire the unemployed to deconstruct structures, clean up the properties and, if there is no immediate buyer for the properties, turn the properties into green spaces. Any business entity or individual engaged in the removal or abatement of asbestos must have obtained a valid license or permit as required in chapter 88B>
2011 Iowa Code/Statutes (Code Chapters & Sections)/Title	• 455E.11 Groundwater protection fund established — appropriations. (ii) The grant recipient shall do all of the following: (A) Expend not more than fifty percent of the moneys for a public education and awareness initiative designed to reduce litter and illegal dumping.

Table 4 continued

Xi Natural Resources/Subtitle1 Control of Environment/CH455E Groundwater protection/455E.11; 2010 Iowa Acts/Chapters/1191	(B) Expend not more than fifty percent of the moneys for a community partnership program designed to support community beautification projects including the **deconstruction**, renovation, or removal of derelict buildings. Eligible communities are limited to cities of five thousand or fewer in population. Eligible costs shall include but are not limited to asbestos abatement and removal, the recovery and processing of recyclable or reusable material from derelict buildings, and reimbursement for purchased recycled content materials used in the renovation of buildings. Special consideration may be given to communities that hire the unemployed to deconstruct structures, clean up the properties, and, if there is no immediate buyer for the properties, turn the properties into green spaces. Any business entity or individual engaged in the removal or abatement of asbestos must have obtained a valid license or permit as required in chapter 88B.
➢ 82nd General Assembly/Study Bills/Senate/ssb3235	• Sec. 6. GREEN STREETS PILOT PROGRAM FUNDS From the moneys appropriated to the department of economic development for the fiscal year beginning July 1, 2008, and ending June 30, 2009, pursuant to section 15G.111, subsection 1, paragraph "a", subparagraph (4), the department shall allocate $500,000 to a **green streets pilot program** to provide technical assistance, grants, and other activities related to green design, green economy, green housing, and energy efficiency.

In the State of Iowa, many of the relevant provisions in Iowa Administrative Rules, Iowa Court Rules can be seen as simply copying or adopting regulations from provisions such as Environmental Protection Commission, without sufficient explanation and elaboration by which current need for green deconstruction is addressed effectively.

On a national level, there are very few policies in place that mandate environmentally friendly construction, buildings, designs, and materials.

Responsiveness

Following a disaster the affected community will have needs ranging from housing and reconstruction of public facilities through restoration of business and community activities, among which needs housing reconstruction is on the top in terms of importance. A critical issue is the speed with which early restoration of the community will be pursued.

In China, land is State-own and the permission for residential uses should be renewed every 70 years. Tearing down of a building can happen in just one day.

In the United States, there is a 30-day process for protesting and a 90-day re-inspection/hearing time frame. It takes an average of about 7 months from the start of the notice process to demolish a building. Cities can tag a property as a nuisance if there are perpetual maintenance issues, break-ins, no water service, unsecured entry, broken windows, or other safety (structural) or nuisance issues. Under Iowa Code 657A, a nuisance takes 6 consecutive months or less to abate (Chapter 675A Abandoned or Unsafe Buildings--Abatement by Rehabilitation, 2009).

In Japan, regulations to ensure post-disaster building deconstruction flow have been well-established. Figure 16 shows the recorded process of 1995 Kobe Earthquake building deconstruction enforcement with bi-corporation of the district, Japanese self-defense force, and the post-disaster waste management office. Figure 17 is an example of 1995 Kobe Earthquake Building Deconstruction Flow which demonstrates the policy flow of building deconstruction practices in Japan.

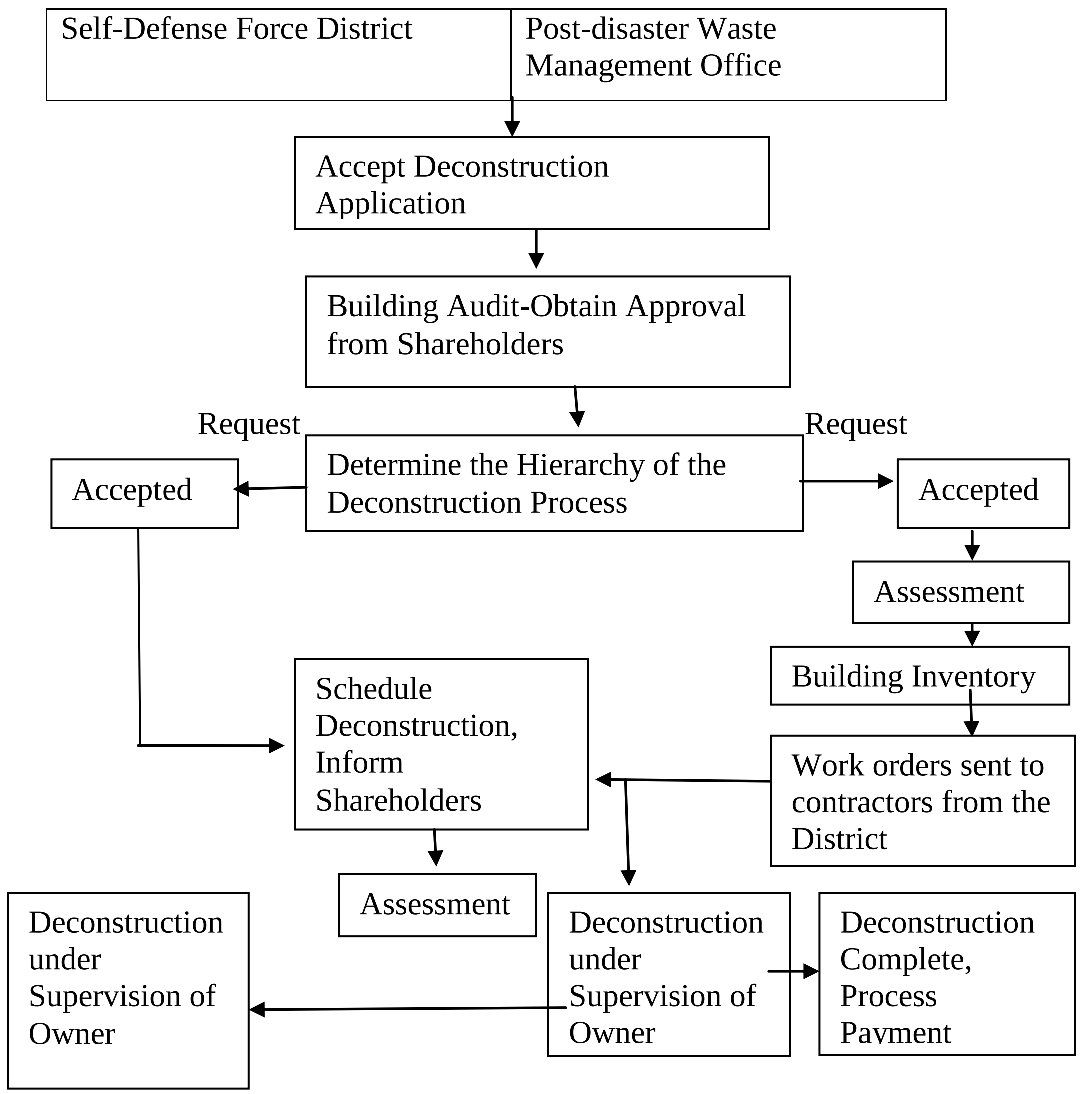

Figure 17. 1995 Kobe Earthquake Building Deconstruction Flow[28]

Financing for Deconstruction

Japan

[28] Record 1995 of the Great Hanshin-Awaji Earthquake in Kobe, *Kobe city study center, Great Hanshin-Awaji Earthquake in Kobe disaster-control office, January 17, 1996*. Retrieved 1/10/14.

After the devastating 2011 earthquake and tsunami and the nuclear crisis that followed, Japan has funneled a reconstruction budget of 19 trillion yen (nearly $239 billion). However, it is noted that the bureaucratic morass has slowed Japan's reconstruction effort, made worse by outlays of money to the unrelated projects seen by many as a throwback to the country's days of unrestrained pork-barrel spending[29]. On the positive side, government funds allocated to specifically support individuals' loss of property have seen to greatly ease the situation. Residents can apply for the funds through various local public organizations such as Social Welfare Division, Ministry of the Environment Afflicted Building Demolition Reception Center, and Environmental Protection Division, etc. For instance, through the "Reconstruction Aid Program", the city of Osaki has granted a "Basic Support Fund" based on the condition of damaged residential building, and another aid to support the re-build process. The amount of funds was granted based on the criteria showed as bellow[30]:

Table 5
Basic Support Fund Paid to Residents According to the Damage of Buildings

Damage of Building	**Amount of Fund Paid**	
	Residents with multiple households	Single resident
Fully collapsed	$1,000,000 Yen	750,000 Yen
Partially collapsed	$1,000,000 Yen	750,000 Yen
Partially damaged or flooded	$500,000	375,000 yen

29 Outcry in Japan Over Diversion of Post-Disaster Aid Funds, Hiroko Tabuchi, The New York Times, 2012 Oct. 30th. Retrieved 1/4/2014.
30 Post-Disaster Recovery Support System (Payment of Subsidies) (Japanese), City of Osaki. Retrieved 1/4/2014.

※If partially damaged or flooded buildings needs to be completely demolished, apply funding criteria of Full Collapsed to residents.

Table 6
Additional Funds Paid to Residents Based on Building Reconstruction Solution

Building Reconstruction Solution	**Amount of Fund**	
	Residents with multiple households	Single household
Purchase/Rebuild houses	2,000,000 Yen	1,500,000 Yen
Repair Damaged/Flooded Houses	1,000,000 Yen	750,000 Yen
Rental House	500,000 Yen	375,000 Yen

United States

In the United States, several federal government agencies demonstrated support for deconstruction by providing financial and technical assistance to pilot projects across the country. The U.S. EPA supported the Riverdale Housing Project. The EPA provided grant funding to the National Association of Home Builders Research Center, the Green Institute, and the Materials for the Future Foundation. In addition to the financial support, the EPA has also provided technical assistance on deconstruction projects. The Department of Health and Human Services' (HHS), Office of Community Services, The Department of Defense, Office of Economic Adjustment, and the U.S. Department of Agriculture's Forest Products Lab (FPL) have all contributed to the deconstruction research effort.

For the green deconstruction reinforcement in the State of Iowa, available funds can be listed as follows:

ARRA Funds

The State of Iowa’s Workforce Development Board was awarded a U.S. Department of Labor American Recovery and Reinvestment Act (ARRA) Grant in 2010, in the amount of $5,997,000 for 36 months of fast-track training and job placement in the Renewable Energy and Energy Efficiency Sectors (SESP Grant: Announcements, 2010). These project funds have been serving businesses, dislocated workers, and underemployed and unemployed Iowans with training funds for occupations as specified in the Green Jobs Act of 2007. Examples might include energy-efficient construction and building retrofits, hazardous materials abatement, materials reuse, wind energy, solar energy, smart grid and electrical transmission, bio-fuels, energy assessment and audit, the manufacturing of energy-efficient products, and sustainable agriculture.

From 2010 to 2013, the SESP fund will be implementing a state-driven green workforce development plan with prioritized training needs, as identified by the Iowa Green Jobs Task Force. The project will focus on creating green jobs and training Iowa workers with skills for the energy sector (Garden-Monheit, 2010).

There are two projects from the SESP that apply to building deconstruction or material reuse. The first project is the Central Iowa Works, with a fund of $430,788. This statewide initiative targets high unemployment counties--Woodbury, Scott, and Louisa to provide training for incumbent workers through the Iowa Laborers Education and Training Fund, Central Iowa Sheet Metal Workers’ Training Fund, the International Association of Heat and Frost Insulators and Asbestos Workers, and the Master Builders of Iowa. (Summary of Projects Funded from Iowa's SESP Grant, 2010). The second project is the North Central Iowa Energy Sector Team--Energy Efficient and Materials Re-use Project. Eligible participants from Butler, Cerro Gordo, Floyd, Franklin, Hancock, Mitchell, Winnebago, Worth and Wright counties will have the opportunity to receive instruction from North Iowa Area Community College in the area of energy assessment and audit for residential, commercial/industrial and agricultural customers in the region. The project funds for the two projects related to deconstruction and materials reuse are $1,275,356 and will serve a total of 855 people.

Training Extension Benefits (TEB)

Training extension benefits are available to individuals who meet the eligibility requirements for unemployment benefits—laid-off or voluntarily separated from a declining occupation or involuntarily separated as a result of a permanent reduction of operations. In 2009, Iowa paid $284,441 in benefits to help with job training programs. There were 2,588 applications, among which 452 have received approvals for occupation/training selection, and 384 were authorized to pay for current schooling. Interest in the program has surpassed projections, with additional staff trained and assigned to assist with green job programs. The TEB has greatly benefited programs ranging from redesign to improving efficiencies.

Workforce Investment Act (WIA) Funds

The Workforce Investment Act (WIA) provides funds to localities for job training and employment services for dislocated workers, youth, and adults. The economic recovery package provided $3.95 billion for WIA training and employment services in 2009. A portion of the funding—$2.95 billion—was distributed to states using standard

WIA grant formulas, among which $1.25 billion was provided for dislocated workers. In addition, the bill provided $200 million for the dislocated workers assistance national reserve. The table available at http://www.cbpp.org/files/1-22-09bud-te.pdf shows how the recovery package distributed the $2.95 billion in WIA formula funding for adult, dislocated worker, and youth services grants, based on data from the Congressional Research Service. Table 7 below puts together several examples, from which the $6.3 million in funding distributed to Iowa's dislocated workers in 2009 was among the lowest. Further, only 2 of Iowa's 15 regions have fully obligated WIA funds.

Table 7
State by State Impact of the American Recovery and Reinvestment Act of 2009 Additional Funding in Worker Training & Employment Services
(Millions of dollars, total allocated in FY2009)

	Youth Services	**Dislocated Workers**	**Adult Activities**
U.S. Total	$1,200.0	$1,250.0	$500.0
Iowa	$5.2	$6.3	$1.6
Illinois	$62.8	$65.3	$26.1
Nebraska	$3.0	$2.9	$1.2
California	$188.5	$225.0	$80.9
Minnesota	$18.0	$17.5	$7.0

HUD Grant

The Department of Housing and Urban Development announced in 2010 that $25,750,000 will be available for grants made through the Rural Innovation Fund (RIF). The RIF was included in President Obama's Fiscal Year 2010 budget request and was enacted by Congress with the 2010 Consolidated Appropriations Act. It replaces HUD's former Rural Housing and Economic Development Program. $25 million was appropriated for the RIF in FY 2010, and HUD added to that amount an additional $750,000 in unspent funds from the FY 2009 budget of the RHED Program.

The RIF will award grants on a competitive basis to state housing finance agencies, community development corporations, state community and economic development agencies, local rural non-profit organizations, federally recognized Indian tribes, and consortia of these eligible groups. Demolition and rehabilitation of existing housing units to increase sustainability and/or energy efficiency is included in ORIF-eligible housing and economic development activities.

HUD has established three categories of funding within the Rural Innovation Fund, including the Single Purpose Grants, the Comprehensive Purpose Grants, and the Economic Development and Entrepreneurship for Federally Recognized Indian Tribes program. An eligible agency or organization may apply only once for funding through the RIF.

Bureaucracy and Government's Role

Post-disaster policy implementation involves especially the bureaucracy, whose presence and style shape the impact of all public policies. The U.S. federal system disperses governmental power by fragmenting authority between national and state governments. Federalism introduces complexity, jurisdictional rivalries, confusion, and delay into the management of environmental problems. Authority over environmental issues inherently is fragmented among a multitude of different governmental entities.

Almost all new federal regulatory programs since 1970 permit implementation by the states.

Building deconstruction can support the economic development of communities by creating potential opportunities for green jobs that helps promote sustainability and grow the green economy. Accordingly, job-skills training and affordable building materials should be provided. The U.S. Department of Health and Human Services summarizes the importance of deconstruction training programs by stating, “Building deconstruction offers new opportunities for career and new enterprises and provides an excellent training ground for employment in the wider construction field where there are serious and growing shortages of trained workers throughout the United States” (Grothe, 2002).

Insurance System

In China, the state encourages and supports the natural disaster property insurance. According to The U.S. Federal Emergency Management Agency (FEMA), after Hurricane Katrina, Insurance companies have paid an estimated $41.1 billion on 1.7 million different claims for damage to vehicles, homes, and businesses in six states. 63 percent of the losses occurred in Louisiana and 33 percent occurred in Mississippi. Hurricane Katrina is the costliest disaster in the history of the global insurance industry. By 2007, 99 percent of the 1.2 million personal property claims had been settled by insurers. The National Flood Insurance Program paid out $16.1 billion in claims. $13 billion went to claims in Louisiana (FEMA). Moreover, in June 2006, the Government

Accountability Office releases a report that concludes at least $1 billion in disaster relief payments made by FEMA were improper and potentially fraudulent.

However, property insurance is still a relatively new concept for many Chinese people. Catastrophe modeling firm AIR Worldwide reported official estimates of insurers' losses at US$1 billion from the earthquake; estimated total damages exceed US$20 billion. It values Chengdu, at the time having an urban population of 4.5 million people, at around US$115 billion, with only a small portion covered by insurance.

CHAPTER 4

DECONSTRUCTION BEST PRACTICES RECOMMENDATIONS

Planning Issues for Deconstruction

There are numerous logistical issues to take into account when considering deconstruction as a building removal method. Steps must be taken to assure the owner that the building is a good candidate for deconstruction, that the proper environmental assessments and permits have been obtained, that all hazardous materials have been accounted for, and that the right contractor for the job has been hired. An integrated "Green Deconstruction Management Plan" is needed to help small communities share resources and work with agencies on green deconstruction. Some of these issues are identified and explored in the following discussions.

Assessing Regional Economic Potential for Deconstruction

For the potential deconstruction contractor/agent, many factors must be assessed when choosing a region to implement deconstruction on a large scale. Not all regions provide the right mix of scenarios that make deconstruction, from a business standpoint, economically viable. The region's building stock, reuse market, and level of public sector involvement all play a key role in whether deconstruction can thrive, or even survive, in the area. The most important factor to be considered when assessing the economic potential of a particular region is its building stock. In order for deconstruction to be a favorable operation, the region must contain a large number of buildings available for removal. In addition, the buildings must be suitable for deconstruction.

Life Cycle Assessment and Structural Determination Assessment

Different parts of buildings have different life expectancies, for economic, service, social, and fashion reasons. An understanding of the life expectancy of parts of a building is an integral part of a strategy of designing for deconstruction. The theory of time-related building layers, that is the idea that a building can be read as a number of distinct layers each with its own different service life, offers some insight into the relationship between building life expectancy and deconstruction. Knowing which layer a component is from, and where the layer begins and ends, assists in determining when and where to deconstruct.

Information Availability

A state Web-based deconstruction information system can provide information exchange service for various stakeholders involved in the cycle of building deconstruction. Such service could include the category of building inventory, registered deconstruction agencies, registered waste collection service providers and waste disposal facilities. This will provide information on available and required waste material for secondary applications by type, source, location, and available quantities.

“Virtual” One-Stop Network

Create “Workforce Exchange,” a virtual one-stop network, to improve access to information about deconstruction green jobs, training and workforce support [31] .

[31] An example of the One-Stop Network can be found at Recycler's Exchange Index,

Workforce exchange can help connect agencies, programs and services electronically to assist employers and individuals in making the right decisions for future success. The information and services made available through Workforce Exchange can be available 24 hours a day 7 days a week. Employers are able to manage their entire recruitment process on-line, and job seekers can build resumes that can be used to apply for green jobs instantly.

Building Inventory

Building inventory is used to identify the types of buildings with ratings for deconstruction potential. The decision of whether or not to deconstruct can be facilitated by a detailed inventory of the building's components. A detailed inventory serves to identify the cost effectiveness of deconstruction. This inventory can be made by anyone with knowledge of building construction techniques. A builder, architect, structural engineer, or a materials inspector would be good candidates. Advice from someone who has an understanding of the materials salvage market may also be helpful. The inventory serves to identify construction methods and fasteners, as well as hazardous materials, which have a direct effect on economic feasibility.

Material Identification

Provide permanent identification of component type, and identify potential materials for reuse and recycling, may use electronically readable information such as barcodes to international standards. The downside to a thorough building material inventory assessment is that it can be very time-consuming for those performing the

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Retrieved 1/4/2014.

assessment to develop and organize the spreadsheets, quantify the materials and their salvage values, and make an accurate final analysis of deconstruction potential. To solve this problem, Bradley Guy of the University of Florida's Powell Center for Construction and Environment has developed a computer software program that can quickly estimate both potential salvage value and deconstruction costs. This step-by-step program will assist in making a rapid assessment of economic potential and facilitate "pre-sales" of materials before the deconstruction process begins (Abdol R. Chini and Stuart F. Bruening, 2003).

Registration System

The establishment of a registration system for deconstruction dealers is highly recommended. Permit fees should be based on the projected volume of wastes. The subcontractor undertaking deconstruction needs to be registered with the municipality and IWD region. The deconstruction subcontractor must also engage an engineer who manages the various technologies for demolition.

Integrated Workforce Centers

A reformed and enhanced Integrated Service Delivery System for statewide workforce services is necessary as it can help provide assessment, employment plan and shared database for unemployed populations.

The enhanced system should include multiple access points for green jobs workforce services throughout the state while providing intensive, fully integrated services within the regional offices for those in need of green deconstruction services and job training. It is recommended that a regional officer should be appointed for each field office to assist deconstruction and green jobs programs.

Marketing Analysis for recyclable materials

A thorough examination of the local reuse market is necessary when determining a region's economic potential for deconstruction. "The supply and demand of salvage building materials can determine the success or failure of building deconstruction." (Macozoma, 2003)

Deconstruction waste is most often recycled into:

- Crushed concrete and masonry as concrete aggregate for road construction;
- Concrete, block, masonry and other clean debris used for rip-rap and borrow pit fill;
- Concrete truck washout used to make onsite containing walls and bins;
- Architectural ornamentation such as weathered lumber and aged brick;
- Wood chips remanufactured into engineered wood products;
- Wood fuels used in co-generation plants and industrial boilers;
- Horticultural mulches made from sanitized woody biomass;
- Dyed, decorative mulches made from construction debris wood;
- Wood chips used as bulking agent in biosolids, compost, and livestock bedding;
- Planks and other dimensional lumber sawn from large wood beams;
- Corrugated cardboard containers from recycled cardboard and paper;

- Metals (steel, aluminum other non-ferrous) for both domestic and export markets;
- Recovered screened material (RSM) for DEP approved uses

Environmental Assessment

An environmental assessment should be made on the site in order to identify hazardous materials. For commercial properties, it is the responsibility of the property owner(s) to make reasonable efforts to identify hazardous materials on the site prior to demolition or deconstruction. Reasonable efforts include a thorough visual, noninvasive inspection of all aspects of the site and structures by individual(s) trained in environmental assessment. However, there are no such requirements for residential property.

Financing for Deconstruction

The State should investigate additional funding sources that will reduce the future disposal costs of dilapidated structures by encouraging maintenance and restoration post-disaster affected buildings.

<u>Funding Template</u>

Set up a template for funding the dilapidated houses that would work in most communities.

<u>Waive land fill fees for the purpose of green deconstruction</u>

Reduced tipping fees for biomass/wood products from diversion of scrap to recyclers added an average of 10 percent more profit in the demolition contracts involved in the studies.

Training Extension Benefits (TEB)

Training extension benefits are available to individuals who meet the eligibility requirements for unemployment benefits— laid-off or voluntarily separated from a declining occupation or involuntarily separated as a result of a permanent reduction of operations. In Iowa, in 2009, $284,441 was paid in benefits to help with job training programs. There were 2,588 applications, among which 452 have received approvals for occupation / training selection, and 384 were authorized to pay for current schooling. The program interest has surpassed projections, with additional staff trained and assigned to assist green job programs. The TEB has greatly benefited programs from redesign to improve efficiencies.

Recommendations for Techniques, Methods, and Tools

Building Audit

Before demolition, a methodology for an audit is presented. The aim of this building audit is to provide building owners, before the stage of invitations to tender, with a qualitative and quantitative valuation of the constituent materials of the building to be demolished and to inform them of the deconstruction possibilities according to the building characteristics, existing techniques and local options for waste recycling. The French Office of Housing and Construction (Ministry of Equipment, Transport and Housing) has planned several studies making it possible to formalize methods for demolition waste management, and give a clear methodology for performing the audit (Frank Schultmann, 2001).

According to the French Office of Housing and Construction documents, persons in charge of the audit, selected by the building owner, must:

- look for general information and data about the building (historical, technical or environmental data);

- inspect the building in order to estimate the constituent materials and especially materials harmful to health and the environment;

- look for local options of waste elimination;

- evaluate specific operations of demolition for the extraction of dangerous materials (Asbestos…).

In addition, the audit report must comprise:

- a chapter on the general data of the building to be demolished;

- a specific part dealing with the presence of dangerous or toxic materials;

- tables that list the different types of materials in the building and the estimated quantities of each material. The total quantity of waste generated by the demolition can be calculated easily;

- evaluation of the demolition work in terms of costs and turnaround time. This provides very helpful data for the building owner for the analysis of offers from enterprises after the invitation to tender.

Safety Plan

Before considering a deconstruction program, the person who will manage the program must create a Deconstruction Safety Plan. For each new project, a Project Safety Plan will be created to handle any additional requirements to maintain safety at that specific project site. Elements of the Safety Plan will include worker orientation, hazard identification and training, guidelines for the use of tools, respiratory protection, fall protection, etc. The Safety Plan will contain procedures to handle emergencies, the proper OSHA forms, a job-site daily log, Personal Protective Equipment (PPE) use, and procedures for correcting unsafe behavior (Guy B. , 2003).

Tool Person

In a situation involving volunteers or any larger number of people, tools can readily get misplaced and consistent communication can be difficult. One management strategy is to assign a Tool Person who is responsible for inventorying all of the tools at the beginning of the project, checking for wear and damage, taking responsibility for either removing or repairing tools, and keeping track of all tools, their condition and additional needs on a daily basis (Guy B. , 2003).

Sorting

The individual components would have to be sorted after demolition in order to address their individual potential for recycling. This extra cost serves as a deterrent to recycling for demolition contractors. Deconstruction, by nature, requires the removal and sorting of individual building components. Piles of brick, wood, roof shingles, drywall, and other materials can then be recycled based on their own properties.

Transportation, Storage, and Sale of Recovered Materials

A plan for the storage, transport, sale of recovered materials should be insured. Storage of construction elements for reuse, on-site sorting of materials and recycling.

In order to guarantee a high quality recycling, the distance between the work site and the recycling installation has to be considered, to limit the costs for transport.

On-site sales are an equally important means of selling salvaged building materials. Time constraints are usually the limiting factor when selling materials on-site. However, many sites lend themselves well to this means of distribution. An ideal deconstruction venue for on-site sales would be one located in a high-traffic area and selling low-cost materials (Abdol R. Chini and Stuart F. Bruening, 2003).

Site Clean-up

Deconstruction can be cost-effective if heavy equipment is used to clean up after selective deconstruction. However, some degree of inspection and manual clean-up may be required.

Potential for Job Creation

Building deconstruction can support the economic development of communities by creating potential opportunities for green jobs that helps promote sustainability and grow the green economy. Accordingly, job-skills training and affordable building materials should be provided. The U.S. Department of Health and Human Services summarizes the importance of deconstruction training programs by stating that, “Building deconstruction offers new opportunities for career and new enterprises and provides an excellent training ground for employment in the wider construction field where there are serious and growing shortages of trained workers throughout the United States” (Grothe, M., Neun, D., 2002).

Deconstruction creates more employment and training opportunities for low-skilled workers than does demolition. This brings jobs and career opportunities into the community, which stimulates the local economy. It has been estimated that for every landfill job created, resource recovery creates ten jobs.

The increased job opportunities serve to stimulate the local economy. On another level, local dislocated and targeted worker populations including those affected by the natural disaster provide low cost labor to the deconstruction industry. Time saved on finding labor and money saved per labor hour increase the chances of deconstruction succeeding in the area.

Skills Training Assistance

Basic Worker Training

The deconstruction process is generally more labor-intensive and less technologically advanced than is building construction. The skill level required to get the job done is not high. However, a well-planned, coordinated effort is required to complete a deconstruction project efficiently and cost-effectively. Workers should be trained in the use of the necessary hand and power tools, they should be made familiar with the various building materials and fasteners, and they should be taught construction techniques and the construction process (Abdol R. Chini and Stuart F. Bruening, 2003).

Hazardous Materials Training

Workers should go through some formal training regarding hazardous materials such as lead-based paint (LBP) and asbestos-containing materials (ACM). This training is an essential job safety measure due to the potentially high levels of exposure that workers can experience on deconstruction projects. Raising worker awareness of proper handling techniques greatly diminishes the potential for exposure and related problems (Abdol R. Chini and Stuart F. Bruening, 2003).

Safety Training

Specialized training may be required. Train all workers and make sure that they acknowledge this training in writing. Job site safety includes not only the actual process of being safe but also the formalities of training and record keeping that serve for legal requirements. Every project should have an assigned Safety Officer who is responsible for overall safety on the project. A safe deconstruction project requires that all those present on the site know the Safety Plan and know how to accomplish the work. It is also necessary to assign clear roles and responsibilities so that each worker knows who is responsible for specific tasks such as Supervision, Safety, Medical and First Aid, Tools, Materials Management, Deconstruction, and knows where information is and what to do in special circumstances (Guy B. , 2003).

CHAPTER 5

SUMMARY AND CONCLUSIONS

As pointed out by Kibert, Chini & Languell (2000, p. 181), "Through deconstruction, natural resources are saved, employment and training opportunities are created, and local businesses are developed that use the materials diverted from landfills." Deconstruction as a labor intensive, low-tech, and environmentally sound process has emerged as an alternative to traditional demolition methods.

The current state of deconstruction is severely limited by numerous factors. The main obstacles can be categorized as costs and time, with these being interrelated. The main opportunity factors for deconstruction are the prohibitive aspects of building materials disposal and the value of recovered materials in environmental and economic terms. Related to the economic costs and benefits of recovered materials are the quality of materials, either for high-quality reuse and economic recycling, hazardous materials, and components and materials that quickly become obsolete, or are unfeasible to process for reuse or recycling. Last but not least, buildings in modern society are not typically designed to be deconstructed.

As Kibert and Chini (2000, p. 181) urged in their report, although the transfer of technology and information about new building materials is important to promote their use, it is also important that research into creating building materials specifically designed for deconstruction becomes a priority. Given that the emphasis on recycling products is only going to increase in the future, it is important that organizations start becoming conscious of the need to design products that are environmentally friendly, despite the belief that this will significantly increase their design and manufacturing costs.

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APPENDIX A
THE DECONSTRUCTION PROCESS

(Guy, 2003)

■ **Deconstruction Process for One-Story Wood Framed Building**

DAY 1 - Abatement

Asbestos Tile and Mastic - Abatement by certified abatement contractor

DAY 2 - General Clean-up inside and out

Site Cleanup and House Cleaning - The location was scattered with debris since the house was abandoned. The yard was cleaned allowing adequate space for the dumpsters and the denailing/processing station to be established. In addition, No Trespassing sighs and job-site signs were posted.

DAY 3 - Doors and Windows

Doors, Windows, Trim, Ext. Awnings - Remove all doors and windows with frame and associated trim. Doors and windows will be maintained as a complete package

DAY 4 - Interior Fixtures and Finishes

Oak floor, Doors, Windows, Ceiling Fans, Baseboards, Crown molding - The oak floor was laid on top of original pine floor. Baseboards were removed before plaster and lathe.

DAY 5 - Interior Finishes

Plaster, Floor felt, lathe - Wall plaster removal with lathe left in place as best as possible. Lathe is easiest to push out from behind rather than rip out and away from the stud nailing surface. Floor felt under oak floor must be peeled up as it is adhered with a water based glue.

DAY 6 - Roof Finish and insulation

Lathe, sheet metal roofing, batt insulation, beadboard walls - Sheet metal roofing is difficult to remove due to the 10:12 pitch of the original structure.

DAY 7 - Roof Finishes, Sheathing and Structure

1 x 8 roof deck, double layer of asphalt shingles, lathe, transfer plaster debris - 1 x 8 roof deck on the 10:12 original roof is punched out from below by crews of 3 to 4 standing on plywood decking. The plywood is positioned to make a continuous work surface on top of the ceiling joists. A secondary roof of two layers of asphalt shingles was left on the 1 x 8's as they easily shattered when punched out.

DAY 8 - Roof Structure

2 x 4 rafters, 1 x 8 roof deck - 2 x 4 roof rafters are removed from 10:12 roof. Rest of 1 x 8 roof deck is removed. After removal of the roof structure, the stud walls can be dropped to the ground level for disassembly.

DAY 9 - Roof Structure, upper chimney

1 x 4 roof deck, top of chimney, transport materials to storage - Small amounts of 1 x 4 roof deck removed from 10:12 original roof, top of the chimney deconstructed.

DAY 10 - Ceiling Finish

Ceiling plaster and lathe, 2 x 4 rafters - Ceiling plaster is removed by standing on plywood deck on top of the ceiling joists and pushing down between joists with a sledge hammer

DAY 11 - Additions - roof, ceiling, and walls

Remove Kitchen addition to the floor deck - Take kitchen addition down. Roof, Ceiling, Walls removed

DAY 12 - Additions – roof

Porch roof tin, asphalt shingles, mixed type wood roof deck, transport materials to storage - West porch addition metal roof is removed. Asphalt shingles are removed using shingle shovels. 1 x 6's and 1 x 3's roof deck is removed

DAY 14 - Additions, roofs, walls and siding

Porch rafters, 2 x 4 studs, 1 x 6 novelty siding - Deconstruct West Porch rafters and walls. Sections of the original exterior wall is laid down.

DAY 15 - Additions, rafters, walls, siding

2 x 4 studs, porch rafters, 1 x 6 novelty siding, front porch canopy - Continue deconstructing porch additions down to floor deck.

DAY 16 - Additions - floor structure

Floor deck, 2 x 8 floor joists, foundation block and concrete - 1 x 3 porch floor deck is removed.

DAY 17 - Ceiling Structure and Walls

2 x 4 studs, 2 x 4 ceiling joists - Removal of original structure ceiling 2 x 4 rafters then 2 x 4 studs. The original house is divided in four equal quadrants by the stud walls. The 2 x 4 ceiling joists were removed in one quadrant leaving the next to brace the exterior wall. Next the surrounding exterior stud wall in the quadrant was cut with a skill saw. The stud wall could then be easily pushed over for deconstruction on the ground.

DAY 18 - Floor Structure

1 x 3 floor deck, 2 x 6 floor joists, 4 x 6 floor beams, transport materials to storage - Removal of 1 x 3 floor deck of porch and support joists continues. Brick foundation pillars left in place.

DAY 19 - Floor Structure

1 x 3 floor deck, 2 x 8 floor joists, 3 x 10 and 6 x 8 floor beams - 1 x 3 floor deck of original structure removed along with floor support beams. 1 x 3 decking appears to cup more when there is less resin in the wood. Every other board of 1 x 3 is cupped due to water damage from rain

DAY 20 - Foundation and Chimney

Foundation and chimney brick, garage demo of roof and walls - Pull remaining chimney over following OSHA guidelines. Pick up as many brick's from chimney and foundation as possible. The rest of the brick are left to the community to harvest. Final unload at the storage facility.

APPENDIX B

BASIC TOOLS NECESSARY

(Guy, 2003)

A complete tool inventory should be done prior to deconstruction. Purchase any additional tools that might be needed.

Safety

- Fire extinguisher
- First-aid kit
- Job contact telephone numbers and job site cell phone
- Personal protective equipment (PPE)- each worker has hard hat, safety glasses, steel-toed boots, long pants, filter masks or 1/2 mask respirators (fit-tested) as needed, gloves, tool-belt and basic personal tools (preferred)
- Roof anchors w/16 d nails, tie straps, safety harnesses, lanyards, life-lines, rope grabs, carabiners

Organization and Security

- Warning signs - Hard Hat area, Construction Site, etc
- Yellow caution tape
- Garbage bags (heavy duty contractors)
- Garbage can for miscellaneous solid waste
- Generator, grounding rod, and GFCI plug
- Water container for drinking water

- Water: for hand washing
- Disposable cups and paper towels
- Hand soap (construction grade)
- Hudson sprayers and germicidal bleach
- Polyethylene plastic sheet
- Rope
- Sawhorses
- Storage for equipment, either on-site or removal each day (if required to remove, then optimally a lockable vehicle)
- Tarps
- Electric current detector
- Electrical cords

Deconstruction Tools – Power and Manual

- Axe (small and large), Pick axe
- Cats paw
- Chain saw
- Crow bars short and long (prefer "Gorilla Bar" type crow bar)
- De-nailing gun and air compressor (optional)
- Drill, cordless with batteries, and battery charger
- Hammers
- Ladders: 6 and 8 foot, 20' extension ladders (fiberglass preferred)
- Measuring tape

- Nails and screws
- Pliers
- Saws: bow saw, hand saw, hack saw rotary saw, Skil saw with grinder and wood cutting blades
- Sawz-alls with bi-metal blades
- Screw drivers regular and phillips head
- Shovels: regular and specialty Snow shovels Roofing shovels
- Sledgehammers (small and large)
- Post-hole digger
- Pry bars
- Rakes
- Tamping bar or “Grizzly Bar”
- Tin snips
- Vise grips
- Wheelbarrows
- Wire and bolt cutters
- Wrenches adjustable

Equipment Rental as needed

- 20 C.Y. to 40 C.Y. roll-off
- Covered truck to remove salvage
- Debris chutes
- Man-lift, Hi-lift, Fork Lift

- Pneumatic or electric hammer with chisels
- Rolling scaffold
- Fall protection safety equipment
- Respiratory protection safety suits and equipment

APPENDIX C

DECONSTRUCTION CHEKLIST

(Guy, 2003)

- Inventory materials in building and assign to categories with estimated quantity and value. Categories are: reuse, recycle, hazardous disposal, C&D disposal, solid waste disposal.
- Know where the reusable, recyclable, hazardous disposal, C&D disposal, and solid waste disposal will go and the means to get it there. Understand and prepare specific outlets (contacts), general markets (advertisement) and methods (equipment, labor, sub-contracts) for removal of all materials from site.
- Determine if the building is has a historic designation, is in a historic district, or the local municipality has a review process, delay, or variable fee structure for demolition permits.
- Estimate cost and finalize contract, this can vary, as with the preference to have the Owner pay directly for lead and asbestos surveys and any asbestos abatement, given the unknown cost. The contract also determines the scope of work for the deconstructor as either a sub-contractor or the contractor responsible for the complete removal of all building-related debris including foundations, septic tanks, site cleaning, etc. Lastly, the contract can stipulate ownership, donation value of the salvaged materials by the Owner, or revenue-sharing between Owner and

Contractor depending upon scope, for-profit versus non-profit, potential reuse of the materials.

- Do lead and asbestos surveys by certified environmental firm if building built before 1981.
- Disconnect all utilities and obtain demolition permit. These are often intertwined - i.e. a demolition permit must have a certification that utilities have been disconnected in order for it to be issued.
- Do building engineering survey and dismantling process plan. This is completed and signed off on by the competent person who will oversee the deconstruction itself. This plan indicates known hazards at the time of the inspection and the general schedule, tasks, techniques and tools to be used to conduct the deconstruction. The survey and plan are updated as the project progresses. Complete asbestos abatements (if needed)
- Secure labor, and materials storage areas both on and off-site. This includes security against pilferage during project if needed.
- Secure use of heavy equipment and disposal roll-offs, access to landfill, i.e. sub-contractors, includes Porta-Potty for duration of project.
- Determine locations and arrangements of delivery or pick-up for recyclables such as metals, concrete including possible trees and plants salvage.
- Determine locations for disposal of any additional hazardous materials found such as paint, oils, refrigerants, and solvents.
- Determine nearest medical care facility, routes and telephone.

- Complete any site access arrangements and/or site security arrangements.
- Complete job site plan for ingress and egress, locations of worker parking, roll-offs, tool storage and dispersal, job "office" (can be a table or bed of pick-up, etc.) job-site sign, metals "pile," denailing and processing stations, materials lay down area(s) for processed materials or materials not requiring processing, "sales area" for on-site sales, and loading area for materials removal. (Roll-offs, de-nailing will change the most over the duration of project.)
- Storage and inventory areas should be as out of way as possible for duration of project to avoid double moving. Organizational and job specific safety plan includes respiratory protection, fall protection, etc. as well as OSHA 200 forms, job-site daily log, job site hazard analysis and personal protective equipment certification forms.
- Conduct worker training pre-deconstruction and sign waivers of liability (if appropriate)
- Prepare site with any site clearing, signage placement, drop-off of roll-offs, placement of sawhorses for processing, materials storage areas, etc.
- Insure adequate clear area around building, shade for processing areas, no overhead hazards such as branches, powerlines that will interfere with roll-off deliver and pick-up, workers on roof. Inspect site for holes, tripping hazards, animal hazards, etc. and remediate all potential hazards.

- Removal of windows and doors, simultaneously inspect and remove all biological hazards, miscellaneous interior and exterior trash, insure water lines are drained, electrical, natural gas, etc. are off and flushed out.
- Continue with daily safety training, tool talks, and task-based safety analysis and training throughout the deconstruction.

APPENDEX D

EPI RANKING & SCORES

(EPI, 2012, P. 10)

The 2012 EPI ranks 132 countries on 22 performance indicators in the following ten policy categories (EPI, 2012, p. 7):

- Environmental Health
- Water (effects on human health)
- Air Pollution (effects on human health)
- Air Pollution (ecosystem effects)
- Water Resources (ecosystem effects)
- Biodiversity and Habitat
- Forests
- Fisheries
- Agriculture
- Climate Change

Environmental Performance Index– Ranking & Scores

EPI Rank	Country	Trend EPI Rank	EPI Rank	Country	Trend EPI Rank	EPI Rank	Country	Trend EPI Rank
1	Switzerland	89	45	Hungary	18	89	Mozambique	102
2	Latvia	1	46	Uruguay	115	90	Angola	6
3	Norway	84	47	Georgia	68	91	Ghana	28
4	Luxembourg	106	48	Australia	79	92	Dem. Rep. Congo	83
5	Costa Rica	113	49	United States of America	77	93	Armenia	49
6	France	19	50	Argentina	112	94	Lebanon	91
7	Austria	71	50	Cuba	101	95	Congo	99
8	Italy	12	52	Singapore	36	96	Trinidad & Tobago	114
9	United Kingdom	20	53	Bulgaria	16	97	Macedonia	75
9	Sweden	63	54	Estonia	128	98	Senegal	39
11	Germany	56	55	Sri Lanka	11	99	Tunisia	40
12	Slovakia	7	56	Venezuela	85	100	Qatar	121
13	Iceland	64	57	Zambia	48	101	Kyrgyzstan	127
14	New Zealand	50	58	Chile	117	102	Ukraine	82
15	Albania	4	59	Cambodia	44	103	Serbia	109
16	Netherlands	92	60	Egypt	5	104	Sudan	94
17	Lithuania	104	61	Israel	78	105	Morocco	37
18	Czech Republic	25	62	Bolivia	122	106	Russia	132
19	Finland	54	63	Jamaica	53	107	Mongolia	54
20	Croatia	74	64	Tanzania	93	108	Moldova	67
21	Denmark	45	65	Belarus	40	109	Turkey	17
22	Poland	107	66	Botswana	21	110	Oman	80
23	Japan	60	67	Ivory Coast	42	111	Azerbaijan	2
24	Belgium	9	68	Zimbabwe	87	112	Cameroon	110
25	Malaysia	33	69	Myanmar	47	113	Syria	62
26	Brunei Darussalam	119	70	Ethiopia	70	114	Iran	118
27	Colombia	34	71	Honduras	86	115	Bangladesh	32
28	Slovenia	51	72	Dominican Republic	88	116	China	100
29	Taiwan	34	73	Paraguay	46	117	Jordan	76
30	Brazil	23	74	Indonesia	66	118	Haiti	111
31	Ecuador	65	75	El Salvador	108	119	Nigeria	59
32	Spain	30	76	Guatemala	31	120	Pakistan	72
33	Greece	81	77	United Arab Emirates	27	121	Tajikistan	38
34	Thailand	10	78	Namibia	98	122	Eritrea	26
35	Nicaragua	15	79	Viet Nam	73	123	Libya	61
36	Ireland	8	80	Benin	120	124	Bosnia & Herzegovina	129
37	Canada	52	81	Peru	96	125	India	95
38	Nepal	14	82	Saudi Arabia	130	126	Kuwait	131
39	Panama	103	83	Kenya	105	127	Yemen	29
40	Gabon	57	84	Mexico	22	128	South Africa	124
41	Portugal	24	85	Togo	90	129	Kazakhstan	126
42	Philippines	43	86	Algeria	58	130	Uzbekistan	69
43	South Korea	13	87	Malta	97	131	Turkmenistan	123
44	Cyprus	116	88	Romania	3	132	Iraq	125

Top 10 Trend Index Performers
Lowest 10 Trend Index Decliners

Scores and rankings for the 2012 EPI cannot be compared with scores and rankings from earlier releases of the EPI owing to changes in data and methodology. However, we do offer a consistent time series of EPI scores from 2000-2010 on the Downloads page at www.epi.yale.edu.

2012 ENVIRONMENTAL PERFORMANCE INDEX 10

APPENDIX E

RIGIONAL TIPPING FEES IN THE UNITED STATES

(Kibert and Chini, 2000, p. 192)

Table 2 National Regional Tipping Fees (shown in $/ton)

Region	1985	1986	1987	1988	1990	1992	1994	1996	% of recycling facilities
Northeast	12.66	17.11	52.41	61.11	64.76	65.83	66.92	68.02	14%
Mid-Atlantic	16.99	22.08	26.32	33.84	40.75	47.94	56.39	66.34	27%
South	3.24	5.76	13.13	16.46	16.92	22.48	29.83	39.59	12%
Mid-West	7.23	11.75	16.42	17.70	23.15	27.10	34.32	37.13	13%
West Central	5.36	6.21	7.23	8.50	11.06	12.62	14.40	16.43	3%
South Central	7.24	7.61	10.17	11.28	12.50	12.53	12.56	12.59	3%
West	10.96	11.10	13.92	19.45	25.63	27.92	30.41	33.13	28%
National Average	9.09	11.66	20.37	24.04	27.82	30.91	35.11	38.60	

The regions contain the following states:

Northeast - Connecticut, Maine, Mass., New Hampshire, New York, Rhode Island, Vermont
Mid-Atlantic - Delaware, Maryland, New Jersey, Penn., Virginia, West Virginia
South - Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, Tenn.
Mid-west - Illinois, Indiana, Iowa, Michigan, Minnesota, Missouri, Ohio, Wisconsin
West Central - Colorado, Kansas, Montana, Nebraska, North Dakota, South Dakota, Utah Wyoming
South Central -Arizona, Arkansas, Louisiana, New Mexico, Oklahoma, Texas
West - California, Idaho, Nevada, Oregon, Washington