Art Disc

UNBUILDING FOR THE ENVIRONMENT

Across the country, deconstruction activity appears to be on the rise as markets for construction and demolition (C&D) wastes emerge and specialty contractors enter the business. Deconstruction has often been described as "construction in reverse." Whereas demolition yields a mixed pile of debris from which some items (for example, scrap metal) may be picked out for recycling, deconstruction involves the selective and systematic disassembling of buildings with the specific goal of generating a supply of materials suitable for reuse. The health and safety aspects of deconstruction are still being documented, but deconstruction has numerous potential environmental benefits over demolition, and, being more labor-intensive, it can provide relatively more jobs. In terms of human health and safety, because it involves more direct human contact with hazardous materials and situations, deconstruction is potentially more hazardous than demolition and must be pursued with caution.

Deconstruction goes back at least as far as the Roman Empire. Records describe how Roman engineers reused stones from their road system in the building of new roads. "Deconstruction was actually the norm for many centuries, as people made use of old building materials to renovate or rebuild," says Charles Kibert, director of the M.E. Rinker, Sr., School of Building Construction at the University of Florida.

It has only been in the modern era, Kibert says, when landfill space has been plentiful and raw materials cheap, that demolition—knocking down structures without regard for reusing the components—has become the rule. Today, it's no longer uncommon to knock down massive structures that are barely 30 years old. For example, shopping malls that have become "outdated" are routinely torn down and replaced by new, bigger malls.

Exactly how much C&D waste is generated each year is a matter of considerable speculation. A 1998 U.S. Environmental Protection Agency (EPA) report titled *Characterization of Building-Related Construction and Demolition Debris in the United States* estimated that about 136 million tons of building-related C&D debris was generated in 1996. William Turley, executive director of the Construction Materials Recycling Association (CMRA), estimates that figure to now be at least 150 million tons, not including the millions of tons coming from road, bridge, and airport construction and renovation.

Although there are no hard figures on the subject, anecdotal data suggest the pendulum has begun to swing away from demolition and back toward deconstruction in the last decade. Neil Seldman is president of the Washington D.C.–based Institute for Local Self-Reliance (ILSR) and coauthor of the ILSR publication *Deconstruction: Salvaging Yesterday's Buildings for Tomorrow's Sustainable Communities*. In the July 2000 issue of the recycling magazine *BioCycle*, he and coauthor Mark Jackson, an ILSR researcher and program director, cited dozens of deconstruction projects across the country, including military bases in California and a public housing project in Connecticut. "If deconstruction were fully integrated into the U.S. demolition industry, which takes down about 200,000 buildings annually," they wrote, "the equivalent of 200,000

jobs would be created and $1 billion worth of building materials would be returned to the economy."

Method Instead of Madness

Several factors are driving the shift toward deconstruction. Landfill space is becoming scarce in many parts of the country, as existing landfills reach capacity and new ones become hard to site. Tighter environmental standards have forced the closure of many existing landfills and made it more costly to build new ones. Landfills that receive only C&D wastes are not subject to the same strict federal requirements as municipal solid waste landfills. However, many states have imposed or are considering imposing requirements on new C&D landfills, ranging from the installation of impermeable liners to monitoring of groundwater for leachate.

As a result of these constraints, tipping (dumping) fees at landfills have increased dramatically in recent years. In a 2000 report titled *Overview of Deconstruction in Selected Countries*, published by the International Council for Research and Innovation in Building Construction, Kibert and coauthor Abdol Chini, also of the Rinker School of Building Construction, stated that tipping fees increased nationally in the United States from an average of $9.09 to $38.60 per ton between 1985 and 1996. In some urban areas such as San Francisco, tipping fees can reach $110.00 per ton.

At the same time, the value of certain materials salvaged from old buildings has increased, and people are paying a premium for particular architectural elements. "A lot of people are demanding heart-of-pine flooring, old bricks, and old mantelpieces," says David H. Griffin, Jr., vice president of the Greensboro, North Carolina–based D.H. Griffin Wrecking Company. "You can't get a lot of this material new."

Faced with rising costs of disposal, coupled with the opportunity to recoup costs through the sale or reuse of salvaged materials, private industry has become increasingly active in deconstruction. Consider a job site in Winston-Salem, North Carolina, where D.H. Griffin deconstructed 20 44,000-square-foot tobacco warehouses made of steel and wood. The company salvaged all the steel and all the wood beams for reuse. Wood that could not be salvaged was ground up and sold as boiler fuel. All the concrete was ground up and crushed onsite to be used as a road base. The company directly prepares and sells much of the material they recover, cutting out the middleman's markup. "All in all, we were able to reuse approximately eighty-five percent of [each of] the buildings," says Griffin. "And we were able to keep about four thousand tons of material out of the local landfill."

Demolition contractors such as D.H. Griffin offer turnkey services from the planning stages of deconstruction to the actual sale of salvaged materials. "We've conducted over thirteen thousand projects around the country, virtually all of which have involved some salvage of materials," Griffin says. "I'd say about fifty percent of these jobs would classify as deconstruction jobs."

Nonprofit companies such as The ReBuilding Center in Portland, Oregon, have cropped up to take advantage of the tax write-offs available through the donation of salvaged materials. The ReBuilding Center takes donations of used building materials from private contractors and sells them back to individuals for use in new and renovated structures. This kind of service has spawned the growth of contractors, such as DeConstruction Services, a division of The

A quick and dirty solution. In traditional demolition, structures are knocked down with little regard for reusing the components. But unless a building is put together with an eye toward eventual deconstruction, demolition may be the only way to take it apart.

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Wood I recycle if I could? If scrap wood can't be used architecturally, it can still be chipped for mulch, boiler fuel, or wood composite fodder.

ReBuilding Center that specializes in deconstructing residential and small commercial buildings.

Many private companies are involved in the recycling of C&D materials. The CMRA estimates there are slightly more than 3,100 concrete and asphalt recycling plants in the country, about 600 single-material or mixed-waste recycling facilities, and several dozen each of asphalt shingle and gypsum recyclers.

Along with rising disposal costs has come pressure by local governments for industry to reduce the flow of waste. A growing number of local governments have passed ordinances requiring haulers to recycle a minimum amount of C&D wastes or banning certain wastes from county landfills. For example, Orange County, North Carolina, has an ordinance that requires haulers operating in the county to demonstrate that they are recycling a minimum amount of C&D materials. Catawba County, North Carolina, bans the disposal of wood waste in its landfills.

In response, markets for C&D materials have increased. Concrete has long been recycled into aggregate as a base material for roads and parking lots. New technologies in crushing and grinding have made that practice far more economical. "The trend has been to make crushing and grinding machinery portable so you can reuse construction materials right onsite," says Mark Friedrich, manager of recycled products at Shoosmith Brothers, a private landfilling company in Chester, Virginia. "This saves transportation costs, new aggregate costs, and dumping fees."

Waste Not, Want Not

Ideally, C&D materials should be reused if they can be recovered in high-quality condition. A good example of this is the recovery and reuse of architectural pieces (such as door moldings and fireplace mantels) for identical purposes in new or renovated buildings. If the materials are not immediately reusable, they may be recyclable—usable as feedstock to manufacture other products, such as scrap metal that is melted down and fabricated into other metal products. If the materials are not recyclable, their energy content might be put to use, as in the burning of wood chips for boiler fuel. The least desirable alternative is landfilling, as it takes up valuable space and poses a potential threat to the environment through the leaching of toxicants into the air and water.

Asphalt from roadwork is being recycled by grinding it up and putting it back in the hot mix to be placed on roads again. As with concrete recycling, this is a well-established industry in North America, with approximately 150 million tons recycled annually, according to the CMRA. Asphalt shingles can be recycled, too. The largest market is for use in hot mix asphalt for roadways. Recycled shingles can also be used as a "cold patch" for filling potholes, or mixed in with gravel to spread on unpaved roads.

Wood can be reused in various ways, depending upon its condition. Framing, flooring, and siding can often be reused for its original purpose. However, wood penetrated by numerous nails or covered with paint (particularly lead-based paint), creosote, or caulking may be unusable. New tools, such as pneumatic denailers and machines to strip lead-based paint, are making it easier to recover usable wood products.

Heavy hitter. Scrap metal is one of the most commonly recycled construction materials, with strong markets in the United States and abroad.

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Local codes determine whether wood can be reused for framing. Wood that is not reusable is often chipped for use as boiler fuel or mulch, or made into a building material known as medium-density fiberboard.

In certain parts of the country, markets are being found for gypsum, the main component of wallboard. Wendy Worley, a market development specialist with the North Carolina Recycling Business Assistance Center, says ground-up gypsum from wallboard is being used as a litter bed for chicken and turkey houses in that state and as a soil amendment in areas where soil is low in alkalinity. In the Northeast, gypsum is being recycled back into wallboard by a few companies. "There's tremendous potential for recovered wallboard to be recycled into new product, but, unfortunately, the raw material is still dirt cheap," Turley says. So there is little incentive to recycle.

Metals including iron, steel, copper, and aluminum have long been recycled from both demolition and deconstruction projects. Scrap metal is sold to mills where it is melted down to serve as feedstock for new product. In 1999, more than 120 million tons of scrap metal were recycled in the United States, according to the Institute of Scrap Recycling Industries, a trade association, and the market is improving. "Right now, the market for scrap metal is very good," says Brian Taylor, editor of *Recycling Today* magazine. "Scrap iron, aluminum, and copper are all at the high end of their trading ranges. This is being driven by huge demand in China and a relatively weak supply here in the United States with the recession."

Building fixtures such as windows, doors, and cabinets can be removed and resold for use in new construction or renovation, provided they meet local building codes. Such materials, even those that do not meet U.S. building codes, are sought after by nonprofit groups for use in building shelter for the poor in Mexico and Central America. Project Mercy, a nonprofit agency based in San Diego, purchases secondhand building materials, including lumber, garage doors, windows, and plywood, to build solid shelters for squatter families near Tijuana, Mexico.

Keeping Health and Safety Up to Code

Deconstruction does pose certain worker hazards, compared to demolition. "In most demolition projects, the worker is sitting in an enclosed cab of a crane or excavator knocking down the building from the outside," says Brian McVay, project manager for DeConstruction Services. "In deconstruction, workers are inside the building, face to face with all sorts of potential health hazards. They're breathing the dust, pulling materials down, carrying them out to the curb."

Deconstruction typically involves a labor-intensive multistep process that requires the contractor to pay special attention to occupational health and safety issues.

Best practices for asbestos. Different types of asbestos-containing materials, which are found in nearly every structure past a certain age, have special requirements for removal or encapsulation.

The first step involves a two-part site assessment to identify each type of material used in the building, its condition, the way it is secured to the structure, and the ease of removal. This is first done through a thorough noninvasive visual inspection of the building, followed by an invasive inspection in which pieces of floors, ceilings, and walls are removed to assess hidden layers.

If hazardous materials are identified, they must be removed before deconstruction can proceed. The most commonly found hazardous materials are asbestos and lead-based paint. "We come across asbestos all the time," says McVay. "You find it in pipe insulation, duct insulation, ceiling tiles, roofing, siding. . . . It's in practically every structure beyond a certain age."

Asbestos is typically classified as friable or nonfriable. Friable asbestos is easily crumbled or pulverized and, if disturbed, can remain suspended in the air, creating a health hazard. Nonfriable asbestos is not easily reduced to dust and thus does not present a serious health hazard if left undisturbed.

Chronic inhalational exposure to asbestos can lead to the lung disease asbestosis, which is a diffuse fibrous scarring of the lungs. Symptoms of asbestosis include shortness of breath, difficulty breathing, and coughing. In severe cases, this disease can lead to death due to impairment of respiratory function. A large number of occupational studies have reported that exposure to asbestos via inhalation can also cause lung cancer and mesothelioma, a rare cancer of the membranes lining the abdominal cavity and surrounding organs.

When contractors come across asbestos, they invariably call in a specialty contractor to remove it. Both the Occupational Safety and Health Administration (OSHA) and the EPA have rules pertaining to the protection of workers and the removal of asbestos. OSHA Construction Standard 29 CFR 1926.1101 establishes procedures for protecting workers involved in building demolition and renovation where asbestos is removed or encapsulated. The standard divides asbestos work into four types, each with its own set of requirements. Class I covers removal of thermal insulation or surface material, such as sprayed-on fireproofing. Class II covers removal of asbestos-containing wallboard, floor tile and sheathing, and roofing and siding shingles. Class III refers to repair and maintenance work where asbestos-containing materials are likely to be disturbed. Class IV covers maintenance and custodial activities during which employees come into contact with asbestos-containing materials.

For most of these types, asbestos work must be conducted within regulated areas, which only trained and authorized personnel wearing respirators and other protective gear may enter. The EPA's National Emission Standards for Hazardous Air Pollutants (40 CFR 61 Subpart M) establishes requirements for removing asbestos, preventing the release of fibers into the air, and disposing of the waste.

Lead-based paint is commonly found in buildings constructed before 1978, when

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Staying safe on the job. The potential for greater hazardous exposures is one drawback to deconstruction. Personal protective equipment, proper work procedures, and good physical condition are essential for coming face to face with building debris.

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the manufacture of such paint was banned. As with asbestos, lead-based paint that is in good condition does not present an imminent hazard, but paint that is flaking off can be dangerous. Lead dust can form when lead-based paint is dry-scraped, dry-sanded, burned, or heated, or when lead pipes are cut or torched. Lead chips and dust can settle on surfaces and objects that workers touch, then reenter the air when people vacuum, sweep, or walk through the area. Lead can affect adults in the form of high blood pressure, digestive problems, nerve disorders, memory and concentration problems, and muscle and joint pain, and may contribute to low birthweight and premature delivery in children of exposed women.

With this in mind, OSHA Regulation 29 CFR 1926.62 requires employers in construction, demolition, and deconstruction to implement specific procedures to protect workers from exposure to potentially harmful quantities of airborne lead dust. Depending upon the level of exposure, workers may be required to wear respirators and even protective clothing.

The EPA has a separate set of standards regulating the management and disposal of lead-based paint debris. These classify lead-based paint debris as a hazardous material to be disposed of in a hazardous waste landfill permitted under the Resource Conservation and Recovery Act. However, the EPA is currently proposing to suspend this requirement and allow lead-based paint debris to be disposed of in traditional C&D landfills, based on an agency analysis published as a fact sheet in 1998 that found disposal in C&D landfills to be safe and less costly than disposal in other types of landfills.

Other than reports on the health effects of removing asbestos, there are virtually no published studies reporting on the health effects of actual demolition or deconstruction operations in the United States. eLCOSH, the Electronic Library of Construction Occupational Safety and Health, posts one report published in 1994 by the Center to Protect Workers' Rights, the research arm of the Building and Construction Trades Department of the AFL–CIO. *Health Hazards to Construction Workers During the Demolition of Two Tenement Buildings* reports on health assessments—including blood lead screening and personal monitoring of airborne lead dust and asbestos—as well as an onsite assessment of work practices and hygiene. Unfortunately, low participation among the workers (only two participated in the blood screening) rendered the personal monitoring results of questionable significance. Airborne monitoring revealed high lead exposures from certain activities (burning of

materials coated in lead-based paint) and significant levels of respirable dust, though the latter fell below OSHA standards for the eight-hour time-weighted average. Most troubling to investigators was that basic dust control procedures (such as wetting of materials) were not practiced, nor were workers provided with respirators.

In February 2003, the CMRA and the U.S. Army Corps of Engineers conducted a yet-unpublished joint study on the potential for recycling concrete covered with lead-based paint. Monitoring the crushing of concrete from demolished housing at Fort Ord in Monterey, California, researchers determined that the concentration of lead in the finished product was below EPA toxicity limits, making it suitable for recycling as aggregate.

DeConstruction Services has developed an extensive safety program for all its workers to minimize the risk of injury or disease. Potential hires are specially interviewed and given a health evaluation to determine if they are physically capable of doing the work. "Every day, our workers move at least twelve hundred pounds of material," McVay says. "We put a pedometer on one crew member and found that he walked six miles in one day going back and forth to a drop-off container. We want to be sure that anyone we hire will not come back in three weeks and say, 'This job is hurting me.'"

DeConstruction Services requires workers to wear half-mask high-efficiency particle air (HEPA) filters on the job. If there is any indication that workers might have trouble doing their work wearing the somewhat breathing-restrictive mask (for example, if they smoke), the company requires them to have their breathing capacity evaluated at the time of hire. Workers also have blood drawn to establish their baseline lead levels.

After three years of monitoring, DeConstruction Services has actually seen its workers' blood lead levels drop. "Most of our workers have been in the construction industry for years and never wore respirators," McVay says. "Wearing them has actually improved their health."

McVay says he has sent out copies of the company's safety procedures to many deconstruction start-up companies at their request, and he believes that quite a few of them are following these procedures.

Deconstructing for a Better Environment

From an environmental perspective, deconstruction and the attendant reuse and recycling of materials offer certain advantages over demolition. C&D wastes make up a large percentage of the total waste headed to landfills—approximately 33% of nonindustrial wastes on a national average, according to the EPA. While there are no figures on the amount of C&D wastes being diverted by deconstruction, any material that can be recycled or reused will help extend the life of existing landfills.

Deconstruction and subsequent reuse of materials also benefits the environment by reducing the demand for raw materials such as wood and iron ore. Savings include not just virgin material itself, but also the energy that would have been consumed and the pollution created in extracting, transporting, and manufacturing these materials into finished products. Recyclers usually assert that reuse of building materials generally saves about 95% of embodied energy that would otherwise be wasted.

The City of Philadelphia recently funded the ILSR to examine the benefits of deconstructing some 19,000 inner-city buildings. The institute determined that a total of 17.5 million board feet of wood could be reclaimed from the buildings over five years. The ILSR asserts that reuse of wood, combined with source reduction and use of alternative fibers for paper, could dramatically reduce the need for harvesting of timber and its attendent environmental problems.

Because federal regulations require that hazardous wastes—including C&D waste such as asbestos and wood covered with lead-based paint—be disposed of in a carefully prescribed manner, deconstruction provides no advantage over demolition with regard to these materials. In some cases, deconstruction firms are able to reuse items coated with lead paint if they are in good condition. However, the additional cost to remove the lead is high, and only worth doing for valuable architectural pieces, according to Brad Guy, associate director of the Powell Center for Construction and Environment at the Rinker School of Building Construction.

Proponents of deconstruction uniformly agree that the chief obstacle to the practice is economics. Deconstruction is labor-intensive and time-consuming, whereas the cost of landfilling is—for now—still relatively cheap. "Demolition contractors are in business to make a profit, and if it's cheaper to knock stuff down and haul it to a landfill than to recycle it in some fashion, that is

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what they'll do," says Kurt Buss, executive director of the nonprofit Used Building Materials Association.

Turley points out that demolition contractors have always done a certain amount of recycling of building materials and would gladly do more as markets dictate. "It's not as if demolition contractors have anything against recycling or reuse," Turley says. "It's largely a question of economics."

Time and timing is another factor working against deconstruction. Deconstruction is more time-consuming than demolition. According to McVay, demolition and removal of a typical 1950s ranch home would take two workers about 3–4 days, whereas deconstruction would require six workers taking up to 15 days. And if a new building is slated to go up on a site, demolition contractors may not have the liberty of deconstruction even if they can afford it. "If The Home Depot is putting up a new building, they aren't going to give you an extra two weeks to take an old building down by hand, even if you can save them ten thousand dollars," Griffin says. Such investors may be borrowing millions of dollars to put up one of these buildings, and the extra interest they accrue wouldn't be worth the savings from reuse of materials.

Local building codes and the prejudices of local inspectors against reused materials may also discourage the reuse of certain building materials. Codes are based in part upon the judgment of building code officials, who may be concerned, fairly or not, about the strength of used materials. "We sometimes have problems getting permission to reuse structural steel," Griffin says. "Some building codes will not allow it to be used in a new building. Some engineers won't put their stamp on used beams. The same is true of wood." Turley says the U.S. Forest Products Laboratory in Madison, Wisconsin, is currently developing a grading system for used wood.

Everything old is new again. Fixtures, windows, and other materials in good condition can be sold or donated to organizations that build homes for families in need.

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At the same time, incentives to promote reuse of building materials are on the rise. Buss points to "green building" programs such as those sponsored by the cities of Boulder, Colorado, and Austin, Texas. The Boulder program requires building contractors to earn a certain number of points to obtain permits for new construction or renovation. Points may be awarded for materials reuse and recycling. Austin's program, which started in 1991, awards residential and commercial buildings up to five stars, reflecting the number of points earned for sustainable use of energy, water, and materials, as well as health- and community-enhancing features such as having a front porch. Builders can earn points for reusing materials including concrete, cabinets, doors, interior trim, and flooring. The program is voluntary, and the stars are being used as a marketing tool.

In San Jose, California, the city requires a deposit from building contractors before they can proceed with construction or renovation projects. The deposit varies by the type and size of the project; residential new construction requires a deposit of 20¢ per square foot. To get a refund, builders must prove they have diverted at least half of their waste from the landfill, usually by hauling debris to certified salvage yards and scrap metal recyclers.

Other cities are promoting recycling and reuse by placing conditions on local land use permits. In Los Angeles, approval of the Playa Vista development of 5.1 million square feet of commercial space and 13,000 residential units included special conditions for recycling of C&D debris. According to the California Integrated Waste Management Board, more than 84,000 tons of C&D material was recycled in this project.

The U.S. Green Building Council sponsors the LEED (Leadership in Energy and Environmental Design) Green Building Rating System, a voluntary national rating system for developing high-performance sustainable buildings. Points are awarded for practices such as using salvaged and refurbished building materials in new construction. Federal agencies including the Department of Defense, the Department of Energy, the EPA, and the National Park Service are participating in the LEED program.

Despite these advances, deconstruction may never become common practice unless buildings are designed from the start with materials recovery and reuse in mind. Modern construction methods, which are focused on permanent fixing of building components, allow for little else but destructive demolition. In May 2003, the Powell Center for Construction and Environment organized the 11th Rinker International Conference on Deconstruction and Materials Reuse, where numerous ideas were presented on how to design for deconstruction. The challenge remains how to incorporate these ideas into the marketplace.

"Builders in the United States are not adopting these methods to any significant degree," Kibert says. "Our hope is that as disposal costs continue to rise and pressure mounts to adopt green building methods, industry will start building with deconstruction in mind."

John S. Manuel