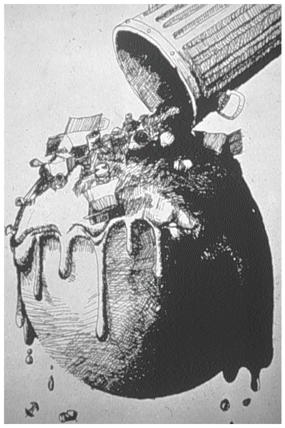
A. Waste Prevention

> Materials are just that: they're very tactile, very visual, and they smell and even taste. They're the skin and bones of a building, and they should be used with a certain reverence, for where they came from, for what they've done, and for what you are asking them to do.
>
> —John Ringel
> Jersey Devil Design / Build



Waste takes the form of spent or useless materials generated from households and businesses, construction and demolition processes, and manufacturing and agricultural industries. These materials are loosely categorized as municipal solid waste, construction and demolition (C&D) debris, and industrial or agricultural by-products. This learning unit covers the fundamentals of waste prevention at the building, community, and regional scales by discussing the concepts of resource efficiency, materials recovery, and industrial ecology.

waste *v.*

1. to use, consume, spend, or expend thoughtlessly or carelessly
2. to cause to lose energy, strength, or vigor; exhaust, tire, or enfeeble
3. to fail to take advantage of or use for profit
4. to destroy completely

waste *n.*

1. a place, region, or land that is uninhabited or uncultivated
2. a devasted or destroyed region, town, or building; a ruin
3. a useless or worthless by-product, as from a manufacturing process
4. garbage; trash

A.1.1 Discussion: Resource Efficiency

Resource efficiency is the proactive process of preventing spent materials from entering air, land, or water. With this "upstream" (instead of "end-of-pipe") approach, we can reduce or eliminate waste at the source and reduce the demand on natural or virgin resources. By designing toxic and hazardous waste out of the manufacturing process, compliance and paperwork costs associated with environmental regulations (such as cradle-to-grave manifests and disposal fees) are also eliminated. Waste prevention and source reduction also improve resource efficiency, allowing businesses to be more competitive with enhanced public image.

In the United States, the legislative road to waste prevention began in 1969 when President Richard Nixon created the Environmental Protection Agency (EPA). Using penalties and permits ("command and control" methods), the EPA regulated discharge and emission standards and enforced the Clean Air Act and Clean Water Act. These statutes were significant because they set ambient standards that would provide the public with a fishable, swimmable, breathable environment. At the time, conditions were such that heavyhanded measures were necessary: due to gross inefficiencies in manufacturing industries, pollution was rampant.

Pollution control emerged as the "end-of-pipe" solution, where waste was handled as a by-product that required treatment prior to disposal. However, this approach succeeded only in concentrating materials as hazardous solid waste. The EPA became ensnared by its increasingly fruitless efforts to deal with symptoms rather than origins.[1] While emissions were prevented from being directly discharged into the air or water, it soon became evident that the resulting concentrated solid wastes posed a threat to soil and ground water quality, as exemplified by Love Canal. In 1978, homemaker Lois Gibbs and her neighbors confronted the state and federal governments with health problems. They attributed them to the fact that their Niagara, New York, neighborhood was built above the Love Canal toxic waste dump produced by Hooker Chemical and the U.S. Army.[2] The ensuing controversy exploded into national debate and marked the beginning of an ideological shift from "downstream" pollution control to "upstream" pollution prevention.

For a complete "cradle-to-grave" description of the life cycle of materials, see **D.1.1 Discussion: Life Cycle Analysis.**

Love Canal became a torch that lit the path for a new breed of environmental legislation. The Federal Resource Conservation and Recovery Act (RCRA) is the major federal statute that addresses hazardous and solid wastes.[3] RCRA's emphasis is to respond to problems associated with solid waste, and it establishes a distinct hierarchy of strategies favoring source reduction, reuse, and recycling over incineration and landfill disposal. RCRA Subtitle D, which deals with non-hazardous wastes, requests that states produce solid waste management plans. As a result, some municipalities prohibit the landfill disposal of certain constituents of C&D debris (concrete rubble, wood, and gypsum wallboard are commonly banned from landfills), and support the development of recycling enterprises. Unlike incineration and landfill disposal strategies, which frequently receive property tax abatements, reuse and recycling businesses offer an increased tax base, additional jobs, and feedstocks to potential value-added industries.

Federal, state, and local government agencies have evolved over the past 30 years to pursue the goal of waste prevention, shifting their focus from pollution control mandates to voluntary strategies that promote resource efficiency. For instance, Washington State's Department of Ecology, in cooperation with the U. S. EPA, has successfully implemented a number of voluntary public-private partnerships and pilot programs offering technical assistance. In the spirit of RCRA, the Department requires individual businesses to submit a Pollution Prevention Plan. The plan's primary focus is to account for all costs associated with waste-generating processes and to identify waste prevention strategies that increase resource efficiency and decrease the company's expenses.

See **B.2.1 Discussion: Recycling Economics.**

In the construction industry, waste prevention begins upstream with the development of material-efficient building technologies that make better use of natural or virgin resources. For example, wood building materials have evolved to make use of formerly undesirable small-diameter and faster growing trees as well as the off-cuts from mills. The new generation of engineered lumber products that are manufactured using resins, heat, and pressure include I-joists, laminated lumber from veneers or strands, and finger-jointed lumber. The consistently high quality of manufactured framing material over solid-sawn lumber results in less waste at the job-site and an immediate 10–15 percent cost savings, because builders can use everything sent to them.[4] Factory-made panel systems, such as the stressed-skin foam-core and paper honeycomb-core structural panels are also inherently less wasteful due to highly efficient material-to-strength ratios. Because engineered and panelized products are manufactured according to the designer's specifications, the wastes can be "swept up" in the factory, thereby avoiding more costly recycling or disposal efforts at the job-site. In the U.S., more than 90 percent of single family homes are wood-framed.[5] Optimum Value Engineered framing techniques (known as "advanced framing" in the Pacific Northwest) reduce lumber consumption and wood waste without compromising structural integrity.

Advanced Framing Techniques

1. 24" o.c. framing modules;
2. 2-stud open corners with drywall clips or wood blocking;
3. open blocking instead of channels where partitions meet outside walls;
4. insulated box beam headers;
5. eliminating non-structural members such as headers over openings on the gable ends;
6. single top plates when vertical framing members align;
7. replacing dimensional lumber with engineered components; and
8. positioning rough openings where 4'x8' sheathing "breaks."

Source reduction by design reduces the demand on virgin resources, thereby reducing the building's impact on the environment. In addition to specifying materials that are inherently less wasteful, the architect can optimize resource efficiency by maximizing the building's use and function while minimizing its size. Strategies that simplify the building's shape, use standard material modules, reduce excess circulation space, and provide for growth and change increase material efficiency by design. At the building scale, resource-efficient construction strategies offer an introspective and upstream approach to source reduction and waste prevention, as exemplified in the following case study.

A.1.2 Case Study: ReCraft 90 (Missoula) and Model Conservation Home (Seattle)

Figure 1: ReCraft 90 House Missoula, Montana
(CRBT)

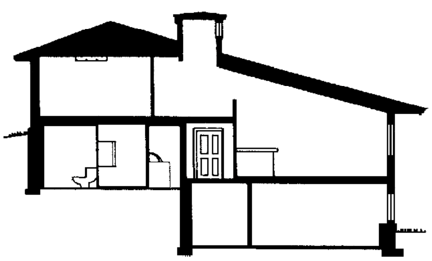


Figure 2: Section view of ReCraft 90
(CRBT)

ReCraft 90

Founded by Steve Loken, a builder concerned about the unsustainable consumption of natural resources, the Center for Resourceful Building Technology in Missoula, Montana, is a non-profit organization dedicated to promoting resource efficiency. Its annual reference, *Guide to Resource Efficient Building Elements*, lists manufacturers of resource-efficient materials and other information including job-site recycling, salvaged materials, and indigenous resources.

One of the goals of the ReCraft 90 project is to demonstrate that resource-efficient building can be made to look like the familiar single-family house. By using unconventional materials in a conventional way, resource efficiency might catch on among mainstream builders who, according to Loken "are a conservative bunch who tend to favor old reliables."

In the house's foundation, fly ash (a cementitious byproduct of coal-burning power plants) displaces 20% of the cement and increases strength; the higher strength allows the use of 6-inch foundation walls rather than the standard 8 inches. Most of the exterior walls are made of structural foam-core panels. The interior framing uses advanced framing techniques and finger-jointed lumber, which allows mills to combine the off-cut lumber that would ordinarily be burned into standard high-quality lengths. Wood I-joists and laminated veneer beams are used for floor joists, roof rafters, and headers. The exterior finish materials include fiber cement composite lap siding, roofing slates, and fascia boards from industrial wood waste.

Most of the wood used for trim is remilled from salvaged clear-grain lumber, and the hardwood flooring in the living and dining areas is tongue-and-groove maple removed from a local church. The tiles for the bathrooms, hallways, and entryway are manufactured from spent fluorescent light tubes, recycled windshield glass, and mining wastes. The carpet padding incorporates recycled rope and burlap or shredded tire rubber, and the carpet fibers utilize recycled polyethylene beverage containers. Built-in bookshelves are made from lightweight Spaceboard (also called Gridcore). This honeycombed panel is made of cellulose fibers that have been recycled up to seven times. Although continuous recycling reduces the paper's structural integrity by shortening its fibers, the hollow-celled core geometry results in a high-strength "board."

Model Conservation Home

Founded in 1970, Environmental Works Community Design Center in Seattle, Washington, is a non-profit architecture firm committed to using resources efficiently and improving the physical condition of the area's neediest communities. Its concern for both the environment and the community has led to the development of the Sustainable Building Specifier: a computer database of materials that can be compared by energy use, recycled-content and recyclability, maintenance and durability and indoor air quality.

Figure 3: Model Conservation Home (MCH) Seattle, Washington (Jonathan Reich)

The Model Conservation Home, designed by Brian Sweeney of Environmental Works, is intended to demonstrate resource-efficient building materials and design strategies. Like the ReCraft 90 project, it uses many building components that consume as few natural resources as possible; however, the design of this house demonstrates several space efficient concepts. The compact, 1,620 ft^2 plan gives the illusion of greater space with open corridors, vaulted ceilings, and connections to the outside through well-integrated natural lighting and continuous sight lines. The basic form is inspired by a traditional farmhouse that accommodates future add-ons due to its simple geometry. The house is also designed to adapt to a variety of living situations. The main floor is handicap-accessible, and a bedroom with a separate entrance allows the possibility of a mother-in-law unit or home office.

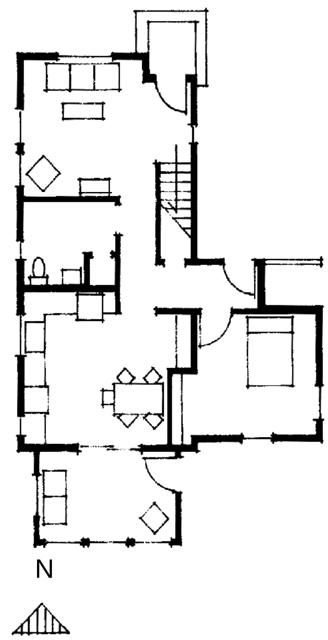


Figure 4: ground floor plan of MCH

A.1.3 Exercise: Resource-Efficient Building Materials

Objective

To investigate resource-efficient strategies in the manufacture of building materials, students will travel "upstream" in the production of conventional or cutting-edge building materials and present a "work-up" that summarizes their investigation.

Preparation

The instructor should make a list of possible work-up candidates based on those that are manufactured locally. Site visits to mills or factories that process materials for construction is essential, and preliminary contacts with facility managers will ensure a more meaningful investigation.

Execution

The "work-up" may include the following:

1. Describe the facility's prior accomplishments in areas of source reduction, recycling, and treatment of wastes.

2. Describe how employees are involved in achieving greater material efficiency.

3. Are all costs of producing wastes accounted for? Categories include direct (conventional costs of waste disposal), hidden (administrative "paperwork" associated with waste management), contingent (potential costs of fines, remediation, and legal costs as a result of improper handling of wastes), and less-tangible (public image and employee morale).

4. Describe the manufacturing process including inputs and outputs (use a flow diagram).

5. Identify all wastes (by-products of manufacturing) and approximate quantities.

6. What opportunities can increase resource efficiency and prevent waste? What might inhibit their implementation?

A.2.1 Discussion: Materials Recovery

The secret of materials recovery lies within the phrase "Verwertung des Wertlosen," or "finding uses for the useless." During WWII, the German economy flourished because of efficiencies in collecting, sorting, and recycling materials. Facing a natural resource crisis 50 years before any other developed country in 1939, they quickly became the most energy- and resource-efficient sovereign state in the world.[6] In addition to the metal, oil, and paper that was conventionally reclaimed, other materials were recovered for further use, such as coffee grounds for oils and waxes and rags, for rewoven textiles. The German system relied on manual labor provided by a network of volunteer organizations. Although "national duty" factored heavily in the success of the material-recovery network, it serves as an impressive example of how scarcity prompted ingenious solutions to recovering materials for recycling. Currently, we are beginning to experience the evolutionary equivalent of the war-induced pressures that forced Germany to develop their recycling economy. Half a century later, Germany remains committed to materials recovery, and is leading the rest of the world in waste-related innovation.

See ecological tax reform by Germany and Sweden within **B.2.1 Discussion: Recycling Economics.**

The Environmental Protection Encouragement Agency in Hamburg, Germany, has proposed an "intelligent product system" to address materials recovery. This visionary concept circumvents the idea of "waste" altogether by dividing all products into three categories: (1) consumables, (2) products of service, and (3) unsaleables. Almost everything produced will fall under the first two, while unsaleables (toxic and radioactive materials) will eventually be phased out of production completely. Consumables, such as packaging, will biodegrade after their useful life is over. Products that provide a service, such as televisions or carpets, will be owned by and eventually returned to the manufacturer. The "license" to use and operate the product would be transferable so you could sell it or give it away, but the product itself could not be disposed of or recycled by the user.[7] This approach to materials recovery requires the manufacturer to address the entire life cycle of a product including issues such as a product's embodied energy, durability, design for disassembly or reuse, and recyclability.

For more information on life cycle design issues, see **D.1.1 Discussion: Life Cycle Analysis.**

See also **C.3.1 Discussion: Reusing Salvaged Materials** and **C.3.2 Case Study: Urban Ore, Inc.**

While the idea of an "intelligent product system" spurs our imagination, sophisticated materials recovery efforts exist in the present. Daniel Knapp of Urban Ore, Inc., reminds us that "waste isn't waste until its wasted." Materials recovery redirects and reprocesses our wastes through an augmented materials recycling and reuse economy. As the costs of waste management and natural resource extraction rise, the development of reuse businesses and recycling networks will accelerate. If reuse businesses and recycling facilities are to compete with suppliers of virgin materials, they must sort and clean the materials to exacting specifications. Depending on the regional demands of various products, materials conform to an assortment of requirements determined by the end-use. However, in the event that some materials are not recyclable due to the lack of sufficient markets today, perhaps we should at least separate materials within our landfills to accommodate their future recovery? Kevin Lynch suggests that in the future it is likely we will be mining our landfills for "raw" materials like paper, plastics, metals, and glass.

Materials recovery can take place at either a centralized municipal or private facility or through a complementary network of new and existing for-profit and non-profit enterprises. These independent businesses try to develop the full potential of various materials by working closely with haulers and end-users to maintain the highest possible quality for any given process. Handling materials in such a way that they retain their highest possible value is critical to the success of recovery efforts.

Figure 5: Clean Dozen™ commodities developed by Urban Ore.

Daniel Knapp has identified 12 master material categories called the Clean Dozen. Contrary to landfills and transfer stations that do not distinguish most materials, the Clean Dozen categories represent all the components of the discard supply, and serve as an orderly means of characterizing recoverable materials. Each of the categories can be further subdivided according to the degree of cleaning and refinement; however, the goal is to match the material to the needs of a particular process or product. The only category that overlaps significantly is reusable goods. Following the principle of highest and best use, reusing an item usually achieves the highest economic return.

A.2.2 Case Study
Serial Materials Recovery (Berkeley)

The City of Berkeley, California, offers an excellent example of a working network of materials recovery operations. This decentralized system combines public facilities with both non-profit and for-profit enterprises, rather than burdening the municipality with the role of inefficiently handling all materials.

The recycling phenomenon began in the late 1970s in response to a proposed incinerator to be built in West Berkeley. Activism and protest accompanied a long political struggle, after which a recycling center and transfer station were established. In the wake of this shift in public policy, community and private reuse and recycling enterprises developed, creating jobs, adding to the tax base and giving haulers a convenient, economical, and resource-efficient way to dispose of their unwanted materials. The resulting configuration of businesses and programs can be thought of as a "serial materials recovery network": haulers unload at a series of independent but complimentary locations.[8]

Operation	Materials
City of Berkeley	grass clippings; leaves; brush; paper, steel, and glass containers, motor oil and oil filters; ferrous and non-ferrous metals
Ecology Center	steel, glass, and aluminum containers; foil; newspaper, mixed paper, cardboard, and magazines
Community Conservation Centers	steel, glass, and aluminum containers; foil; newspaper, cardboard, magazines, and mixed and white ledger paper; and PET (#1) plastic
American Soil Products	grass clippings, leaves, brush, and other bulk agricultural materials
Ohmega Salvage, Ohmega Too	mid- to high-end building materials, house parts, and fixtures
Urban Ore General Store and Building Materials Exchange	low- to mid-range building materials, household and office furniture, appliances, antiques and collectibles; also recycles ceramics, metals, wood, and textiles

Figure 6: Berkeley Serial Materials Recovery Network
(Urban Ore, Inc.)

Source separation and load stratification enable haulers to deliver clean feedstock material back into the economy while saving money. Materials recovery operations charge either lower tipping fees than the landfill or no fee whatsoever. Some recycling operations, such as scrap metal dealers, pay cash. Investigating the available recovery enterprises and educating the public and municipal solid waste agencies to both the existing facilities and "recycling voids" will help sustain and expand the community serial materials recovery network.

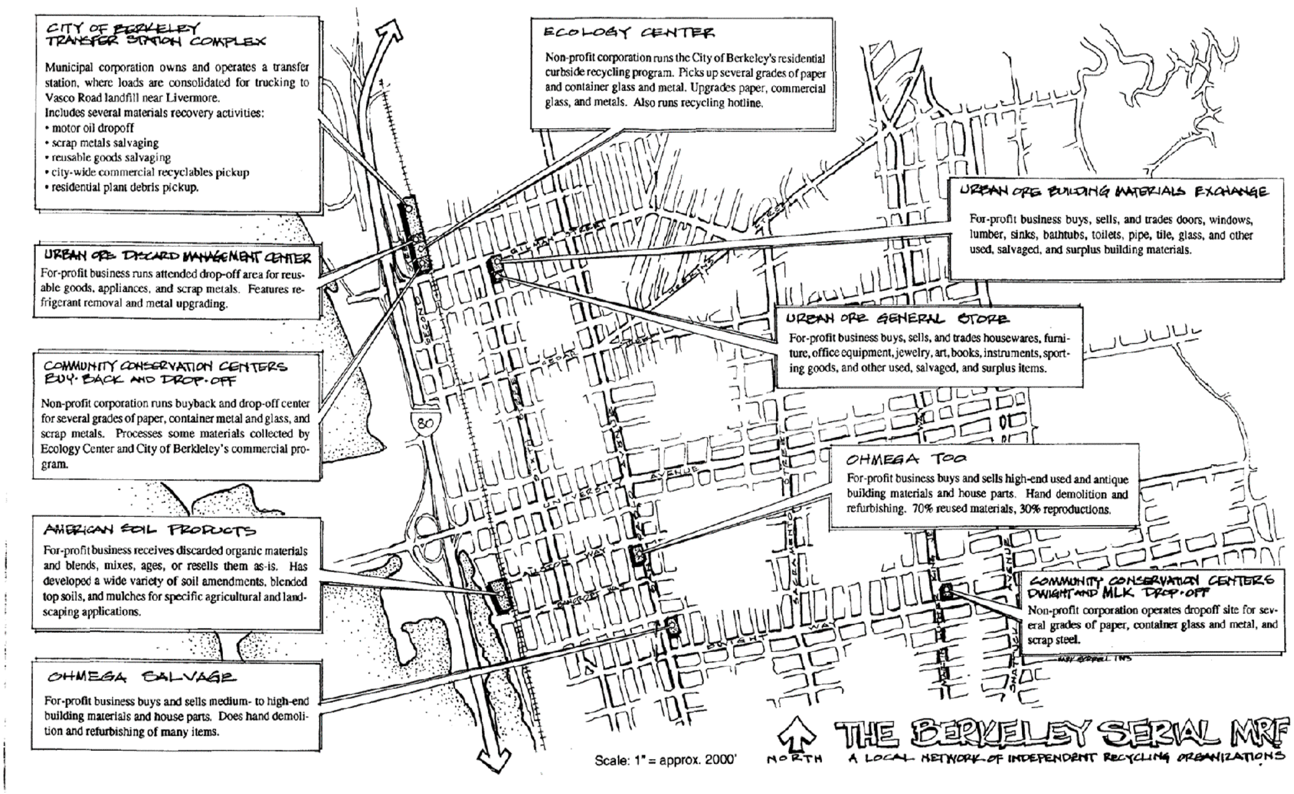


Figure 7: The Berkeley Serial Materials Recovery Facility, a local network of independent recycling organizations
(Mark Gorrell, Architect)

A.2.3 Exercise: Mapping Materials Recovery

Objective

Students investigate materials recovery in their community by producing a well-crafted, well-researched booklet or newsletter that outlines existing facilities and identifies "open" material streams (underutilized materials and potential feedstocks given the availability of a marketable end-use).

Preparation

Choose a format that is appropriate to how the information will be presented. (For example, in Latah County, Idaho, the Moscow Recycling Center produces a quarterly newsletter called *Talkin' Trash* and delivers it to all residents.) Talk to the local newspaper. Can the publication be displayed as a poster? Collaborate with your municipal solid waste agency to ensure the work will have some impact beyond the boundaries of the university.

Execution

1. Seek out reuse, recycling, and disposal operations in your area using Urban Ore's Clean Dozen categories, your local solid waste managers, and the Yellow Pages as a guide.

2. Interview the managers of recovery facilities in person, by phone, or through a written questionnaire; follow-up with phone calls. Ask permission to include them in the booklet.

3. Find out what materials are accepted and their quality requirements. Do recovery facilities pay for the material, or is there a drop-off charge? Will they pick up materials? What are some of their concerns, problems, barriers to expansion? What is their history? Are they a municipal facility, private for-profit enterprise, or non-profit organization? What is their mission? How many employees do they maintain?

4. Compile this material in a booklet with descriptive text and images designed to educate and enlighten the public about their community's serial materials recovery network. The graphic manipulation of a spatial map as a "screen" to transfer the information into an easily digestible form has great potential.

A.3.1 Discussion: Industrial Ecology

> ...It may be said that the one-way flow of energy and the circulation of materials are the two great principals or "laws" of general ecology, since these laws apply equally to all environments and all organisms including man.
>
> —Eugene Odum

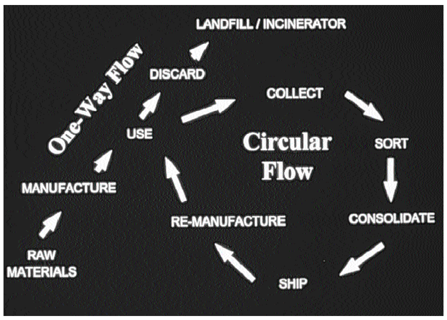


Figure 8: Circular vs. linear flows of materials.

An ecological system is a "web of food and mineral flows that involves major pathways of populations including animals, plants, and microorganisms; each specialized to live in a different way."[9] An ecological food web describes which kinds of organisms in a community eat which other kinds.[10] Individual organisms are part of an interacting community affecting each others' use of the shared resources. If one population dominates all others, usually as a result of an overabundance of a given resource, the balance is disrupted. Our incomplete understanding of natural systems has led to air and water pollution, waste disposal problems, ecological degradation, and the loss of biodiversity. We have reached the point where only the hardiest of natural systems can endure humans' relentless denial of ecological carrying capacities.

Linear industrialism, as it has evolved since the late 18th century, is a one-way, "make-take-waste" throughput system that seeks to use more resources with less people. Its success is measured in terms of productivity and profit.

This impressive system of resource exploitation, manufacturing, and distribution produced the Los Angeles Aqueduct and the Hoover Dam as well as factory farms and fast food; however, like all one-way systems, it eventually disrupts and destroys the ecological systems and natural resources upon which it depends. According to Paul Hawken, "We are all doing this precisely at a time when we have less and less stuff, and more and more people."[11] The underlying assumption to linear industrialism is inherently flawed. It presumes the availability of an unlimited supply of resources and environmental "sinks" in the form of air, water, and soil.

What is the next step? What underlying assumptions will support a new way of producing goods and servicex? What new technologies will aid our search for a non-destructive industrial system sensitive to ecological life-support systems?

Martin Pawley believes that

> the solution to world problems such as ecological imbalance, pollution, homelessness, hunger, and poverty does not lie in the direction of some counter-dynamic opposing that which already exists in Western society, but in the deliberate acceleration of conditions that already exist within it. . . . A number of isolated forces need only to converge in order to bring this about, for all we are discussing is the elimination of a linear technology by a multidimensional technology.[12]

This new paradigm describes the essence of industrial ecology.

According to Hardin Tibbs,

> the aim of industrial ecology is to interpret and adapt an understanding of the natural system and apply it to the design of a man-made system, in order to achieve a pattern of industrialization that is not only more efficient, but which is intrinsically adjusted to the tolerances and characteristics of the natural system.

By treating industry as an *interacting* web of inputs, processes, and wastes rather than a collection of *individual and independent* ones, we mimic the natural ecosystem in its overall operation. Environmental "illness" and its effect on the economy has become the driving force for imaginative, integrative, and symbiotic technological solutions.

The definition of boundaries is critical. Industrial ecosystems can be defined in four ways:

1) by material flow (e.g. wood);

2) by a specific product (e.g. engineered wood I-beams);

3) by industry sector (e.g. forest products manufacturing); or

4) by geographical area of human activity (e.g. timber-producing area).

Depending on which boundary is selected, the industrial ecosystem will differ. In reality, an industrial ecosystem of any given product will link its own energy, materials, suppliers, manufacturers, haulers, retailers, and consumers with those of other products, industries, and regions.

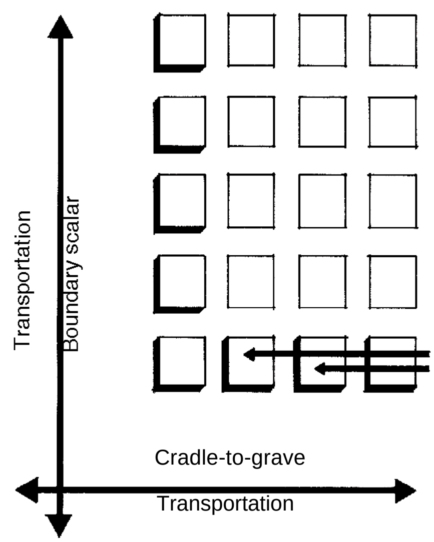


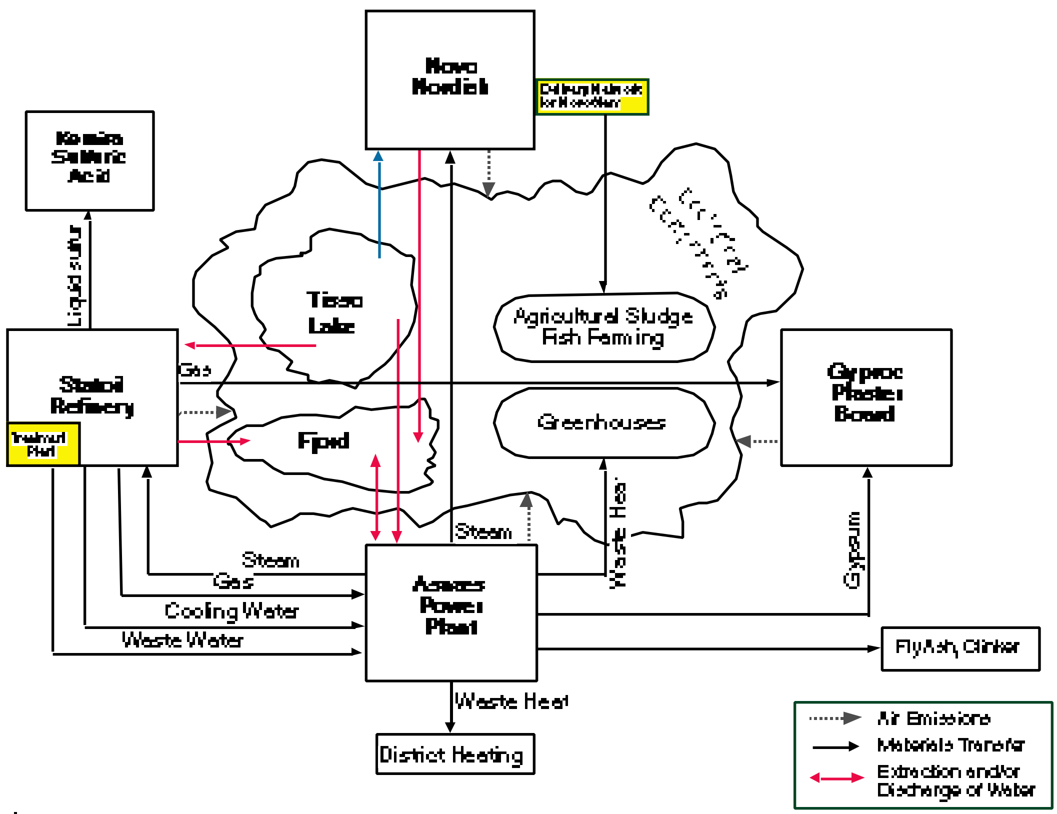
Figure 9: Life cycle analysis framework showing the horizontal "cradle-to-grave" process of materials and the vertical boundaryscaler. (For more information, see D.1.1 Discussion: Life Cycle Analysis.)

This highly complicated scenario requires a method of simplification in order to be meaningful for design purposes. Life cycle analysis is the process whereby the environmental impacts of materials are considered "from cradle-to-grave." A life cycle assessment matrix describes the entire production sequence of a material including sourcing or extraction, processing and manufacturing, use, and disposal. The "capturing" of the entire production sequence including reuse and recycling within a region's boundaries minimizes the amount of transportation energy; what Pliny Fisk refers to as "vertical integration." Life cycle analysis implements the concept of industrial ecology and provides a basic framework and set of issues upon which design decisions can be made.

A.3.2 Case Study:
Industrial Symbiosis (Kalundborg, Denmark)

While there are many examples of industries that "sweep up" and reincorporate their own wastes, there are few that promote byproduct exchanges between companies. While both approaches espouse closed-loop recycling, pulling together a network of private and public organizations can radically reduce both front-end resource use and back-end waste. A host of complementary industries that are networked together according to their inputs and outputs can pool and share by-products. Collaborating to serve reciprocal needs can also result in self-sustaining partnerships that expand local job, incomes, and tax revenues.

The most famous industrial ecosystem for resource sharing is in Kalundborg, Denmark. It networks a power plant, an oil



Notes:
(1) This figure is not drawn to scale, nor is it an accurate geographic depiction.
(2) Unused residuals resulting from all activities in the industrial ecopark are eventually released into the biosphere.

Figure 10: industrial ecosystem in Kalundborg, Denmark
(Hardin Tibbs, Novo Nordisk)

refinery, a sheetrock factory, a road-builder, concrete producers, a pharmaceutical company, a chemical company, a fish farm, some greenhouses, and local agriculture. The material and energy exchanges have resulted in a net return of more than $60 million in cost savings and new revenues.[13] The coordinated linkages create profitable wastes and a cheap source of supply.

In the 1980s, the Asnæs coal-fired power plant started recycling its steam instead of condensing it and returning the water to the fjord. Now Asnæs sends the steam to the Statoil refinery and the Novo Nordisk pharmaceutical company. The waste steam also supplies heat to a fish farm, greenhouses, and nearby residents, allowing 3,500 oil-burning furnaces to be turned off. The sludge generated by both the fish farm and Novo Nordisk's fermentation process go to local farmers as fertilizer. The Statoil refinery produces waste gas containing large amounts of sulfur. After installing a process to remove the sulfur, the gas is sold to the sheetrock factory and the power plant, saving 30,000 tons of coal per year. The separated sulfur is sold to Kemira, a chemical company. Calcium sulfate is produced in the smokestacks of the power plant, which is sold to Gyproc as a substitute for mined gypsum. Meanwhile the fly ash generated by coal-burning is used in road construction and concrete production.

The amazing thing about this whole process is that it happened without any governmental regulation as the primary motive. Hardin Tibbs writes

> It is significant that none of the examples of cooperation at Kalundborg was specifically required by regulation, and that each exchange or trade is negotiated independently. The earliest deals were purely economic, but more recent initiatives have been made for largely environmental reasons and it has been found that these can be made to pay, too.[14]

Unfortunately, practical planning and design tools needed to lay out a complex industrial ecosystem do not exist. However, as part of a Regional Industrial Symbiosis Plan in Brownsville, Texas, Bechtel Corporation has been developing prototype planning tools to match byproduct, waste, and recycle streams to manufacturing feedstocks. According to David Cobb of Bechtel Research and Development in San Francisco,

> We have assembled a large process industry database, the search-and-match methods to sort through a lot of data, and methods to prepare regional recycling webs.

On-going investigation will result in a detailed cost analysis as well as process modifications necessary to increase the efficiency of the industrial ecosystem and reduce production of unusable wastes. The Brownsville project provides the opportunity to apply the prototype tools to a real problem. In addition to the economic exchange of material streams, Bechtel predicts reduced costs of feedstocks and their transportation, reduced waste treatment and disposal costs, and reduced environmental degradation.

A.3.3 Exercise: Regional Material Streams

Objective

To investigate potential regional building materials and examples of symbiotic waste exchange. The development of a “soft palette” of reused, recycled-content, and byproduct-based building materials that networks regional material flows effectively bridges the concepts of resource efficiency, materials recovery, and industrial ecology. (The term “soft” refers to the often ephemeral nature of the sources—they may not consistently available—and the possibility that the materials either are not currently manufactured in the area or remain “experimental.”)

Preparation

The previous discussions and exercises within this learning unit are intended to guide students through progressively more comprehensive issues of waste prevention. To be most meaningful for the students, this exercise is best suited as a preliminary investigation toward a design problem or building project. It is recommended that students become familiar with the life cycle issues presented in D.1.1 Discussion: Life Cycle Analysis.

Execution

Identify the major industries, manufacturers, reuse businesses, and recycling operations in your area. The physical boundary used for this exercise shall be determined according to the extent of industrialization and urbanization. It may help to focus on a particular industrial section of a city, whereas an entire region might be more appropriate in a rural area. In either case, diagram the raw material flows (inputs) and byproducts or wastes (outputs) emphasizing their relevance to the building industry. Complement the findings with product research through directories (see Appendix III: Product Directories and Sourcebooks) and computer or Internet searches. Present a list of a regionally significant resources that can be used to inform the design / build process.

A.4.1 Endnotes for Waste Prevention

[1] Barry Commoner, *Making Peace with the Planet*. (New York: Pantheon, 1990), 181.

[2] Jennifer Seymour Whitaker. *Salvaging the Land of Plenty: Garbage and the American Dream*. (New York: William Morrow, 1994), 35.

[3] Richard A. Denison and John Ruston, editors, *Recycling and Incineration: Evaluating the Choices* (Washington: Island Press, 1990), 258.

[4] Fred Albert, "Clearly Green," *The Seattle Times: Northwest Living* (November 6, 1994), 20.

[5] Tracy Mumma, et.al., *Guide to Resource-Efficient Building Elements*. 5th ed. (Missoula: Center for Resourceful Building Technology, 1995), 97.

[6] Martin Pawley, *Building for Tomorrow* (San Francisco: Sierra Club Books, 1982), 61.

[7] Paul Hawken, *The Ecology of Commerce* (New York: HarperCollins, 1993), 68.

[8] David Stern and Daniel Knapp, *Reuse, Recycling, Refuse and the Local Economy: A Case Study of the Berkeley Serial MRF* (documented by Urban Ore, Inc., and The Center for Neighborhood Technology: October, 1993), 1.

[9] Eugene Odum, *Ecology*. (New York: Holt, Rinehart and Winston, 1963), 38.

[10] R.J. Putman and S.D. Wratten, *Principles of Ecology* (Berkeley: University of California Press, 1984), 181.

[11] Sarah van Gelder, "The Next Reformation: An Interview with Paul Hawken," *In Context*. no. 41 (Summer 1995): 19.

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