Curbing our appetite for wood products | Market obstacles and opportunities for alternative building materials

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Curbing Our Appetite for Wood Products:  
Market Obstacles and Opportunities for Alternative Building Materials

By
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B.A. Colorado College, 1991
Presented in partial fulfillment of the requirements
for the degree of
Master of Science
The University of Montana
2001

Approved by:

[Signature]
Chairperson
Dean, Graduate School

2-11-02
Date
Summary: Purpose and Methods of Research

The following research was requested by the Northwest Ecosystem Alliance (NWEA), a non-profit, environmental protection organization located in Bellingham, Washington. NWEA works in part on trans-boundary environmental issues affecting Canada and the United States. As part of this work, the organization is interested in obtaining information on alternative, non-wood, residential building materials as a means to decrease U.S. consumer dependence on Canadian softwood lumber, specifically endangered old growth forests. Currently, the United States imports 80 percent of all Canadian softwood lumber exports, more than any other country in the world. Approximately 90 percent of this wood comes from old growth forests, in a country lacking sufficient forest protection and commercial logging regulations. (Mastel, 2000)

As discussed in Chapter 1, this professional paper focuses on alternative building materials specifically for the residential construction market for several reasons. First, at least 37 percent of all U.S. consumed softwood lumber is used specifically in residential applications, generating 25 tons of waste per average, new single-family home. (Johnston, 2000) Second, a 1999 Harvard study confirmed that housing starts for the next decade would continue the trend of nearly 1.5 million average annual starts. Third, it is universally agreed that residential construction is one of the primary market segments for softwood lumber producers. Wall, roof and floor framing use more lumber than any other end-use application. Finally, the U.S. Wood Products Promotion Council estimates that residential construction consumes 15.6 billion board feet of softwood lumber annually. (Eastin et al, 2000)

Initially, NWEA requested research specifically on steel construction as an alternative to wood. The organization wanted to know how steel compared to wood from both an environmental and economic standpoint. In addition, NWEA was interested in the market barriers, such as international trade snarex, prohibiting steel from competing with wood. I personally was interested in this study because my focus as a graduate student centered on international trade and related environmental issues. Thus, I took on this project intending to uncover a myriad of trade related barriers prohibiting an
otherwise environmentally superior, non-wood building material from competing with "environmentally destructive" wood.

Critical lessons were immediately learned and are examined in Chapters 1 and 2. First, steel is not the perfect, "green" wood substitute the U.S. steel industry claims it to be. Second, all building materials are accompanied by unique benefits, as well as impacts. Third, curbing consumer dependence on wood lies in a combination of alternatives—not in any single material. Fourth, the barriers facing alternative building materials are many, but the key problems are not found in international trade. Rather, the most important issues to resolve are domestic, as are the solutions. Finally, the claim made by some environmental organizations, such as the Rainforest Action Network (RAN), that environmentally preferable, non-wood building materials readily exist in the marketplace, is not accurate. In fact, as I began my research, I attempted to contact many of the alternative material manufacturers recommended on RAN's website. What I discovered were many disconnected numbers and bankrupt operations. Many of the contacts still in existence were tiny, one-person "companies", not exactly stiff competition for softwood lumber producers.

On the other hand, I also found that environmental organizations do have a critical role to play in fostering the growth and success of alternative building materials, as well as the companies that produce these products. Recommendations for environmental organizations to assist the alternative, non-wood building industry are discussed at the end of this paper.

The information presented in this paper was gathered utilizing an extensive literature review of industry and independent comparative studies, government documents, and articles found in architectural, building industry journals and other professional publications. In addition, twenty-five personal interviews were conducted with a variety of alternative building industry representatives, including: architects, builders, former timber industry executives, non-wood product manufacturers and salespeople, farmers, local and federal government officials, legislators, and activists. This paper thus reflects the biases of those interviewed.

Initially, leaders of environmental organizations were also contacted for interviews. However, environmental organizations are generally issue-focused. It was
quickly evident that most environmental groups are not the experts--nor even cognizant of--the products and companies that may coincide with, and even enhance, environmentalists' efforts to decrease old growth wood consumption or save an endangered forest-dependent species. This paper is an effort to inform environmental organizations, specifically those groups focused on forest protection, about the realities facing alternative, non-wood residential building materials.

The following six, alternative, residential building materials are examined in Chapter 3: light gauge steel, recycled plastic lumber, fly ash concrete, agricultural fibers, stressed skin insulation panels, and engineered wood. Although more than six alternative building materials are utilized by the building industry, the products discussed in this paper were chosen based on life cycle analyses, literature reviews and recommendations by building industry experts. Environmental and other advantages and disadvantages of each alternative material are accompanied by summarizing tables.

It is important to note that although most of this paper is devoted to non-wood building alternatives, two wood-based alternative building materials, engineered wood and stressed skin insulation panels, are included. These products were chosen for two reasons. First, they are popular among builders. Second, these materials mostly make use of small diameter, fast-growing, "scrap" trees, once deemed commercially unsuitable. Environmental sustainability concerns do exist with the use of these materials and will be discussed later. However, it must be stressed that the object of this paper is not to suggest wood is an inappropriate building material. Rather, this paper aims to shed light on building technologies that could eliminate U.S. consumer dependence on old growth, endangered forests, dwindling native forest ecosystems, and specifically, Canadian softwood forests under near-term threat.

Wood is and will continue to be an important component of our homes. Furthermore, recent community forestry projects in the western U.S., in addition to successful building deconstruction and wood salvaging programs, demonstrate that ecologically sustainable wood utilization and economic development can coexist. This is an entire topic unto itself, however, and will not be discussed in detail in this paper.

Chapter 4 investigates the reasons alternative building materials do not compete successfully with wood in the marketplace. As detailed in this chapter, the reasons are
varied, complex and not easily resolved. Of the six alternative building materials profiled, agricultural fibers are recommended as the preferred alternative from an environmental impact standpoint. In addition, agricultural fibers are profiled because this material exemplifies the major reasons alternative, non-wood residential materials falter in the marketplace, despite the fact that environmental organizations call for their increased use.

Chapter 5 follows with a case study of agricultural fibers and a northern Rockies mill that re-trains former timber mill workers to manufacture particleboard made solely from straw. Using this case study, chapter 6 examines the market obstacles specific to the agricultural fiberboard industry, while detailing the effort to utilize local materials and local labor to enhance economic development in a small, western, resource-dependent community.

It is this author's opinion that the environmental benefits, local economic development opportunities, and potential financial savings resulting from the use of alternative, non-wood building materials are sufficient to encourage the development and use of these products. As previously mentioned, this paper does not argue for the elimination of wood in the residential construction market. However, it does call for increased utilization of certain non-wood building materials to supplant current logging levels with environmentally sustainable harvest levels. Americans' current use of wood comes with devastating environmental costs in water quality, fisheries degradation, and habitat and wildlife loss.

This paper concludes with several recommendations to foster the research and development of alternative, non-wood building materials, with special attention given to agricultural fibers. The numerous recommendations are investigated in Chapter 7. As mentioned previously, the paper summarizes in Chapter 8 recommendations for environmental organizations to assist alternative, non-wood products and product manufacturers. By expanding their focus and taking a proactive role, environmental organizations can assist non-wood materials, such as straw particleboard, compete with wood products, subsequently decreasing consumer dependence on softwood lumber and old growth forests. In return, environmental organizations have the unique opportunity to
foster new strategic alliances and critical political support of current--and future--forest protection campaigns, education efforts, and legislation.
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Chapter 1

The Case for Alternative Building Materials

Demand for forest products continues to grow. United Nations data show that total global roundwood consumption (including fuelwood and charcoal) increased by 40 percent between 1970-1996, reaching 3,354 million cubic meters. Inhabitants of the U.S., Japan and Western Europe consume on average about ten times as much wood per person as the average developing country citizen. (Sizer, 1999)

During the late 1990's, the environmental organization Rainforest Action Network (RAN) initiated a relentless corporate campaign against home improvement retail giants Home Depot, Lowe's, Home Base and others, to stop these companies from purchasing and selling wood products cut from old growth forests. Citing that less than 20 percent of ancient forests remain and stigmatizing old growth logging with the sound bite, *The oldest living things on Earth, or tomorrow's lawn furniture?* RAN solidified support from many other environmental groups, consumers and even some builders to pressure these corporations to end their use of old growth wood. (RAN, 2001)

RAN’s two-year grassroots campaign was successful. In 1999, Atlanta-based Home Depot, the world’s largest home improvement retailer and purveyor of old growth wood products, announced its commitment to stop selling old growth by the end of 2002. In its public announcement, Home Depot promised to cater to the heightened awareness of the wood buying public, offering to provide a line of building products certified as "environmentally sustainable". Soon, several of Home Depot’s competitors followed suit. These victories came on the heels of another successful 1998 RAN campaign that secured a commitment from Canada’s largest timber corporation, McMillan-Bloedel, to end its practice of clearcutting ancient forests. (RAN, 2001)
According to a Rainforest Action Network spokesman, "Americans recognize that destroying thousand year old trees to make plywood and office paper is barbaric and unnecessary.... With plenty of alternatives already on the market—it’s simply immoral to make consumer goods out of the world’s last ancient trees, some as old as 2,000 years." (RAN, 2001)

Despite soundbites and the well-publicized accounts of the impacts of large-scale commercial logging and tree plantations, however, the Rainforest Action Network’s claim that viable building material alternatives exist in the marketplace is not so clear. There is a maze of environmental and economic factors to consider when deciphering whether a so-called “green” non-wood construction material is preferable over wood. This paper will investigate several alternative building materials specifically for the U.S. homebuilding industry.

Where Do All The Trees Go?

Although Americans certainly consume staggering quantities of wood for paper, the construction industry accounts for nearly half of the world’s demand for wood and uses over 40 percent of the United State’s natural resources, particularly wood products. Almost one-third of this wood satisfies consumer demand for lumber, plywood, particleboard, and other structural building material. (Johnston, 2000)

In addition, our country imports 80 percent of all Canadian softwood lumber exports, more than any other country in the world; approximately 90 percent of this wood comes from virgin old-growth forests. (Mastel, 2000)
World Resources Institute (WRI) found that 72 percent of the world’s remaining, relatively intact forests considered under near-term threat are most imperiled by logging operations and associated impacts. (Sizer, 1999) At least 37 percent of all U.S.-consumed softwood lumber goes specifically to residential construction, generating approximately 11 billion dollars worth of wood (RAN, 2001) and 25 tons of waste per average, new single-family home. (Johnston, 2000)

These trends are not likely to decline any time soon. In 1999, researchers at the Joint Center for Housing Studies at Harvard University confirmed that, "Housing starts should continue the trend of roughly 1.5 million average annual housing starts for at least another decade." According to the Center for International Trade in Forest Products, "It is universally agreed that residential construction is one of the primary market segments for softwood lumber producers, and that wall, roof, and floor framing use more lumber than any other end use application." Indeed, in a 1995 study, the Wood Products Promotion Council estimated that residential construction consumed 15.6 billion board feet of softwood lumber, with wall and roof framing utilizing about 30 percent of this total. Floor framing, at 11.5 percent, is the third largest end use application. These totals also include the lumber utilized to manufacture wood trusses. (Eastin et al, 2000)

The National Association of Homebuilders (NAHB) Research Center, in a 1999 study, found also that home restoration and remodeling increasingly demands a significant ratio of wood. "The R and R market has grown significantly large, continues to consume an increasing share of lumber production, and should...grow 2% annually through 2010." (Eastin, et al 2000)

Today, most builders and individuals involved in restoration and remodeling
projects purchase their lumber from home improvement retailers such as Home Depot. Small conventional lumberyards, which once controlled over 80 percent of the market through the 1980's, have lost much of this control. Industry forecasts predict the large home center chains will double their market share during the current decade, while large wholesale distributors, serving professional contractors and builders, will rise from 5 percent market share to capture at least 40 percent. (Eastin et al, 2000)

With global wood consumption expected to double over the next few decades (Sizer, 1999) and native forest cover vanishing, pressure increases on the wood products industry to develop alternative building products that utilize less sawn lumber. A tremendous opportunity exists for non-wood building products to not only make in-roads within the construction market, but also supplant wood in particleboard and other engineered wood products. The steady growth of housing starts, combined with the proliferation of the home improvement industry and the price volatility and quality decline in solid sawn lumber, are promising openings for alternative building materials to enter the residential construction market.

This paper will explore several non-wood, alternative, residential building materials, including: steel, structural insulated panel systems (this material does use some wood, but a minimal amount), fly ash concrete and agricultural fibers. This paper will also review alternative, wood-based materials that do not have to rely on wood fiber from old growth forests. These materials include engineered lumber and salvaged wood.

While public education and outreach are integral components of any conservation effort, they may not prove enough to preserve old growth forests and forest dependent species, such as grizzly bears, marbled murrelts and salmon. Creative solutions must also
be found in the marketplace, so that consumers have viable, environmentally sustainable building materials to build their homes. As discussed later in this paper, environmental organizations can play an important role in creating and supporting these new markets.

What Exactly Is Green?

It is critical to remember that so-called "environmentally sustainable" or "green" building materials present their own array of environmental impacts, in addition to benefits. A "green" label, whether attached to a piece of certified lumber or recycled steel, can be deceiving without thorough environmental impact analysis.

Lack of critical analyses leads to false claims and manufacturers that, "decide to wing it by having their art department slap a label on, thinking that by "simply putting a tree or a frog or a waterfall on their labeling will make consumers feel comfortable." (McDowell, 1994) The following chapter defines and summarizes criteria utilized to determine if a particular building material is worthy of the green label.
Chapter 2
Defining Environmental Impacts

The impacts of building materials occur at different phases of a material's life cycle. Life Cycle Assessments (LCAs) must be completed to determine the impact of a particular building material from "cradle to grave." To determine environmental sustainability or "greenness" of a particular material, an LCA should consider the following criteria:

- *How materials are obtained (including energy used in extracting raw materials);*
- *What pollutants are given off during material manufacture;*
- *Health concerns during manufacture;*
- *Installation and use;*
- *Disposal at the end of a material's useful life.* (Wilson, 1995)

When all of these factors are considered together, it is difficult— if not impossible—to point to any, one, alternative building material as supreme.

Comparing the life cycle assessments (LCAs) of different materials is complicated by the fact that you are often comparing apples to oranges. Material A might result in contaminated water runoff from mining, while Material B's major impacts might be air pollution emissions from incineration when the material is worn out and disposed of. Deciding which impact is less severe and thus, which is the greener building material, is a tricky judgment call. It depends on the conservation choice you want to make.

(Wilson, 1995)

Environmental Building News (EBN) is a Vermont based, non-profit organization and professional publication that educates the building industry about current green building materials and techniques.
EBN identifies five distinct categories for choosing green building products:

- Products made from environmentally attractive materials;
- Products that are green because of what is not there;
- Products that reduce environmental impacts during construction, renovation or demolition;
- Products that reduce environmental impacts of building operations;
- Products that contribute to a safe, healthy indoor environment. (Malin, 2001)

Residential construction materials, whether used in a home's floors, walls, roof, decks, or interior fixtures, impact each one of these categories. All building materials are accompanied by unique characteristics, benefits and problems. The object of this paper is not to suggest that wood no longer has any use as a residential building material.

This paper will suggest, rather, materials and methods that may reduce our dependence on remaining old growth, endangered forests and large-scale tree plantations. Dimension lumber and wood stud production have historically relied on vastly diminished larger, old growth trees. Today, due to the scarcity and high prices of large trees, dimension lumber, such as 2X4s, are often manufactured with small diameter, tree plantation wood, once deemed commercially unviable. (Loken, 2001)

The proliferation of tree plantations, producing fast-growing tree species such as aspen for dimension wood and engineered wood products, raises other environmental and social concerns. These mono crop “forests” often replace virgin or secondary forests and displace native species. Tree plantations also rely on an intensive input of chemicals, which can negatively impact surrounding forest communities, soil and water. (Edminster, 1998) In addition, tree plantations demand vast amounts of land. If plantations, despite environmental drawbacks, were even to meet consumer demands in the future, the
establishment of more than 247 million acres of high-yield plantations is required. It is predicted that much of this land would derive from developing nations and that the effort "would require most of the world's land that is suitable for planted forests and which currently is surplus to food production, but which is not already in forest." (Bowyer, 2001)

Despite valid concerns regarding U.S. wood consumption, it is critical to remember that there is no single, perfect, truly "green" replacement to wood. The use of alternative, non-wood residential building materials may not be appropriate in all applications. The use of a combination of alternative building techniques is probably the best solution to curb our appetite for wood products, rather than replacing wood with one material.

This paper also investigates the claim made by the Rainforest Action Network and espoused by several other forest conservation organizations, that many environmentally preferable alternative building materials readily exist on the market. Certainly, building materials produced without a risk to old growth forests do exist. Whether all of these materials are environmentally superior to wood or capable of successfully competing with wood in the marketplace, however, is another story.

The mere existence of alternative "green" building materials is not enough to save a tree. In order to replace wood as the material of choice for contractors, builders, architects, engineers, carpenters and homebuyers, these materials must be cost competitive with wood. Furthermore, alternative construction materials must perform structurally equal to, or better than, wood. If an alternative building material is more
costly to use than wood and is not accompanied by a proven track record, it will never succeed in the residential construction market. If an environmental organization seeks to curtail consumer dependence on old growth or tree plantation timber, it is not enough to simply list the alternatives with which we can build our homes. The success or failure of alternative building materials depends on a complex assortment of factors that will be explored in this paper.

Using a case study of an alternative building material company located in the Northern Rockies, this paper will consider the obstacles, pitfalls and opportunities for success that the green building industry faces today.

**The Slow Transition Towards Alternatives**

A recent survey published by the Center for International Trade in Forest Products (CINTRAFORE) at the University of Washington concludes that American home builders perceive the cutting of softwood (cone bearing trees), predominantly used by the home-building industry for exterior applications, causes more harm to the environment than the use of any other building material. The study also reports that since 1995, builders have slowly shifted in favor of alternative, non-wood materials. (Eastin et al, 2000)

Despite some builders' environmental concerns, the overwhelming catalysts for experimentation with alternative building materials are volatile wood prices and the declining quality of available, small dimension lumber. Today, the three biggest alternative competitors with softwood lumber are engineered wood products, non-wood materials such as steel and concrete, and composite framing substitutes. (Eastin et al, 2000)
Whatever the driving force, softwood lumber substitutes are gaining ground. The Center for International Trade in Forest Products found in a 1998 study that only 1.1 percent of surveyed builders reported using softwood lumber exclusively. This conclusion compares with 8.5 percent of the builders in a 1995 study. By 1998, nearly half of the 284 respondents had tried at least six of twelve substitute building materials, including engineered wood, steel framing, concrete, and plastic lumber. However, the study also discovered that overall builders viewed engineered wood products as more environmentally friendly compared to non-wood products. (Eastin et al, 1999)

In order to change this perspective, non-wood product manufacturers must make the long-term--and often frustrating--commitment to educate the U.S. residential building industry and consumers about the environmental, structural and other benefits of non-wood construction materials.
Chapter 3

Summary of Alternative Building Materials

The following chapter summarizes the advantages and disadvantages of several alternative residential construction materials, compared to traditionally cut wood. Information on the market obstacles facing many alternative building materials will be discussed later in this paper, utilizing a case study of an agricultural fiber mill.

Alternative 1: Light Gauge Steel

Of the entire alternative, non-wood building choices, the use of light gauge steel is most steadily increasing. Although more than 11 million tons of steel are utilized annually for construction (AIA, 1994) steel has traditionally been used for commercial applications. The use of light-gauge steel for framing homes is a new trend.

This shift may be partly due to well-funded publicity campaigns led by steel industry organizations, such as the American Iron and Steel Institute. Over the last ten years, several articles promoting light gauge steel for residential construction have been published in architectural, real estate and builder magazines. Steel's relative price stability, compared to wood, is also a likely factor in its increased application. (Malin, 1994)

The Center for International Trade in Forest Products found that almost half of builders surveyed in its 1998 study reported to use steel lumber, a 63.9 percent increase since 1995. While the use of wood and plastic composite lumber has increased by almost
250 percent since 1995, the data indicates that it is primarily being used to build decks, versus the use of steel for structural purposes. Steel framing for wall applications increased by almost 10 percent across all four US regions, up from just 2.5 percent in 1995. (Eastin et al, 2000)

The steel industry has touted its product as a preferable building material over wood for a variety of environmental, economic and structural reasons. From a construction standpoint, steel does offer a ‘piece by piece’ substitution for wood. Steel studs replace wood studs, steel joists replace wood joists, and steel channel sections replace wall plates and band joists. Building crews can thus adjust using the new material without learning a new framing method. (Malin, 1994)

**Price and Environmental Advantages**

Steel prices are predictable, stable and low compared to the volatile shifts in solid lumber prices. This is the primary reason some homebuilders have begun to utilize the metal. According to steel industry calculations, materials for a 2,500 square-foot wood house would cost approximately $10,300.50 compared to $8,166.64 for the same house framed with steel. (Han, 2000)

The increase in steel utilization has bolstered the environmental claims made by steel manufacturers. Most often heard is that steel is 100 percent recyclable. "Yesterday's scrapped car can become today's steel framed home" is a frequently heard sales pitch. (The New Steel, 2001) According to the American Iron and Steel Institute, more than 100 billion pounds of steel are recycled annually. (Sichelman, 2000)

Indeed, steel does have its own green qualities. The steel industry points out that
a typical wood-framed, 2,000 square-foot house requires about forty to fifty trees, (approximately an acre) while a steel-framed house can be made using only six-eight recycled cars. That same 2,000 square foot, steel-framed house generates as little as one cubic yard of recyclable scrap during construction, alleviating financial costs and pressure on landfills. (Steel Framing Alliance, 2001)

Finally, the steel industry claims that in the last decade, more than one trillion pounds of steel scrap have been recycled, kept out of landfills, and manufactured into products for domestic use and export. (Steel Framing Alliance, 2001) In addition, the industry asserts that, "Steel recycling saves enough energy to power about one-fifth of all the households in the U.S., or about 18 million homes, for one year." (Hart, 1999)

Claiming that timber industry practices have led to deforestation and the scarcity of old growth trees has caused soaring lumber prices and decreasing lumber quality, the steel stud industry set a goal of 25 percent market share for light gauge steel framing by 2002. This campaign has led to a flurry of cross accusations exchanged between the steel and wood industries. (Hart, 1999)

As the steel industry points to the devastation that timber companies have had on forests, the timber industry rebuts that the production of a single, light-gauge steel stud requires nine times more energy than is required to produce one wood stud. Industry executives also highlight the fact that steel lags well behind wood in thermal properties, as steel is a thermal conductor. Finally, The timber industry dismisses the notion that forests are completely denuded, stating that the growth of new, replanted timber far exceeds harvest levels. (Malin, 1994)
The American Iron and Steel Institute counters that recent technology has reduced the energy requirements for steel production by 34 percent since 1972. In addition, the Institute asserts that steel does not biodegrade as wood fibers do, and that steel recycling decreases energy and resource consumption over the long-term. (Malin, 1994)

The truth to both industries' claims probably lies somewhere in between. According to Nadav Malin, editor of *Environmental Building News*, “Statistics about forest growth exceeding harvest are misleading. The numbers include growth in all forests, even those not managed for commercial use.” (Hart, 1999) Although the overall recycling rate for steel is 66 percent, (AIA, 1994) Malin states, “The high percentages cited for steel recycling include the tons that are exported and never even reused in the United States, as well as those scraps that never leave the factory.” (Hart, 1999)

In fact, both steel and concrete were omitted from the Natural Resources Defense Council’s *Guide to Resource Efficient Building Materials*. The group states that “the jury is still out” on steel’s environmental costs and benefits due to the extremely high amounts of energy used in steel production and steel’s poor thermal performance. (Edminster, 1998)

**The Steel Manufacturing Process**

During the steel manufacturing process, iron is produced in blast furnaces by reducing iron ore with a hot gas. The large, refractory-lined furnaces are charged with iron ore, limestone, dolomite, and coke.

Steel is made in one of two ways, using significant amounts of recycled scrap. The Basic Oxygen Process (BOP) requires 25 percent scrap steel and 75 percent virgin
material. In this process, molten iron from a blast furnace and iron scrap are refined in a furnace by injecting high-purity oxygen. The oxygen reacts with carbon and other impurities to remove them from the metal. (AIA, 1994)

The Electric Arc Process (EAP) requires 100 percent scrap steel and is used to manufacture carbon and alloy steels. This process operates using cylindrical, refractory-lined electric furnaces, equipped with carbon electrodes that can be raised and lowered through the furnace roofs. Alloying agents are added and electric current generates heat between the electrodes and the scrap metal. This process uses significantly less energy than the Basic Oxygen Process. (AIA, 1994)

Regardless of which manufacturing process is used, 100 percent virgin metal does not exist. The steel industry correctly claims that when new steel products are purchased in North America, the buyer always receives some recycled steel. Yet, despite its impressive recycling rate, steel production still requires a stunning amount of raw materials.

On average, to manufacture one ton of steel requires approximately 2.5 tons of natural resources, including:

- 3,170 pounds of iron ore;
- 300 pounds of limestone;
- 900 pounds of coke;
- 2,575 pounds of air;
- 80 pounds of oxygen;
- 100 pounds of hydrocarbon fuel to fire the furnaces.

In addition, steel production releases 4,550 pounds of gaseous emissions, up to 50 pounds of dust, and results in about 600 pounds of slag. (AIA, 1994)
<table>
<thead>
<tr>
<th>Dimensional Properties/Stability</th>
<th>Strength and Design</th>
<th>Earthquake Performance</th>
<th>Weather/Fire/Insect Resistance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Can be manufactured to exact dimensions off or on a building site, significantly reducing the amount of construction waste. Simpler to erect and easier to reassemble than wood framing.</td>
<td>Strongest building material for its weight. Requires less material to frame a home than wood. Offers more design options. Varied curves and linear shapes can be incorporated.</td>
<td>Superior engineered performance. Steel's lighter weight reduces structural damage during an earthquake. Structural advantages translate to lower insurance premiums, especially in earthquake prone areas such as California.</td>
<td>Withstands weathering and natural disasters far better than wood. Steel maintains its integrity through years of heavy snow, rain, high winds and hurricanes. Structural advantages translate to lower insurance premiums in hurricane and termite prone areas like Florida. Does not burn. However, steel loses its strength and structural integrity quickly at high temperatures. Steel is not attractive to insects such as termites, but wood is.</td>
</tr>
<tr>
<td>Indoor Air Quality</td>
<td>Resource Availability/Extraction</td>
<td>Energy Use/ Emissions</td>
<td>Recycling/ Disposal</td>
</tr>
<tr>
<td>-------------------</td>
<td>----------------------------------</td>
<td>-----------------------</td>
<td>---------------------</td>
</tr>
<tr>
<td>Preservative treated wood contains toxins. Engineered wood contains binders that emit volatile organic compounds (VOCs). Steel is inert. It does not off gas toxins as wood can.</td>
<td>Building a home of steel saves wood. It may decrease dependence on native forests and tree farms. All new steel contains some recycled content.</td>
<td>Technological advances in steel manufacturing may reduce energy expenditure by 37-43% by the year 2010.</td>
<td>Steel has overall recycling rate of 66%, the highest rate for any building material. During the past decade, more than one trillion pounds of scrap steel have been recycled. Steel recycling extends life of nation’s landfills by more than three years. Steel recycling reduces: *Oil use-47%; *Air emissions-76%; *Water contaminants-40%; *Mining wastes-97%.</td>
</tr>
</tbody>
</table>

Preservative treated wood must be handled as hazardous material.
Table 3. Environmental Disadvantages of Steel Construction (AIA, 1994) (Malin, 1994)

<table>
<thead>
<tr>
<th>Resource Availability/Extraction</th>
<th>Energy Use/ Emissions</th>
<th>Recycling/ Disposal</th>
<th>Thermal Bridging</th>
</tr>
</thead>
<tbody>
<tr>
<td>The recycled content of steel used in residential construction is only 25%. Mining operations disturb land and pollute soil, water and air. Causes erosion and habitat destruction. Several of the raw materials used to manufacture steel are in very limited supply in the U.S.</td>
<td>Steel processing produces significant toxic air, water pollutants and solid waste. Lumber milling is a comparatively low-energy process and emits significantly fewer pollutants.</td>
<td>Recycling steel saves energy, but still requires intensive output.</td>
<td>Severe thermal bridging results where steel spans from the inside to outside of a building. Steel is 400+ times more thermally conductive of than wood.</td>
</tr>
</tbody>
</table>

Steel or Not?

Residential builders and carpenters are accustomed to working with wood. Despite the increased use of steel, the majority of residential builders have never worked with this metal. Builders and contractors are reticent to switch to using a new building technique because it ultimately requires higher outputs of time and money, the major obstacles to trying any new building material. In addition, builders shy from using a
product with which they are unfamiliar due to liability concerns.

Furthermore, several of the engineered wood products on the market now offer the structural stability and design options to compete with steel. Builders can attain some of steel’s structural and design benefits without switching to a new product. Many construction experts believe that steel should not be used as a piece-by-piece replacement for wood framing. Steel’s attributes, such as uniformity and high strength, combined with its poor thermal characteristics, suggest that it should be used in a building system that requires far fewer framing members, spaced farther apart. (Malin, 1994)

Rather than thinking of steel as an overall replacement for wood, it may be wise to encourage steel frame construction for situations in which is proven. For example, steel may be the material of choice for chemically sensitive people because it does not require toxic preservative treatments. Steel may also be preferred in areas where excessive moisture, termites and natural disasters are concerns. Florida, California and Hawaii are three states where steel framing has been used and should be encouraged, as these locations share similar construction issues. In addition, steel’s thermal bridging is not as much of a concern in these locales as it is in colder states.

From an environmental standpoint, steel is clearly not superior to wood in all categories. As Environmental Building News states,

The extraction of raw materials used to make steel can have serious environmental impacts, and the manufacturing process, even from recycled steel, is extremely energy intensive. Wood, on the other hand, is naturally renewable, requires less processing energy, and is ultimately biodegradable. (Malin, 1994)

However, it is critical to remember that although trees can be renewed, forests and biodiversity cannot. Steel should be utilized where appropriate. Its increased utilization
in these locales may alleviate pressure on native forests and foster a return to ecologically sustainable wood harvest levels.

**Alternative 2: Stressed Skin Insulating Core Panels**

Architect Alden Dow, the brother of Dow Chemical founder, originally designed stressed Skin Insulating Core Panels (SIPS) in the 1950s. SIPS consist of a manufactured "sandwich" assembly, made of a rigid insulating core and exterior/interior surfaces bonded to sheeting material. SIPS are utilized to build walls, floors and roofs.

Oriented strand board (OSB), is the most commonly used sheeting material, but wafer board, sheet metal and drywall are also used. (Edminster, 1998) Most SIPS today are manufactured with 11 millimeter to 16-millimeter OSB skins glued to expanded styrene foam (EPS) insulation cores. (Wilson, 1998)

Although invented in the 1950's, structural insulating core panels only began making inroads in the U.S. residential construction industry during the 1980s. Over the past few years, the use of this building system has grown by approximately 30 percent each year. However, the use of SIPS in construction still represents less than one percent of all residential and light commercial building. (Wilson, 1998)

There are close to seventy SIPS manufacturers in North America that produce an estimated 32 million square feet of panels annually (about 80 million dollars). This represents enough material for the walls and roofs of more than 8,000 houses. SIPS are used in part for their exceptional strength, which is reportedly up to twice the strength of conventional wood framing. This material also provides an attractive construction tool
because it enables rapid erection of the building shell, thus keeping labor costs at a minimum. Finally, SIPS construction can reduce the time to erect a building shell by more than one-third. A builder with one crew, building four houses a year, can increase annual profits by $5,990. (Edminster, 1998)

Table 4.

Environmental Advantages of SIPS Construction
(Wilson, 1998) (Edminster, 1998)

<table>
<thead>
<tr>
<th>Energy efficiency</th>
<th>Wood Efficiency</th>
<th>Emissions/Indoor Air Quality</th>
<th>Recycling Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy efficiency is the most significant environmental benefit of a SIPS building system. SIPS building systems result in energy savings and lower utility bills compared to wood-frames.</td>
<td>SIPS uses 5% less total wood than a traditional wood-framed house and 50% less framing lumber. Wood used in SIPS panel skins generally come from small-diameter trees, mostly harvested from tree farms. SIPS construction uses less dimension lumber.</td>
<td>Future SIPS will be constructed with non-ozone depleting polyurethane foam substitute.</td>
<td>SIPS foam cores can be melted and remanufactured into other polystyrene products.</td>
</tr>
</tbody>
</table>
Table 5.

Environmental Disadvantages of SIPS Construction
(Wilson, 1998, Edminster, 1998)

<table>
<thead>
<tr>
<th>Wood Efficiency</th>
<th>Emissions/Indoor Air Quality</th>
<th>Hazardous Chemicals</th>
<th>Recycling Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tree farms displace native forests and forest dependent species. Tree farms rely on heavy input of chemicals.</td>
<td>Air pollution emissions and ozone depletion are the greatest environmental problems with SIPS use, resulting from the ozone depleting foam insulation used between wood panels. Indoor air quality and offgasing are a concern. The oriented strand board used in SIPS sheeting contains toxic chemical binders. Experts have conflicting opinions about which is more toxic—offgasing from the wood panels or the foam cores.</td>
<td>Foam cores are derived from petroleum and natural gas. Hazardous chemical emissions are inherent to the SIPS manufacturing process. Chemical factory workers face the greatest health risk during SIPS manufacturing.</td>
<td>Plastics industry initiative to set up a national network for polystyrene recycling failed. The oriented strandboard wood skins are not easily recycled, due to the foam bonded to their surface.</td>
</tr>
</tbody>
</table>

Structural insulated foam panels are susceptible to ants and termites. Manufacturers recommend an aggressive pesticide treatment program both during and after construction to prevent infestation, which presents another serious public health issue.

This concern has been addressed by the industry and there currently exists a patented process for incorporating a non-toxic borate solution into the foam itself, which has proven effective at preventing infestations. However, this process can attract
Alternative 3: Engineered Wood Products

Engineered wood refers to products made from roundwood that have been reduced to smaller pieces of wood, or structural panels made from residue materials leftover from wood processing operations. These materials are adhered together with an adhesive bonding agent to produce wood products with specific mechanical properties.

Engineered wood products include particleboard, a composite wood product made of wood chips or residue as fine as flour, held in place by adhesive resins. Particleboard includes insulation board, oriented strand board (OSB), medium density fiberboard (MDF), hardboard and plywood. Approximately 76 percent of particleboard is used for furniture and cabinets, 8 percent for floor underlayment, and the remainder for other applications. (Guss, 1995) Other types of engineered wood products include: parallel strand lumber (PSL), laminated veneer lumber (LVL), wood I-Joists, and glued laminated timber (glulam). These products have gained popularity among American builders because they enable large wood components constructed from small diameter timber.

In addition, these engineered products allow the incorporation of special properties, including increased load carrying capacity and varied designs. The range of performance is narrower for engineered wood compared to dimensional lumber. However, expectations of performance are more likely to be realized because the process of manufacturing engineered wood homogenizes the raw materials, eliminating defects and weak points. (Guss, 1995)
Most engineered wood is used in the western U.S., where dimension lumber longer than 16 feet and wider than 12 inches is increasingly difficult to find. Even when the shifting price of softwood lumber drops, western builders continue to use engineered wood. A 1990 Forest Service study projected the consumption of plywood and other structural panel products to increase by 50 percent by the year 2040.

Perhaps the best argument for using engineered wood products is that the old growth trees that were the foundation for visual grading no longer exist for commercial purposes. Almost all structural lumber is now derived from second (or third) growth, as well as from species (e.g., aspen) that were not considered commercial four decades ago, when we had an 'inexhaustible supply' of old growth timber. (AIA, 1994)

However, a host of environmental and economic issues arise when considering engineered wood products from a green standpoint, and the use of this material has not exactly been a savior of native forests. The following criteria should be considered when investigating engineered wood products:

- *Species used and its conservation status;*
- *Environmental impacts of harvesting practices—including effects on biodiversity;*
- *Actions that are taken to renew the supply after harvest;*
- *Environmental concerns during processing and marketing, such as mill by-products and air pollution;*
- *Life cycle energy intensity;*
- *Recyclability or disposability;*
- *Functional traits in use, such as durability, insulating value, on-site wastes.*

(Malin, 1999-b)

In addition, the potential for maximum economic development in local communities is diminished with engineered wood products, compared to solid lumber.

More diverse industries based on mature hardwood forests tend to keep seventy percent of the economic value in the local community, compared with fiber products such as engineered wood, pulp and paper, which retain only thirty percent of the value locally. (Irland, 1993)
Table 6.  
Environmental Advantages of Engineered Wood  
(Ireland, 1993)

<table>
<thead>
<tr>
<th>Sustainability Issue</th>
<th>Recycling Capability</th>
<th>Energy Efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engineered wood uses small, lower-grade (plantation-grown) tree species. More of the wood fiber ends up as part of the structural component compared to solid sawn wood.</td>
<td>Most solid waste recovered in particleboard or plywood mills is used to fuel the mill—or—recovered for manufacturing future products. Approximately 90% of the wood component in particleboard comes from sawmill waste.</td>
<td>A wall made of brick veneer or concrete blocks uses 6-8 times more energy than a wood wall.</td>
</tr>
</tbody>
</table>
Table 7.

Environmental Disadvantages of Engineered Wood
(Irland, 1993) (Vittori, 2001)

<table>
<thead>
<tr>
<th>Forest Diversity</th>
<th>Toxic Binders</th>
<th>Sustainability Issue</th>
<th>Recycling Capability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quick rotation forests lack diverse wildlife habitat.</td>
<td>Urea-formaldehyde resin is highly toxic. Used to process 98% of all hardwood particleboard for interior applications.</td>
<td>Large-scale, quick rotation tree farms replace native forests.</td>
<td>Very little post-consumer particleboard recycling takes place; it is often bound into an assembly with other building materials.</td>
</tr>
<tr>
<td>Quick rotation forests have diminished potential for local economic development from value-added products, made from high quality, sawn timber. (i.e., beams)</td>
<td>VOC Offgassing is the most serious health risk from urea- and phenol formaldehyde binders. (Urea is more toxic.)</td>
<td>Pesticides and other tree crop chemicals can damage soil and water.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Formaldehyde has been classified as a probable human carcinogen.</td>
<td>Phenol formaldehyde is derived from coal tar or petroleum. Urea formaldehyde is derived from natural gas.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Offgasing is especially a concern in manufactured and mobile homes, which use significant amount of engineered wood products.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Indoor air pollution is the greatest health concern regarding engineered wood products, resulting from the toxic phenol and urea formaldehyde resins used to bond the particles. (see Table 5.) The same air pollutants regulated by U.S. environmental laws have been found at even higher levels in the average American residence. (Johnston, 2000)

Fifty percent of all illness is a direct result of indoor air quality problems, and fifteen percent of the population has specific chemical sensitivities brought on by various volatile organic compounds found in wall paneling, particleboard in cabinets...furniture.... (Aven, 2001)
In fact, indoor air has been found to contain at least five—and sometimes ten or more--times higher concentrations of toxins than outside air. In a survey of American homes, researchers found the concentrations of seven toxic organic chemicals were above levels that would trigger a formal assessment for residential soil at a Superfund site.

Much of the offgasing stems from seemingly harmless household objects, such as, countertops, cabinets, shelving and furniture made from particleboard. The “new house smell” is actually the odor of volatile organic compounds, which can continue offgasing for years. (Johnston, 2000)

Increasingly, engineered wood product manufacturers are trying a new binder, methylene diphenyl isocyanate (MDI). MDI currently is used only in medium density fiberboard and straw particleboard. It is not considered suitable to use for wood veneer such as plywood and laminated veneer lumber because it soaks too deeply into the wood. Adhesive manufacturers are currently working on an emulsion to keep MDI on the surface to increase its applications.

The wood products industry is keen to increase MDI’s exposure because this resin is manufactured from waterproof polyurethane and contains no formaldehyde. It thus has earned recognition as a “green” binder because it does not offgas. MDI is not the perfect substitute, however. Although this binder is preferable from an offgasing standpoint, it is very toxic before curing, creating a potential health risk to wood factory workers, unless proper precautions are taken. (Lengel, 2001)

There is ongoing research to develop new, green resin sources from soybeans, tannins, bark and different types of biomass, in an effort to reduce dependence on petroleum and reduce emissions from volatile organic compounds. (AIA, 1994) None of
these materials, however, are on-line to replace PF or UF binders to date.

**Certification of Engineered Wood:**

To date, only two engineered wood manufacturers have introduced products that carry Forest Science Certification (FSC). This issue remains controversial, as the actual content of recycled wood—as opposed to freshly chipped trees—can vary greatly in products. (Malin, Wilson, 1997)

**Alternative 4: Recycled Plastic Lumber**

Plastic lumber is typically manufactured from 100 percent recycled post-consumer plastic and is available in a wide variety of dimensions, shapes, finished sizes and colors. For the consumer, one benefit of plastic lumber is that it does not require painting, sealing or staining as required with wood-based lumber. Although recycled plastic lumber tends to be more expensive than treated wood initially, in the long-term, the maintenance costs for plastic are negligible compared to wood. (Vlosky, 1999)

Like steel, plastic does not split, shrink, swell or rot, and it is impervious to termites and other pests. Although plastic lumber is most cost effective in large dimensions, where wood tends to be more expensive, its use as a replacement for wood fiber is in its infancy. Despite benefits, the plastic lumber industry has had its share of failed ventures, due largely to the variability of materials and manufacturing processes. The term recycled plastic lumber does not describe one specific product, but a broad
spectrum of building materials. To date, recycled plastic has been used as a wood replacement in landscape timbers; shipping pallets; fencing; park benches; picnic tables; livestock facilities; decks; and soundwalls along highways. (Vlosky, 1999)

Plastic lumber is slowly gaining ground as a replacement for wood in seawalls, picnic tables and playgrounds because of what it lacks. Unlike wood, plastic lumber does not require chemical treatment to preserve its structural integrity outdoors. Wood, on the other hand, is treated with chromated copper arsenate (CCA) to discourage fungi, insects and decay. CCA contains arsenic, a carcinogen linked to skin, bladder, liver and lung cancers. A University of Florida study found that surface soil below CCA treated wood decks contained arsenic concentrates elevated on average by 2000 percent. (Healthy Building Network, 2001)

The use of arsenic treated wood especially poses a health risk for children playing on wood playgrounds. Across the U.S., many communities are shifting to recycled plastic lumber playgrounds for this reason. Furthermore, there is growing concern regarding aquatic pollution from the CCA preservatives present in wood seawalls. Plastic lumber seawalls have replaced many wood seawalls and provide greater longevity than preservative-treated, wood walls. (Vlosky, 1999)

The Manufacturing Process

To manufacture plastic lumber, post-consumer plastics are sorted, crushed and baled. Bales that are clean and well sorted have the highest commercial value. However, the manufacturing process does make use of less pure plastic wastes, utilizing approximately 46 pounds of waste per 3 feet. High-density polyethylene (HDPE)
comprises the largest part of the plastic waste stream. HDPE is the material most commonly used by plastic lumber producers, although polystyrene is also used. (Malin, 1993-d)

Plastic from material recovery facilities (MRF) are granulated into small flakes. The flakes are then fed into machines that melt them and either extrude or mold the molten plastic into new shapes. Contaminants in the liquid mix, such as aluminum, (usually from bottle caps) cellulose from paper or wood, in addition to plastics with higher melting points, are processed as whole flakes and are visible in the finished product. Although all plastic lumber contain a small amount of contaminants, too many can cause severe structural and aesthetic damage. Thus, this product has not made its way into structural, load-bearing applications. (Malin, 1993-d)

**Quality Concerns**

The plastic lumber industry faces many challenges. First, variations in manufacturing equipment affect the efficiency and production capacity of each company, in addition to the type of plastic waste each can accept. Second, the molecular bonds that provide homogenous, virgin plastic its strength are not always reproducible even with a single recycled resin, and less so with commingled resins. As a result, products from non-reinforced commingled plastics have significant weaknesses. (Vlosky, 1999)

Until these issues are resolved, plastic will never replace wood as a structural material. In addition, due to manufacturing disparities, plastic lumber lacks common testing standards. Without standards from recognized organizations, building code officials are reluctant to approve the product in structural applications. Engineers and
designers are unable to compare data accurately with wood. Some building professionals believe that structural wood standards should be used for plastic lumber, since plastic lumber is utilized as a direct replacement, but this suggestion has not been implemented.

(Malin, 1993-d)

**Table 8.**

**Environmental Advantages of Plastic Lumber**
(Malin, 1993-d)

<table>
<thead>
<tr>
<th>Toxins</th>
<th>Solid Waste</th>
<th>Resource Efficiency/Energy Use</th>
<th>Carbon Emissions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plastic lumber decreases dependency on 3.8 billion board feet of chemically treated wood used in North America per year. Plastic lumber provides non-toxic substitute for playgrounds and decks.</td>
<td>Diverts millions of pounds of plastic waste from landfills. Manufacturers will accept scraps and off-cuts to feed back into production process.</td>
<td>Recycled plastic is used as filler for manufactured wood composite products. Reinforced plastic wood enables the use of less and lower-grade timber.</td>
<td>Increased use of recycled plastic decreases carbon emissions stemming from use of concrete. Energy used to make recycled plastics is low and pollution emissions less severe, compared to concrete.</td>
</tr>
</tbody>
</table>

**Table 9.**

**Environmental Disadvantages of Plastic Lumber**
(Malin, 1993-d)

<table>
<thead>
<tr>
<th>Toxins</th>
<th>Solid Waste</th>
<th>Resource Efficiency/Energy Use</th>
<th>Wastewater</th>
</tr>
</thead>
<tbody>
<tr>
<td>Additives are used in manufacturing process. Cadmium is present in plastic dyes. Several states have outlawed the use of cadmium.</td>
<td>Material that has been chemically cross-linked is not recyclable and will end up in waste stream.</td>
<td>Plastic lumber is heavy, making transportation both expensive and energy consuming. Industry initiative to facilitate recycling at all plastic production facilities failed.</td>
<td>Cleaning of plastic recyclate can deposit surface and ground water contaminants.</td>
</tr>
</tbody>
</table>
Alternative 5: Fly Ash

In 1998 alone, over 80 million metric tons of cement was produced in the U.S., and another 20 million tons imported to meet the demands of a booming economy. (Malin, 1999-a) Coal fly ash is a mineral admixture and industrial byproduct of coal burning that can stretch cement supplies, quicken its curing process, improve durability, and dramatically reduce the environmental impacts of concrete manufacturing. The ash, primarily composed of silica, aluminum, iron and calcium, is trapped in smokestacks.

Carbon Dioxide (CO2) is released as an emission from the fuels used to process cement, totaling one ton CO2 per ton of cement produced. The 1.5 billion metric tons of cement produced worldwide in 1997 alone accounted for over 6 percent of world carbon emissions. Just U.S. cement consumption alone is equivalent, in terms of global warming, to 22 million passenger cars per year. (Malin, 1999-a)

According to the American Coal Ash Association, 55 million tons of fly ash was produced in the United States in 1997 and about 8.5 million tons were utilized to make concrete. Fly ash utilization makes use of an industrial waste from a highly polluting industry, while putting a significant dent in U.S. carbon emissions. According to one structural engineer, fly ash is “one of the few clean, simple no-brainers in green building, because the technology is worked out, the cost is usually equal to or less, and the quality of the product is far higher.” (Malin, 1999-a)
Table 10.

Environmental Advantages of Fly Ash Cement
(Malin, 1999-a)

<table>
<thead>
<tr>
<th>Emissions</th>
<th>Heavy Metals</th>
<th>Transportation</th>
<th>Radiation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increasing use of fly ash in concrete from 15% to 50% eliminates up to 600 million tons of CO2 emissions. This increase is equivalent to removing 1/4 of all cars in the world.</td>
<td>Heavy metals in fly ash are locked up once hardened into concrete.</td>
<td>Coal plants are served by rail, providing more efficient transportation than trucking.</td>
<td>Reduced likelihood of exposure to radon gas. This emission is less likely to escape from concrete strengthened with fly ash.</td>
</tr>
</tbody>
</table>

Table 11.

Environmental Disadvantages of Fly Ash Cement
(Malin, 1999-a)

<table>
<thead>
<tr>
<th>Heavy Metals</th>
<th>Transportation</th>
<th>Radiation</th>
</tr>
</thead>
<tbody>
<tr>
<td>When stored inside coal plants, fly ash can leach heavy metals into water and air.</td>
<td>Coal power plants are not usually located near construction sites. Fly ash requires longer freight distances, necessitating higher fuel use if trucked.</td>
<td>Increased gamma radiation exposure is a slight risk with fly ash—it contains more gamma radiation than cement, sand, or soil. Formaldehyde offgasing can be an issue for chemically sensitive people, but amount of offgasing is small.</td>
</tr>
</tbody>
</table>
Alternative 6: Agricultural Fibers

Agricultural fibers include: bagasse (derived from sugar cane), coir, corn stover, cotton, flax, industrial hemp, kenaf, rice straw, roselle, sisal, switch grass, bluegrass, and wheat straw. Particleboard made from agricultural fibers shares the same general processing procedure as wood-based particleboard. Fiberboard, as it is often referred, is made by heating, compressing and bonding agricultural fiber particles into sheets. The sheets are then cut to various specifications.

The use of agricultural fibers in building applications is not new. Wheat straw was first used in industrial applications in 1827. In 1940, Sweden became the first country to develop compressed agricultural fiberboard. Between 1950-1970, over 130 million square feet of fiberboard were used to construct roofs, decking and interior partitions throughout Europe and Canada, while the U.S. developed a wheat-based medium for commercial use in 1960. (Bowyers, 2001)

Many alternative building advocates continually call for the increased use of kenaf and hemp for both paper and construction purposes. However, a common finding of several studies reveals that,

The highest and most commonly published yields {for hemp and kenaf} are attainable only on the best agricultural lands, and often only with intensive inputs...these are the same lands that will be needed in the future to ensure sufficient food supplies for a growing population. This reality raises a question as to whether annual agricultural crops planted specifically to produce non-food raw materials make sense over the long term. (Bowyers, 2001)

In addition, U.S. federal law prohibits the cultivation of commercial hemp. This ban was instated in the 1950s and lists the crop as a Schedule One drug, due to its distant
relation to marijuana. Before hemp can be taken seriously as a building material in the U.S., the Drug Enforcement Administration must reclassify it. Despite concentrated lobbying efforts, this has proved no easy task. Currently, hemp is imported from countries where production is legal, such as Canada and Europe. Its commercial cultivation in this country remains moot until the federal ban is removed. (Sholts, 2001)

As building material, agricultural fibers are plentiful, adaptable, strong, fire and water resistant, not to mention biodegradable and renewable, yet they have not flourished in the U.S. building industry. The failures and future of the fiberboard industry will be explored in detail, because this industry provides an excellent example of the varied and complex market obstacles—and opportunities—facing the alternative residential building industry today.
### Table 12.

**Environmental Advantages of Agricultural Fibers**  
(Bowyers, 2001) (Lengel, 2001)

<table>
<thead>
<tr>
<th>Resource Availability/Extraction</th>
<th>Recycling Capability</th>
<th>Toxins</th>
</tr>
</thead>
<tbody>
<tr>
<td>Straw fiber is a waste product. It requires no resource extraction—just collection, transport and storage. Crops that produce straw (i.e. bluegrass, wheat) are plentiful and quickly renewable. Straw utilization in building materials saves significant landfill space. Straw utilization offers an alternative to residue burning, lowering air pollution emissions.</td>
<td>Fiberboard can be recycled for future use.</td>
<td>MDI bonding resin is formaldehyde free. Does not offgas once installed.</td>
</tr>
</tbody>
</table>

### Table 13.

**Environmental / Other Disadvantages of Agricultural Fibers**  
(Bowyers, 2001) (Lengel, 2001)

<table>
<thead>
<tr>
<th>Toxins</th>
<th>Land Use</th>
<th>Costs</th>
<th>Storage</th>
</tr>
</thead>
<tbody>
<tr>
<td>MDI resin is highly toxic before cured. Can pose serious health risk to mill workers, if precautions not taken.</td>
<td>Majority of U.S. crops rely on intensive chemical inputs. Toxic runoff and water use are major concerns with agriculture in the arid West.</td>
<td>MDI resin is costly, results in higher pricing.</td>
<td>Agricultural fibers must be kept dry year-round, also increasing production costs.</td>
</tr>
</tbody>
</table>
### Table 14.

**Summary:**

**Agricultural Fibers Versus Other Alternative Materials**

<table>
<thead>
<tr>
<th></th>
<th>Agricultural Fibers</th>
<th>Steel</th>
<th>Plastic Lumber</th>
<th>Fly Ash Concrete</th>
<th>Engineered Wood</th>
<th>SIPS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cost</strong></td>
<td>Expensive MDI resin and storage requirements add costs.</td>
<td>Costly if transported long distances, due to weight.</td>
<td>Costly if transported long distances, due to weight.</td>
<td>Higher freight costs result from coal plants located far from construction sites.</td>
<td>Not a factor.</td>
<td>Not a factor.</td>
</tr>
<tr>
<td><strong>Structural Strength</strong></td>
<td>Strawboard still in laboratory testing for structural use.</td>
<td>Strongest material for its weight.</td>
<td>Not used structurally-except in decking.</td>
<td>Rates highly for structural use.</td>
<td>Rates highly for structural use.</td>
<td>Rates highly for structural use.</td>
</tr>
<tr>
<td><strong>Toxic Emissions</strong></td>
<td>No formaldehyde offgasing after installation. MDI is dangerous during manufacturing-if proper precautions not heeded.</td>
<td>Air and water pollution are serious risks during manufacturing process. No offgasing once installed.</td>
<td>Emits water and soil contaminants from additives.</td>
<td>Decreases CO2 emissions. Can leach heavy metals into water/air during storage.</td>
<td>Offgases formaldehyde for years after installation.</td>
<td>Hazardous chemical emissions inherent in the manufacturing process.</td>
</tr>
<tr>
<td><strong>Resource Availability/Extraction</strong></td>
<td>Straw is a waste product-no extraction needed.</td>
<td>Serious environmental risks from raw material mining</td>
<td>Utilizes waste product.</td>
<td>Utilizes waste product.</td>
<td>Sometimes utilizes wood waste--but often derived from tree plantations.</td>
<td>Foam core derived from petroleum. Tree plantations also used.</td>
</tr>
</tbody>
</table>
### Table 14.

**Summary:**

**Agricultural Fibers Versus Other Alternative Materials**

<table>
<thead>
<tr>
<th></th>
<th>Agricultural Fibers</th>
<th>Steel</th>
<th>Plastic Lumber</th>
<th>Fly Ash Concrete</th>
<th>Engineered Wood</th>
<th>SIPS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Energy Use</strong></td>
<td>Offers alternative to burning—use of waste saves energy during processing.</td>
<td>Very energy intensive. Thermal bridging also an issue.</td>
<td>Uses significant energy in transport due to weight.</td>
<td>Saves energy during cement processing. Can require high fuel use for transportation.</td>
<td>Wood walls are energy efficient.</td>
<td>Extremely energy efficient.</td>
</tr>
<tr>
<td><strong>Disposal</strong></td>
<td>100% biodegradable and recyclable.</td>
<td>All steel contains recycled content, but only 25% in residential steel material.</td>
<td>Chemically cross-linked plastic ends up in the waste stream.</td>
<td>Recyclable as an aggregate in new concrete, or as crushed stone in construction.</td>
<td>Oriented Strand Board derived solely from new trees. Other particleboard may be recycled for re-milling or mulch.</td>
<td>Not easily recycled due to foam-bonded materials.</td>
</tr>
</tbody>
</table>
A Note About Deconstruction

Although this paper focuses on manufactured alternative building materials, the deconstruction of existing buildings and reuse of building materials must be mentioned as an important method to reduce wood consumption.

It costs no more to recycle wood than it does to landfill. Perhaps with this in mind, deconstruction as a building tool has seen increased use since the mid-1990’s. Deconstruction contrasts with the term demolition because disassembly and salvage of materials are emphasized, whereas materials from a building demolition are generally only recycled or added to the solid waste stream. (Malin, 2000)

Just two generations ago, material reuse was the industry norm. However, increased mechanization, higher labor rates and worker protection laws now favor recycling or disposal of materials. In addition, changes in building systems, including complex load pathways, monolithic structural systems, non-modular components and the increased use of composite materials using laminates and adhesives, act as barriers to material reuse. Building design and building type determine the appropriateness of building disassembly. (Malin, 2000)

Another obstacle prohibiting wood re-use is the fact that some salvaged wood contains heavy metals and other toxins. For example, wood salvaged from decommissioned military installations like the Presidio can contain lead, plutonium, pesticides and other poisonous substances, making this wood unusable and slated for hazardous waste sites. (Loken, 2001)

Many contractors also identify time as the biggest obstacle to taking a building apart instead of knocking it down. Labor costs must remain extremely low to make wood
reclamation worthwhile. However, additional labor costs and time can potentially be offset by avoided disposal fees and added revenue for reusable materials. In addition, the building deconstruction industry provides new job opportunities for displaced workers. (Malin, 2000)

The cost effectiveness of building deconstruction certainly varies case-by-case, “but in the building trades, the myth that recycling and /or reuse always costs more is especially entrenched.” (Malin, 2000)

**Designing for Deconstruction**

Most new buildings are simply not constructed for easy disassembly. Designing a building for reuse is equally important to the utilization of resource efficient building materials. Deconstruction should be included in any plan or public education effort to curb our dependence on wood.
Building Codes

There are several reasons why alternative building materials falter in the marketplace. One of the most critical barriers is the U.S. building code system.

The U.S. building industry adheres to three general building codes: the Southern Building Code, Uniform Building Code and the National Building Code. These codes are developed by trade groups and adopted by individual states, usually with amendments. Individual counties administer enforcement of a state code. Different sections of each building code address different building types, applications and structures. (Edminster, 2001)

A builder may use a different construction material outside of building code specification, as long as a local building code official approves the new material. This acceptance, however, entirely depends on the open mind of the particular official. Changes to any building code are notoriously slow to occur. (Vittori, 2001)

Public safety is the primary responsibility of a building code official when approving materials for a project. For this reason, many officials are skeptical of new construction alternatives. Unfortunately, this skepticism leads many officials to overlook effective, safe materials that are produced with a less severe impact to the planet—and ultimately—to public health. According to Ann Edminster, staff architect for the National Resources Defense Council in San Francisco, “Environmental and planetary health are low priorities on the {building code} list.” (Edminster, 2001)
Building code regulations are updated, however, every three years, offering alternative materials the possibility of eventually being accepted into code. Catastrophic natural disasters, such as earthquakes and hurricanes, often provide the catalysts to change codes. The regularity of earthquakes in California and hurricanes in Florida, for example, have led these states to experiment with light gauge steel framing in residential construction.

**Industry Acceptance and Costs**

In addition, alternative building materials must gain acceptance by insurance companies, homebuyer's banks and real estate agents. Changes to building codes often reflect property damage and loss, due to pressure from the insurance industry. Industry pressure can work against the acceptance of alternative materials, but it sometimes works in favor, as in the case of light gauge steel. (Eastin et al, 2000)

Exorbitant financial costs present yet another obstacle associated with building code alterations. In order to qualify alternative materials for specific applications, a new material must pass scrutiny required under the International Code of Building Organizations (ICBO). The price tag to submit new materials for testing is steep. Yet without these costly ICBO test ratings, new building materials do not stand a chance of mainstream acceptance. (McGillivray, 2001)

The building industry thus views the use of new, unknown building materials as simply adding to higher final costs. According to Steve McGillivray, a southern California-based builder who, for the first time, is constructing a high-end, custom home made of recycled wood chips and concrete,
Many alternative building materials don’t have ICBO ratings yet and the code officers kick these materials back to the builder to test them. But builders often don’t have the money to test these materials. Maybe in some states with more relaxed codes, like Nevada or Wyoming, I could still use the material. But here in California where the codes are strict, you can’t just do what you want. (McGillivray, 2001)

Financial conservatism characterizes the building industry. Builders do not generally welcome experimentation or change, a critical obstacle to the acceptance of alternative materials. McGillivray wearily admits that his first experience utilizing green materials has been frustrating.

The building methodologies change when you use a new building system. Figuring out how to put in a house's utilities, like plumbing and the water system, plus attachments like windows and cabinets with a new method pushes costs up probably 25-30 percent and takes three times the amount of time to build. Plus, subcontractors bid on a competitive basis. When people don’t know how to bid on new, alternative materials, they double their prices because they don’t know how long it will take to work with the new system. And if the system fails, the builder has to eat the failure financially. It’s scary. (McGillivray, 2001)

Yet he acknowledges that eventual success of alternative building materials and methods ultimately relies on the nation’s builders. “Alternative building materials have to proliferate through the industry before they become efficient.” says McGillivray.

**Lack of Research and Development**

The building industry’s inertia is not entirely difficult to understand. Builders are liable for their structures. Because the safety of future occupants depends on a building constructed from tested, reliable materials, the building industry is extremely risk adverse. ‘We’ve been doing it this way for one-hundred years, why change?’ is a pervasive and difficult attitude to overcome.
Although in reality some alternative materials, such as straw, have been used for centuries and are not intrinsically more difficult to use or more costly than wood, the obstacle lies in simply convincing builders to try a new method. It is an uphill battle to overcome the building industry's lack of familiarity with new alternative building materials, because many people within the industry are simply unwilling to overcome their unfamiliarity.

Industry uncertainty also hinders innovation and the research and development of new products. Economic fluxes, such as shifting interest rates and unemployment levels, in addition to a transient labor force, result in a high degree of uncertainty within the industry. Consequently, many builders resist the research and development of anything new. (Edminster, 2001)

According to the Center for International Trade in Forest Products (CINTRAFOR), other factors contributing to the lack of research and development of alternatives include:

- variable sales;
- lower rates of profit;
- smaller firms;
- sparse management;
- low investment in capital equipment and specialized labor;

Fragmentation and the dominant presence of smaller firms within the building industry are major constraints to innovation. Smaller firms rely heavily upon individual raw material producers, manufacturers, suppliers, and subcontractors. This lack of consolidation results in discordant priorities and discourages research and
development. Large building firms are more likely to integrate their business than smaller firms. They are thus more inclined to try new building technologies and use a broader mix of substitutes. As a result, it is the fewer, large firms that tend to drive innovation in the residential construction industry. (Eastin, et al, 2000)

However, concern for the environment is not what drives large firms' use of substitutes. Rather, these builders take advantage of the cost savings inherent in alternatives, such as engineered wood systems, that lend themselves to a systematic building approach. Large builders' emphasis on multi-family, large-scale development projects provide the impetus to switch from pricey solid lumber to less expensive, systematic engineered wood.

The small, individual builder, on the other hand, is more likely to try less mainstream alternative materials, such as agricultural fibers, that may also have more actual environmental benefits. And these builders are still key to the industry. Despite the tendency towards market expansion and consolidation through acquisition, the top 100 builders of 1998 still held less than a 20% share of total residential housing starts. (Eastin et al, 2000)

**Lack of Education**

The residential construction workforce is traditionally transient and mobile. In many cases, carpenters are simply not aware that alternatives even exist. Retraining laborers is a difficult task, as a builder's crew usually changes from project to project. Consequently, teaching an entire crew to handle a new material and different tools can prove frustrating and fruitless, putting this responsibility in the hands of the alternative
building materials industry. (Edminster, 2001)

**Non-Industrial Products**

Many of the most highly acclaimed alternative building materials, from an environmental standpoint, are not researched and developed for wide-scale use because they are non-industrial products, also known as "base materials". Unlike plastic or steel scrap, materials like strawfiber and rammed earth are not bi-products of a particular industrial practice. No corporation stands to turn a profit on the development of these products. (Edminster, 2001)

As will be discussed later, this situation could change for straw-based products, as more U.S. farmers begin to utilize straw waste in lieu of field burning, due to recent state legislation banning this practice.

**Higher Expense**

According to Robert Habian, the first U.S. architectural designer to use a composite wall system made of recycled polystyrene and cement, "Builders have always thought that environmentally green building products and technology will cost them more. That's the message developers are getting." (Gonzales, 1997)

Although certainly not the case across the board, some alternative building materials are more costly to use compared to wood. More than any other barrier, higher costs prohibit experimentation with alternative materials, except in the rare instance when a homebuyer specifically requests a certain alternative product. The National Association of Homebuilders asserts that the cyclical and fragmented nature of the building industry,
tend to increase the costs and risks of conducting and implementing formal research and development, reduce its benefits, lower the amount of feedback from the housing industry's work force and markets, limit the range of search for new ideas and products and lower the prospects for sale of innovation. (Eastin et al, 2000)

However, it should not be assumed that the building industry's thriftiness alone is fully responsible for impeding the commercial success of alternative building materials. Many of the now struggling alternative building industries assumed consumers are willing to pay a premium for green homes. In reality, the majority of consumers refuse to pay higher costs for products deemed "sustainable" and "green". A study conducted by the Center for International Trade in Forest Products concluded that,

Although they may have strong feelings about the environment, typical U.S. consumers are still reluctant to pay a substantial premium for environmentally certified products... (Eastin et al, 2000)

Market research indicates that the 67 percent of American consumers interested in purchasing green building products are willing to pay no more than a 5-10 percent premium for these alternative materials. (Johnston, 2000)

Subsequently, when building industry innovation and the utilization of alternative materials occur, the following characteristics are usually present:

- Most changes are practical line extensions of existing problems;
- New innovations rarely alter the basic appearance of the home;
- Changes often result from technical or practical problems encountered in the field;
- Over the long-term, innovative builders will generate some competitive advantage over those who are reluctant to change. (Eastin et al, 2000)
Strikingly evident in the CINTRAFOR study is the fact that reduced environmental impacts rate low with both small and large building firms when considering and choosing alternative materials, as does energy efficiency.

Each one of the aforementioned barriers causes significant financial strains on U.S. alternative material producers. Pacific Northwest Fiber (PNF), an agricultural fiberboard company located in northern Idaho, daily combats these burdens, as well as other issues unique to fiberboard manufacturers. Though PNF's market longevity remains to be seen, every day this small, struggling company gains a little more ground in overcoming the complex challenges facing the green building industry.
A Tough Start

Highway 95 snakes south through Benewah County in Idaho's panhandle, skirting Washington's eastern edge. Endless, undulating fields of bluegrass and wheat surround the meandering two-lane route. Tucked among the picturesque, rolling Palouse Valley hills are several small towns belonging to an American era seemingly past.

To a visitor, Plummer, Idaho—population 1,000—may not appear different from any other small, western, natural resource dependent community. It is home to farmers, many who work the same land their homesteader ancestors tilled over a hundred years ago. The Coeur d'Alene Indian Reservation spreads across Plummer and 550 square miles of Benewah and neighboring Kootenai Counties. Until destroyed by fire in 1998, the Rayonier, Inc. sawmill was the primary employer of this community, providing jobs to 130 residents.

The razed wood processing plant was rebuilt and now boasts a new mill. Not one board foot of wood is processed here, however. Inside this facility, thousands of tons of straw waste, salvaged from nearby bluegrass and wheat farms, are transported, ground to a pulp, and heated and glued together into particleboard. The mill, Pacific Northwest Fiber, (PNF) is the only agricultural fiberboard plant in the intermountain United States. It is, in fact, only one of six, operating agricultural fiberboard plants in all of North America. (Kingman, 2001)
“We did this exactly backwards,” says Paul Dashiell, a tall, angular man, with silver hair and a sunburned face that looks to be in its early fifties. Dashiell owns and farms local bluegrass fields that have been in his family for 114 years. He is president of Pacific Northwest Fiber and also part owner of Seeds, Inc., a grass seed company owned by seven local families and a partial investor in PNF. (Dashiell, 2001)

By “starting backwards”, Dashiell bitterly refers to the fact that Pacific Northwest Fiber did not begin the way most businesses do. There was no new product idea, followed by a carefully crafted business and marketing plan. There were no handpicked investors eager to supply capital for start-up costs.

Rather, Pacific Northwest Fiber was born out of a last ditch effort to process more than 25,000 acres of rotting straw piles languishing in eastern Washington. The waste resulted from a 1997 ban, passed by the Washington State Legislature, prohibiting the burning of bluegrass and wheat stubble. For over 100 years, eastern Washington farmers burned their crop residues for a little over a month every year, during the July-August harvest season. (PNF Business Plan, 2001) Burning the straw stubble is not simply a means to rid fields of unwanted material. Many farmers view field burning, specifically the burning of bluegrass residue, as an integral component to maximize crop production and profits.

Burning the bluegrass stubble "shocks" the plants to regenerate and produce more seeds the following year. According to Richard Cramer, an Australian fiberboard expert brought to Idaho to manage PNF's processing plant, burning bluegrass residue after harvest can generate between 800-1000 pounds of new seeds the next year. The same plants, without burning, will only produce 200-400 pounds of seeds. (Cramer, 2001)
Farmers claim that bluegrass crops are essential to the Palouse Valley not only because they provide a livelihood in a volatile commodities market, but bluegrass also provides an important foil to soil erosion in a region under constant cultivation. Bluegrass roots maintain soil in place, saving tons of dirt every year and protecting watersheds from siltation. (Dashiel, 2001)

It may seem surprising that in a region long dominated by agriculture, a burning ban could even be discussed, let alone passed as law. The mandate was a response to growing pressure from residents of the Spokane and Coeur d’Alene areas, the two largest—and expanding—communities in the vicinity. According to David Bauermeister, a Washington-based farmer and general manager of Pacific Northwest Fiber, the burning ban stemmed from the region's newer residents, unaccustomed to local agricultural practices. (Bauermeister, 2001)

Both blame and praise for the burning ban are rampant among local residents. The 1997 mandate halted the fires on 25,000 acres of bluegrass seed production in the eastern Washington counties of Whitman and Spokane. In those same counties, over 600,000 acres of wheat fields were affected. (PNF Business Plan, 2001)

Though several area residents, including some farmers, believe the agriculture community should have foreseen the burning ban for several years, after the law passed, Washington bluegrass and wheat farmers abruptly had no place to go with 1,473,500 tons combined wheat and grass crop residues. The value of grass seed production alone in Spokane and Whitman counties totals $11,250,000, a number enhanced by the seed-spurring burning practice. (PNF Business Plan, 2001)
With the implementation of the ban, farmers hoped that closely raking and mowing their crop stubble with gigantic and costly machinery could simulate the benefits of burning. Yet Washington farmers still desperately needed a means to recoup their costs in straw baling operations. (Dashiell, 2001)

In states such as Oregon, farmers are able to bale their straw waste and export it to China, Korea and Taiwan as feed for dairy cattle. However, do to the more severe weather-related crop damage that occurs in eastern Washington, combined with the higher freight expense to ship from an interior locale, exporting the straw waste was not a realistic option for Washington farmers. Manufacturing the straw waste into feed pellets, paper, methane gas, electricity, and composting were also explored, but these options proved even less economically viable than processing the straw into building panels. As David Bauermeister concedes, the strawboard plant “was the least unattractive solution”. (Bauermeister, 2001)

The Coeur d’Alene Indian Tribe, eager to boost employment in a county with a shrinking timber base and an unemployment rate of 14 percent, joined Pacific Northwest Fiber as one-third partner. (Rosenbaum, 2001) PNF would operate in northwestern Idaho on newly purchased tribal land and the former sawmill site, processing unwanted crop residue from eastern Washington. The strawboard plant opened with an initial investment of six million dollars and a staff of forty in August 1999. (PNF Business Plan, 2001)

PNF’s strawboard product is certified, having passed required testing for use as floor underlayment, shelving inserts, doors, moldings, cabinets, countertops and furniture. To date, strawboard is not certified for structural uses, as more field-testing is
required. (Bauermeister, 2001)

Seeds Inc. coordinates with affected grass growers to remove and market the crop residues. As Paul Dashiell states,

Seeds believed that the industry would be more successful if a coordinated effort was made, rather than leaving each grower to deal with the residue on their own. Many growers cannot afford the investment in baling, stacking, and loading equipment, and a combined marketing effort has more potential than each grower being in competition with every other grower. (Dashiell, 2001)

Bluegrass operation costs are indeed high. According to Kyle Cordill, a field consultant for Seeds, Inc. and principal coordinator of the eastern Washington straw baling operations, each acre of bluegrass grown requires an initial investment of 200-300 dollars. (Cordill, 2001) Added to this are the new costs and time required to remove harvest residues. The straw baling process alone is a costly endeavor. Giant swaths are first needed to cut the grass crop, followed by combines to collect the plant heads and thrash out seeds. Massive rakes then collect the straw waste, followed by balers that move and stack the bales. Semi-trucks transport the bales to storage warehouses and eventually to PNF’s production mill. Finally, mowers cut the residue even shorter, in an effort to mimic the burning process and stimulate the plants to produce more seeds. (Cordill, 2001)

Just one combine can cost over $200,000 and the price tag for adequate storage facilities is estimated at $12 million. It is crucial the bales are protected from weather, as the manufacture of strawboard requires dry materials. High moisture content makes it difficult to grind the straw and can damage milling equipment. (Armstrong, 2001)
Kyle Cordill also notes that prior to the burning ban, bluegrass crop rotations were generally seven-ten years. Without burning, however, the rotation is significantly less; crops last between four-five years. Cordill states that it is difficult for a farmer to recoup his costs after only a four-five year period and thus extremely difficult to afford the added costs of the new baling requirements. (Cordill, 2001)

Some of Pacific Northwest Fiber’s production problems stem from the fact the company began in reverse. As Paul Dashiell explains, “We put in the plant and now we’re building all the infrastructure.” Clearly, PNF’s financial backers did not have ample time to consider the best economic and engineering options to initiate a competitive fiberboard plant. (Dashiell, 2001) However, a myriad of other issues also present Pacific Northwest Fiber—and all North American fiberboard companies—with an uphill battle to success.
Chapter 6

Market Barriers Facing the North American Fiberboard Industry

Tepid Government Assistance

Except for some “training money” available from the state of Idaho to any start-up Idaho business, Pacific Northwest Fiber received no state or federal funding from Idaho or Washington. When the Washington Legislature passed the burning ban, the bill mandated the state’s Department of Ecology to determine economically viable alternatives for straw waste. (Bauermeister, 2001)

Yet David Bauermeister contends, “Up to date, the position of the state of Washington has been that there is an {economically viable} alternative to field burning. Well, anyone involved in this project knows it is currently not economically viable. The only reason it’s viable is that the owners keep putting in more cash.” (Bauermeister, 2001)

During the 2001 Washington State Legislative Session, Bauermeister lobbied to pass a tax break, eliminating sales tax on all straw-based building products. Despite some legislative supporters, the bill was never heard on the floor. Wayne Meyer, a life-long northern Idaho bluegrass farmer and member of the Idaho Legislature Joint Finance Committee, concedes there is not much legislative support for Pacific Northwest Fiber. Meyer insists that, “Many legislators don’t really have a feeling for the mill.” since they
were not involved in the project from the start. Meyer also contends that Washington’s many coastal, urban legislators are not empathetic to eastern Washington’s agricultural concerns—and subsequently are not eager to learn about or lend support for the PNF mill. (Meyer, 2001)

Meyer, however, is invested in the mill, because in addition to his position as a four-term state representative, his family has grown grass seed for Seeds, Inc. since 1972. As part of Idaho’s appropriations committee, he approved a bill in the 2001 session, allocating money through the Department of Commerce to support the PNF. In addition, the Coeur d’Alene Tribe received a $500,000 grant from the state of Idaho for facility improvements. The money will be utilized to build additional straw storage warehouses. (Meyer, 2001)

Despite Idaho’s growing financial support, however, Meyer concedes that Pacific Northwest Fiber is in dire need of more government assistance in the future, specifically from the state of Washington. (Meyer, 2001)

**Undercapitalization**

Due to the lack of both government funding and private capital, Pacific Northwest Fiber was built on a shoestring budget. Although 6 million dollars is no small sum, it is a pittance compared to the start-up costs of today’s competitive wood panel board operations, some of which start at 300 million dollars. Don Lengel, a California-based wood and strawboard industry consultant, refers to Pacific Northwest Fiber as a “backyard operation” and states simply that the Plummer mill is “uneconomical and too small.” (Lengel, 2001)
Lengel insists that in order to have any chance of competing in an industry defined by narrow profit margins, an agfiber production facility must be large scale.

The efficiencies and consequent cost advantages of scale are inexorable, as can be amply demonstrated by the demise of most smaller panel board plants in North America in the last ten years; the smallest commodity type non-captive, non-specialty North American wood based panel plant today produced well over 200 tons per day. (Lengel, 2001)

Lengel contends that the relatively young and unproven agfiber industry's growth relies on pilot projects to attract both government and private capital. He claims that skeletal start-up budgets and undercapitalization always catches up to mill owners, due to the lack of efficiency, production capability and the coinciding high maintenance and production costs. (Lengel, 2001)

**Harvest Season and Storage Requirements**

Wood can be harvested throughout the year, stored green, does not usually require significant drying prior to milling, and is easily machinable. Straw, on the other hand, is harvested during a one-month period and must be dried before processing, requiring costly storage throughout the year. In addition, straw contains large amounts of silica and tramp material, which damages machinery and requires removal prior to processing. Unlike wood, straw's fibrous, course consistency does not lend itself to easy milling. (Lengel, 2001)

Strawboard prices assume 15-20 percent storage, cleaning and milling loss that is simply not a factor for wood. Accordingly, straw processing is generally more
economical than wood only when the straw facility is located closer to a specific market. (Lengel, 1999)

**Expensive Resin**

Strawboard is also more costly to produce because the resin used to bond the fibers, methylene diphenyl isocyanate, (MDI) is significantly more expensive than the formaldehyde-based resins used in engineered wood products. From a marketing perspective, industry professionals initially viewed MDI as the reason consumers would favor strawboard—not the reason they would shy from it. The agfiber industry quickly learned two harsh lessons. Consumers' demand for "green" building materials was grossly overestimated and, as mentioned earlier, consumers will not pay a high premium for green products. (Tennier, 2001)

Although much of the public claims to prefer environmentally sustainable and healthy products, when it comes to paying more for these materials, consumer resolve weakens. Although the MDI used in strawboard is formaldehyde-free and does not offgas like the urea and phenol formaldehyde used in wood based panelboard, most consumers are willing to tolerate potential health risks when a considerable cost advantage exists. (Malin, 1999-b)

The high cost of MDI is due in part from the fact that this resin is highly toxic before it is cured. Though the odorless resin is harmless to consumers, it is potentially dangerous to mill workers.
This concern places inordinate operating costs on small agfiber facilities. As Don Lengel states,

\[\text{The requirements for proper equipment, installation and training to forestall serious respiratory problems as a result of working in the area of MDI, particularly in the event of a fire, place a relatively heavy cost burden on smaller plants that may not be completely assumed. (Lengel, 2001)}\]

**Lack of Consumer Confidence**

As discussed earlier, a key to market success for any alternative building material relies on consumer and builder education. According to Richard Cramer, the lack of public knowledge about PNF's product is a major barrier to acceptance and expansion. He finds, however, that the education process often falls upon deaf ears. Cramer states, "[Builders] don't want to listen because it means one more step...and that puts costs up. It's very hard to educate people." (Cramer, 2001)

Contractors often assume that strawboard will--or should--handle like wood particleboard. However, to install strawboard, holes in the panel must be pre-drilled, as opposed to wood based panelboard, which does not require pre-drilling before placement. Contractors are often reticent to make these extra efforts because this can translate to higher construction and labor costs. As David Bauermeister states, "Just getting builders to change a fitting on their staple guns in order to try a different product is difficult." (Bauermeister, 2001)

John Tennier, a former executive with CanFibre, a New York-based manufacturer of building panels made from recycled wood chips, also points to the dilemma of improving a new product's quality while retaining consumer confidence. He states,
Once consumers are offered a comparable product, it must have a quality and ease of use that customers are used to. In the start-up of a board mill, there is always a period where the facility produces a lo-grade product due to issues surrounding the start-up. If care is not taken to procure a per-sell to a market familiar with this grade, then this inferior starter board is put into circulation. Consequently, there will be a negative backlash as consumers experience substandard product and are not easily won back, thus creating an image in the consumer's mind that alternative or recycled products are inferior. (Tennier, 2001)

Al Simpson, a Canadian importer/exporter of wood products and strawboard, agrees that as recently as three-four years ago, strawboard manufacturing in the U.S. was of such poor quality he could not export the product. He claims the process of working out the kinks in a new industry and subsequent quality problems, “have killed the business.” Due to a combination of poor funding and the use of low quality, used mill equipment, “Many of these mills put out products not up to wood standards.” says Simpson. (Simpson, 2001)

Distribution Snares

Yet another obstacle to market success is that commercial distribution networks are controlled by the timber industry. It is difficult for new, small companies such as PNF to break into the home improvement retail market because of the long-standing, personal relationships the timber industry has with these retailers.

Timber companies such as Louisiana Pacific and Weyerhaeuser employ their own staff throughout the United States to check and resupply Home Depot and Lowes’ shelves with products. Pacific Northwest Fiber, with an administrative staff of four, is
incapable of servicing every store to which it sells fiberboard. For companies like Home Depot, built on a foundation of rock bottom prices and unwavering customer service, PNF simply cannot meet retailer demands. (Bauermeister, 2001)

In the 1990’s, the popularity of green labeling and initial consumer demand for green products attracted Home Depot to carry alternative building materials, such as strawboard. When many of these alternative materials proved more expensive than wood and the "green demand" quieted, most strawboard products, including Pacific Northwest Fiber's, were pulled from store shelves.

Special products and customer loyalty to products made from local materials can also be important, however...if there is much of a difference in price to the customer, loyalty does not seem to go very far in influencing their selection. Many smaller companies find it difficult to meet the demands of these (home improvement) firms with respect to negotiating, pricing, packaging, transport...which frequently put a taxing demand on these items. (Lengel, 2001)

As a sales clerk at the Spokane, Washington Home Depot concluded, “I've been working in this business for over twelve years, and I've only been asked about green products maybe five times. Customers simply won't pay more, even if a product is better for the environment.” (Home Depot, 2001)

**Competition from Forest Certification Programs**

The proliferation of the wood industry’s internal forest certification programs has also dampened sales of strawboard products. As many of the large timber companies gain green certification labels for inexpensive lumber, small fiberboard companies are squeezed from the market.

In John Tennier’s experience, the average consumer barely reads the fine print to
determine the percentage of a product that is actually recycled or "green". Thus many certified, so-called "environmentally friendly" wood products, with marginal recycled content, out-compete strawboard because they are mass-produced, cheap and labeled with a feel-good green sticker. (Tennier, 2001)

**High Freight Costs**

David Bauermeister is encouraged by a growing interest in PNF's product among architects and builders in Seattle and along the coastal Interstate-5 corridor. However, the high cost of freight poses an obstacle to shipping to far-flung locales. The shipping costs of strawboard are high due to the material's heavy weight. (Bauermeister, 2001) John Tennier explains that, due to the added transportation costs, “Often the raw materials may not be cheaper than ‘virgin’ wood, while being touted as such.” (Tennier, 2001)

**The Quagmire of Federal Purchasing Programs**

Although people within the alternative building industry have mixed opinions on the effectiveness of government subsidies, one measure used to assist strawboard and other alternative building materials is federal procurement programs. These programs encourage federal agencies to utilize recycled and bio-based materials in federal building projects.

In 1993, President Clinton signed an executive order mandating that all federal agencies take preference in buying products made from “environmentally responsible” materials. This order affected federal agencies and the tenants of federally owned
buildings, rather than projects funded by the government, although funding recipients could choose to comply. (Schreffler, 1994) The order stated that federal agencies must:

strive to increase the procurement of products that are environmentally preferable or that are made with recovered materials and set annual goals to maximize the number of recycled products purchases, relative to non-recycled alternatives. (Schreffler, 1994)

"Environmentally preferable products" were identified as those with a lesser or reduced impact on human health and the environment when compared with competing products or services that serve the same purpose. The comparisons utilized complete life cycle analyses for each material. The Environmental Protection Agency (EPA) oversaw the development of Comprehensive Procurement Guidelines, identifying building products and other office products, such as paper, derived from recycled materials. The order also mandated the research and testing of potential green materials. (Schreffler, 1994)

Later, in 1998, Clinton issued Executive Order 13101 entitled, Greening the Government Through Waste Prevention, Recycling and Federal Acquisition. This EO stated:

Consistent with the demands of efficiency and cost effectiveness, the head of each executive agency shall incorporate waste prevention and recycling in the agency’s daily operations and work to increase and expand markets for recovered materials through greater federal government preference and demand for such products…. (EO 13101)

This executive order specified working with state and local governments to increase their use of recycled products and environmentally preferable materials that were cost competitive with traditional materials. (EO 13101) The EPA stated that it would “use government purchasing power to stimulate the use of these materials in the manufacture
of new products, thereby, fostering markets for materials recovered from solid waste.”

(40CFR Part 247)

These government actions are designed to ensure that alternative materials competitive in price, availability and performance succeed in the marketplace. However, federal laws and EOs languish from lack of implementation and enforcement. John Tennier agrees the legislative environment is critical to the success of alternative materials, but points out these efforts are weak because,

The policies contain the ubiquitous weasel clause about cost and availability. I do not believe any studies have been performed on the effectiveness of such legislation and whether or not it is being obeyed or effective. Many of the definitions for recycled content are defined by the EPA and are often crafted by trade groups or organizations with a consequent lack of clarity. (Tennier, 2001)

In addition, young companies like Pacific Northwest Fiber must maneuver through the often-impregnable federal government bureaucracy. Before federal acceptance, PNF is required to have its product approved by the General Services Administration, (GSA) the EPA and associated government purchasing agents. Even when an alternative product is approved by a federal agency, it does not guarantee the purchase or use of that product. Despite the fact that federal and state government agencies have 800 billion dollars worth of purchasing power, (Buckhalt, 2001) Eun-Sook Goidel, program officer with the EPA’s Environmental Preferable Purchasing Program, concedes that government officials, accustomed to purchasing from particular vendors, hinder the shift to new vendors—even if they offer a greener product. (Goidel, 2001)

Both Paul Dashiell and David Bauermeister wearily concur with this assessment. They have been working for over a year to add Pacific Northwest Fiber’s product on a
GSA list of federally approved, alternative building materials. PNF was informed by the agency that its product would appear on the government’s distribution list. However, due to an unexplained agency "oversight", the company's strawboard does not appear on any list. (Bauermeister, 2001) To elevate these policies above simply ink and paper mandates, implementation and enforcement funds must become available to the EPA to overcome inertia. However, Pacific Northwest Fiber lacks the financial reserves, staff, or time to launch an organized, sustained lobbying effort to encourage government utilization and inclusion of strawboard.

Poor Marketing Strategy

Al Simpson plainly states, “The agfiber industry in North America has failed because of their marketing strategies.” (Simpson, 2001) Indeed, the lack of a clear marketing strategy may be the downfall of many alternative building industries. According to John Tennier, the marketing effort for alternatives must be two-pronged. First, says Tennier, a product must be effectively introduced into the market. Second, the producer must ensure the necessary support to instruct the buyer on how to effectively utilize the product. This has not occurred to date. (Tennier, 2001)

Every alternative building material, whether steel or strawboard, has particular construction specifications and requirements. Within the construction market, the first step to guaranteeing an alternative material's success is to ensure that architects can use it to specify and substitute. In addition to designing projects, architects issue specifications for what material to use and where to use it. If steel studs are not specified, for example, they cannot be used in a project. (Tennier, 2001)
In addition, many building materials fall under the category of commodity market goods. Like all commodities, they are subject to fluctuations of the market. These shifts can be large, sudden and a company must have sufficient management skills and money to weather these bad times. Small companies often do not have these survival resources. (Tennier, 2001)

The agfiber industry's best solution to offset these challenges may lie in niche markets. As Don Lengel states,

The plain, simple, hard truth is that unless an agricultural residue composite panel made in North America has some special attribute that will carve out a sufficient market share that cannot be reproduced easily by wood based plants, the agricultural residue-based plant must be capable of competing directly with wood-based plants on economic and product quality bases. At present, no such valid special attribute is evident. (Lengel, 2001)

Without competitive niche markets, government support, whether in the form of loan guarantees, tax incentives or grants, is often money down the drain. Ron Buckhalt, Senior Marketing Specialist for the Office of Technology Transfer of the Agriculture Research Service, believes that agricultural fibers and other alternative materials have tremendous market potential, but the lack of marketing expertise, combined with government funding spread too thin across marginal companies, has ultimately failed the alternative building industry. Buckhalt believes that the government must begin acting more as a real venture capitalist, rather than a social one, while green industries develop realistic marketing strategies. (Buckhalt, 2001)
Chapter 7

Recommendations

Non-wood residential construction materials face a dizzying array of barriers to overcome. There is one certainty. No single solution exists to decrease U.S. consumer demand for wood products derived from ancient forests and large-scale chip mill operations. A successful effort to decrease the cutting of forests at risk and increase the use of alternative materials must be broad-based and involve a combination of strategies.

Build Efficiently

Before non-wood building alternatives are even adopted by the residential construction industry, every builder should incorporate the fundamentals of resource efficient building. One of the best ways to ease pressure on forests is to use the wood we do cut more effectively to reduce waste.

It is estimated that at least 10 percent of construction lumber could be saved in conventional U.S. homes if building practices were changed. (AIA, 1994) In its publication, Efficient Wood Use in Residential Construction, The Natural Resources Defense Council (NRDC) provides builders with eight methods to incorporate resource efficient methods in residential construction:

- Build small.
- Choose a resource efficient location.
- Use simple, flexible designs to avoid the need to remodel.
- Avoid designing for a narrowly defined market.
- Make structure durability a priority.
• Use materials and designs that can be easily disassembled.
• Minimize waste by carefully purchasing only the amount of wood needed.
• Collaboration between the developer, architect, engineer and builder is important so that resources can be combined and efficient.

The efficient practices described above typically reduce the wood used in a new home by 15-30 percent. Furthermore, houses that generate less building wastes save money. Builders who adapt waste reduction practices generally save at least $300-$800 per job site. (Edminster, 1998)

**Expand Incentive Programs**

Due to the lack of enforcement of green building executive orders and other legislation, market incentives may prove one of the most effective means to encourage the use of alternative building materials. Pacific Northwest Fiber and similar companies can benefit from efforts to incorporate incentive-based, green building programs throughout the country. A green building program would enable PNF, for example, to introduce its product to regional and local builders, architects, developers and community leaders.

This type of program does exist. The EPA currently provides funding for the *Build America Program* (BAP), an initiative that teams the EPA with the Department of Energy (DOE), Department of Housing and Urban Development (HUD), the General Services Administration (GSA), mainstream home builders, and environmental organizations in an effort to devise resource efficient and environmentally sound methods to build homes.

The *Build America Program* approaches green building pragmatically. BAP
encourages the use of environmentally preferable materials through the promotion of the related economic savings and efficiency. BAP is currently active in several cities, such as, Santa Barbara, Santa Monica, Portland, Seattle, San Jose, Boulder, and Austin. These cities have adopted voluntary “green measures” that provide marketing incentives for builders to utilize on projects. The incentives succeed by making the often agonizingly slow building permit process more efficient and faster—if a builder proves that his/her structure will provide innovative, improved energy efficiency or improved indoor air quality, for example. (Edminster, 2001)

Ann Edminster, staff architect for NRDC, stresses these incentives, "don't have a lot of teeth. They are more like pats on the back.” The Build America Program cannot force builders to use green materials. (Edminster, 2001) However, at a time when green building mandates languish, these "pats on the back" may prove effective. Pacific Northwest Fiber could benefit from the facilitation of a Build America Program in the Spokane, Washington region. This effort would provide critical exposure for PNF's product and improved access to wider commercial market.

Facilitate Pilot Mills

Despite tension between the wood product and strawboard industries, Don Lengel stands firm in his belief that the most realistic means to succeeding in the alternative panel business is to connect a fiberboard company to an operational wood particleboard mill. Lengel is investigating such a proposal. He has support from the North Carolina Wood Department to develop a strawboard panel business in conjunction with a wood-based, medium density fiberboard mill. He plans to modernize and expand an existing
wood mill, if he can successfully raise the 30 million dollars needed to do so. Lengel plans to utilize profits made from the sale of wood-based MDF to support operations of the fiberboard pilot project. (Lengel, 2001)

He envisions this project as a two-stage process. First, the pilot plant would engage in research and development of non-wood panel products. This would, in Lengel’s opinion, secure an adequate market before the strawboard was actually produced. Once the strawboard component of the plant proves itself technically and economically, “The mill could try operating a week at a time solely on agfibers. And then we’d see if it worked.” (Lengel, 2001)

If this method proves successful, only then would a second mill be built, devoted solely to agricultural fiberboard production. Mill operators and staff would be trained at the pilot plant. Lengel is quick to add that environmental organizations and private foundations could--and should--play a major role in this venture by helping to secure funding for the agfiber pilot project and offering general support. (Lengel, 2001)

By tying the fiberboard business to the wood business, Don Lengel believes success is assured. In fact, he is positive this method is the only means to future success for the fiberboard industry.

**Grow Business Community Support**

Jim Armstrong, public information officer with the Spokane County Conservation District, asserts that alternative building materials will ultimately succeed if consumers and the building industry make the difficult shift from a short-term to long-term perspective. Armstrong stresses it is vital to include homebuilder associations,
appraisers, banks, developers, county commissioners, chamber of commerce, city council members, legislators, and mortgage and insurance companies in the alternative building industry equation. For example, Armstrong states,

The appraiser has to be willing to take into account the fact that the energy efficiency of this [alternative] home in the long term is going to add value to that home, so that it may appraise at $180,000 instead of $160,000 ... The appraiser must give the long-term energy value for the homes at a higher value in the long-run so that the banks will be willing to loan the money for them. (Armstrong, 2001)

He adds, “It’s going to be real estate companies, it’s going to be the Spokane Home Builders, it’s going to be those people with the money, with the say-so, with the power and all those corporate entities that are going to make it or break it.” Armstrong has found that when financial institutions are educated about alternatives, they are willing to cooperate in support of environmentally sensitive buildings and materials. (Armstrong, 2001)

**Tax Credits? Hotly Debated**

There are different opinions within the alternative building industry regarding the efficacy of tax credits to bolster green building. Leaders of Pacific Northwest Fiber have vocalized support for tax credits to encourage the use of their product, and several states are pushing for tax credit legislation to support green technologies.

In May 2000, New York State became the first to pass “green building tax credits”. The credits go to building owners and tenants who invest in recycled and recyclable building materials, improved indoor air quality, and energy efficiency. These credits could serve as a model for similar federal legislation. (NRDC, 2001)

However, according to Alex Wilson, former editor of Environmental Building
News, “…tax credits did more harm than good to the solar water heating industry in the 1970s and ‘80s, and I don’t want to see the same mistakes repeated with the broader green building industry.” **He outlines four reasons tax credits fall short.** (Wilson, 2000)

- Tax credits create an artificial market driver that may foster growth beyond what is economically sustainable. If tax credits were to be eliminated by a new administration or congress, sudden, shrinking markets could damage fledgling industries.

- Tax credits may be unnecessary. The photovoltaic industry has maintained healthy market growth without them.

- New technology tax credits send a subtle message to consumers and taxpayers that these technologies are not yet cost effective. This message may have thwarted the solar industry in the 1970s.

- Tax credits open opportunities to fraud. Some companies may be enticed to increase the purchase price of their technology, enabling the buyer to receive the maximum tax refund, returning some of the inflated purchase price in the form of a finder’s fee for the next customer. Similar scams occurred within the solar industry during the 1970s and 1980s.

Although Wilson raises valid concerns, tax incentives for alternative building materials do have merit. Most successful American companies and products were—and continue to be—fostered with tax credits and other forms of government subsidies. New technologies require financial assistance to reach target markets and consumers. Tax credits have
proved effective in meeting this need. Products like strawboard especially need tax incentive programs to compete with heavily subsidized wood products. Alternative building materials simply cannot compete with wood on the uneven playing field that currently exists. Tax incentives promoting the use of alternative building materials offer one step to leveling the field. Finally, state and federal tax incentive programs offer tangible steps to transitioning U.S. consumer preference towards the use of products that reduce waste, utilize renewable, biodegradable materials, and support economic development initiatives in underemployed locales.

**Bolster Research and Development**

Alex Wilson suggests other methods to support the green building industry, which have widespread industry support. First, he believes enhanced funding for research and development is critical, combined with low-interest bank loans to green product manufacturers to complete their research. (Wilson, 2000) This endeavor will require a federal commitment to enlist experts to research and develop solutions to current technical issues surrounding alternative materials. Funding of independent facilities responsible for testing alternative, non-wood materials is integral to this solution. (Roddy, 2001) In addition, Wilson states that government agencies should be mandated—*and the mandates enforced*—to regulate the purchase of green technologies and materials for government building projects. (Wilson, 2000)
Remove Timber Subsidies and Externalities

As recently mentioned, the playing field must be leveled for non-wood building materials to fairly compete with wood products. This sentiment has widespread support from many within the alternative building industry, in addition to environmental organizations, legislators, taxpayer/consumer advocates, and citizens who call for the removal of many of the subsidies supporting the timber and other extractive industries.

Subsidies exist for nearly every industry imaginable, including farming, ranching, dairy, timber, newsmagazines, and steel and airline industries. Subsidies are indeed beneficial in helping fledgling companies make inroads against large, established industries. However, many of the current subsidies to U.S. and Canadian timber industries result in inefficiency, degradation to natural resources, and exorbitant costs to taxpayers. In the U.S. alone, the public lands logging program operates at a net loss of nearly 1 billion dollars per year, the consequence of below cost timber sales and lack of environmental regulatory enforcement. (National Forest Protection Alliance, 2001)

Total government subsidies to the British Columbia timber industry amount to approximately 2.8 billion dollars every year. These subsidies stem from several factors: below cost land tenure (rent) provided by the Canadian government to logging companies; below market cost stumpage (cutting) fees to timber companies; lack of enforcement of environmental regulations; lack of compensation to First Nations people for logging constitutionally protected ancestral lands; and direct government payments for costly mill bailouts. (B.C. Coalition for Sustainable Forest Solutions, 2001)

The financial burden of runaway subsidies and restoring lands devastated by poorly regulated logging practices falls on taxpayers. In addition, the aforementioned
subsidies create what economists refer to as "displacement costs", displacing jobs that would otherwise be available from new industries, such as Pacific Northwest Fiber. Although vested timber interests argue the timber subsidy maze is necessary to respond to the social needs of rural communities and keep these communities afloat, these financial crutches artificially depress markets and rob rural communities of more efficient economic producers and industries. (National Forest Protection Alliance, 2001)

The current timber subsidy framework inhibits innovation and investment in new industries. Phasing out just some of these subsidies would allow companies like Pacific Northwest Fiber the opportunity to truly compete with wood in the marketplace, creating a value-added industry and fostering stable, long-term employment. Finally, some industry professionals even suggest a new tax on corporate practices that pollute and damage the environment, to encourage resource, energy conservation and the utilization of less polluting building materials. A similar "consumption tax" on environmentally damaging products could encourage consumers to demand more resource efficient goods and services. (Bowyers, 2001)

Initiate Regional Training Programs

Regional training programs should be established around the country for alternative building material applications, especially in regions where builders are receptive to these products, such as the Pacific Northwest and California. Preference should also be given to displaced wood industry workers and citizens in high unemployment urban and rural areas. Training programs will not stem from builders in charge of projects. These initiatives must come from alternative material manufacturers
themselves, in the form of in-person education workshops and video and literature training materials. (Couette, 2001)

**Revise Building Codes**

Non-wood building materials will not flourish if dramatic revision of U.S. building codes does not occur. Current U.S. building codes favor wood products, reflecting an era when timber was viewed as an inexhaustible resource. Most alternative building materials do not fit into wood-frame design parameters. The few that do fit the wood code designs are those materials capable of resisting high tensile forces, such as concrete and steel. Materials like rammed earth and straw, however, cannot compete in the marketplace under this current system. (Roddy, 2001)

A new section of the U.S. building codebook is necessary to standardize the approval and inspection of buildings constructed of alternative materials.

**There are several necessary steps to initiate this process.** (Outram, 1995)

- First, the overall efficiency of an entire building should be used to assess energy efficiency throughout the year, rather than just the R-value (the resistance of a material to the passage of heat) of an individual building material. This method of analysis would encourage energy efficiency through design, while providing materials such as straw or recycled plastic a chance to compete with sawn and engineered wood.

- Second, existing test results for alternative materials should be gathered for inclusion in a new code section. A variety of independent tests have already been conducted in the US and abroad. An effort is now needed to compile the data to ensure that tests are not duplicated. Results must be standardized to ensure they are not left to the interpretation and will of individual building inspectors.
Third, a builder or homebuyer should be allowed to take some of the burden of responsibility when building with alternative materials. Liability fears hamper building officials from issuing permits for structures and materials with which they are unfamiliar. If an individual desires a particular type of house using alternative materials, he/she should be allowed to take some responsibility for it.

Finally, building code approval is the cornerstone of bank financing and insurance for any new building project. Banks shy away from a residential development project unsanctioned by building code, even if a builder can point to successful existing structures. However, banks and insurance companies are willing to invest once alternative materials and methods are codified. Just adding a separate section to U.S. building code for alternative materials could release the enormous untapped potential of many new industries.
Chapter 8
The Role of Environmental Organizations

Pushing Home Depot and similar retailers to carry alternative building products is certainly important. However, this effort alone does not go far enough in securing a market for non-wood materials. Environmental and forest protection organizations can impart several long-term strategies to foster more environmentally sustainable businesses, such as Pacific Northwest Fiber. John Kingman, PNF's marketing director is frank in his advice. "Instead of throwing out opinions and platitudes, they {environmental organizations} should get involved to put together a program of support." (Kingman, 2001)

Lobbying Assistance

Kingman believes that environmental organizations are most effective with direct lobbying efforts. He would like to see environmentalists initiate direct involvement with both state and federal lawmakers on behalf of alternative industries like PNF. Kingman suggests environmental organizations are skilled at reaching decision makers and "carrying the message"—especially a message on behalf of the public good and public health. (Kingman, 2001)

He also asserts that a trans-industry trade organization is necessary to enhance lobbying efforts and garner widespread financial support for the alternative building industry. As there are relatively few U.S. strawboard, recycled plastic, residential steel and other non-wood manufacturers, Kingman believes a trade group comprised of every
alternative, green industry is necessary. Environmental organizations could also be a component of this group. (Kingman, 2001)

An organization such as the Sierra Club could assist these efforts by canvassing producers of various alternative building products in different regions of the country, in an effort to bring together the different manufacturers under one umbrella. (Kingman, 2001) Non-profits could assist a trade group with needed research, such as compiling data on premiums paid for green building materials and homes, (Taylor, 2001) or summarizing life cycle analyses for legislators and other decision makers.

Getting the Message To Consumers

According to Tom Taylor, founder and CEO of the Seattle-based Environmental Home Center, a home improvement retailer specializing in green building materials, environmental organizations can play an important role in consumer education. Taylor does not think the corporate boardroom focus of the Rainforest Action Network and others have been productive in the long-term because most consumers "don't even know what FSC certification is." He believes consumers need significant education to understand what makes a product truly green, as opposed to a product that simply has a green label. He believes public outreach and education is a perfect and critical niche for non-profits to fill. (Taylor, 2001)

There are many avenues to accomplish this goal. First, environmental organizations should make a commitment to inform their membership about alternative, non-wood building materials. Organizations can publish a series of educational articles in newsletters and magazines about the current selection of alternative building materials,
including comparative life cycle analyses and information regarding performance and cost competitiveness. This same information could be developed for organizations' websites. Just as important, information should be dispersed about the companies who manufacture and distribute these products.

Companies that manufacture alternative building materials should be sought and encouraged to advertise their products in magazines with a green readership, such as *Sierra* and *Audubon*. Also available is a wide array of nature and environmental oriented magazines not associated with a particular environmental organization, such as *Outside Magazine* and *Mother Jones*. These publications offer untapped advertising potential. Pacific Northwest Fiber could open new market avenues by exploring these and other national publications.

**Accessing Target Markets**

Manufacturers can gain valuable information about target markets if alliances are established between green companies and local and regional environmental groups. For example, Sierra Club’s Spokane and Seattle, Washington groups could provide Pacific Northwest Fiber with links to green markets, if local Sierra Club leadership and PNF’s management initiate possibilities for collaboration.

These collaborative efforts should include field trips to PNF’s mill, advertising and articles aimed at local Sierra Club members, collaborative fundraising/grant possibilities, and opportunities to introduce PNF and its product at future Sierra Club and other environmental community events.

Finally, to maintain and strengthen alliances, invitations to local and regional
environmental leaders to serve on the board of directors and advisory boards of alternative building companies should be explored. John Kingman notes,

> Environmental organizations have maybe been put off by the 'for-profit' aspect of the alternative building industry. These groups need to know how costly this industry is and that people are losing money. Maybe then {environmental groups} would be more eager to take an active role. (Kingman, 2001)

The National Forest Protection Alliance (NFPA) provides a network of environmental organizations large and small working to end commercial logging on national forests. These organizations are precisely ones that could lend support to struggling alternative industries such as PNF. The NFPA regularly lobbies federal lawmakers on behalf of its bill to end commercial logging, restore national forests, and foster non-wood building materials. Lobbying efforts encouraging the research and development of agricultural fibers and other alternative materials must naturally be a component of this initiative. Companies like PNF could be well served by establishing contact with the NFPA.

It remains to be seen whether Pacific Northwest Fiber will survive under current market conditions. However, if environmental organizations seek to curb or replace the public’s demand for wood, their commitment is required to ensure that alternative, environmentally sustainable building industries do survive and flourish. This may not be an easy move for some groups, because it will require an open mind towards for-profit outfits. It may also necessitate communication and some cooperation with organizations and individuals historically at odds with environmentalists, such as homebuilder associations and arch conservative lawmakers. Case in point is Idaho Governor, Dirk Kempthorne, and former Idaho congresswoman Helen Chenoweth, no friend of environmentalists--but vocal supporters of Pacific Northwest Fiber.
Rhetoric regarding the need for appropriate, non-wood residential construction materials can be seen and heard in environmental organization literature and soundbites. Environmental leaders must move beyond this phase to ensure that concrete, viable solutions take place to help the PNFs of the world survive. Otherwise, their soundbites sound hollow and the call for fiberboard and strawbale construction is carried by the occasional dreadlocked, patchouli-reeking visionary. While the messenger's intentions may be earnest, the National Association of Homebuilders is not ready for this messenger. Established, recognizable environmental organizations and their leadership must make the effort to deliver the message about the benefits of non-wood, green building materials.

Consumer preferences and demand continue to drive forest policy and practices here and abroad. The dwindling ancient forests of the U.S. and Canada and the amazing array of forest dependent species will probably not be saved on court battles and unilateral trade quotas alone. As consumers, we must shift our preferences to building products that do not require the felling of a 1,000-year old tree for decking material. With companies like Pacific Northwest Fiber in their backyard, environmental organizations have a unique opportunity. They can help ensure that consumers make the long-term transition to building materials that are plentiful, easily renewable, non-toxic, and would otherwise go to waste in a world that can not afford to throw away its natural resources.
Chapter 9

Conclusion:
Both Sides Have Much to Gain

The purpose of this paper is not to suggest that environmental organizations such as Sierra Club make an overnight shift and suddenly launch major campaigns in support of alternative building materials. Rather, the goal of this research is to inform environmental organizations, particularly those that focus on forest related issues, as to the merits and challenges facing alternative building materials and the industry. It is this author’s hope that the research provided can mark the beginning of substantive, long-term professional and political relationships with the alternative building material industry.

The environmental community is poised to gain significant environmental and political successes from establishing a connection to alternative building industries, such as Pacific Northwest Fiber. These potential victories require substantial time, effort and a long-term outlook, however, which prove challenging for environmental organizations faced with limited resources, staff, and ever varying environmental issues requiring immediate action.

Establishing communication with a company like Pacific Northwest Fiber will not provide immediate wins, such as halting a timber sale or a stopping a mine permit. The payoffs exist, however, and are indeed politically valuable. For example, if the Spokane Sierra Club builds a relationship with Pacific Northwest Fiber, agreeing to assist the company in publicizing its strawboard to Sierra Club members and actively working to establish new target markets, the organization is poised to make some requests of its own. Perhaps PNF would publicly support important Sierra Club campaigns, especially those
focused on forest conservation and logging. Would PNF publicly stand by the Sierra Club, for example, if the Club initiates a campaign to protect a wilderness area critical for salmon habitat? Would PNF support the National Sierra Club’s long-term goal of providing federal funds to restore and regenerate overcut forests, rather than log them? The potential payoffs will never be known if no relationship is forged.

It is not assumed that building a working relationship will be easy. Relations between environmental organizations and industry have a shaky history, built largely on mistrust, fear and bitterness. Neither party should assume that new relationships established between environmentalists and the alternative building industry translates to consistent support on every environmental issue or industry concern. However, there may exist incredible opportunities for particular, key wins.

For environmental organizations, working with companies like Pacific Northwest Fiber offers the much championed—but rarely found—opportunity to gain political inroads with labor, industry and powerful lawmakers and lobbyists. In addition, a potentially tremendous public relations opportunity arises for environmental groups. Environmentalists, especially those working in the rural, historically resource-dependent west, have long been accused of "anti-business" sentiments and uncaring attitudes regarding the livelihoods and economic development of rural people and communities. Actively supporting the use of Plummer, Idaho strawboard could shift this negative perception and broaden the Club’s base of support, particularly in rural areas.

In return, a fledgling company like PNF gains new marketing outlets, access to potentially thousands of "green" customers, lobbying assistance, and its own significantly enhanced P.R.—especially in urban locales like Seattle, home to many environmentally-
minded inhabitants and members of environmental groups. Finally, through all of these new political associations and public relation conquests, there hopefully lies the biggest winner of all--native forests. If environmentalists and the alternative building industry successfully join forces and shift consumers' preference away from old growth Canadian softwood and towards sustainable building materials, the goal of preserving the last big trees and dwindling forest biodiversity may just be more attainable than ever before.
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