

INNOVATIONS IN DESIGN & CONSTRUCTION
OPPORTUNITIES FOR THE WOOD INDUSTRY

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Executive Summary

The wood products industry is not generally recognized as having a creative, innovative approach to product development and marketing. Yet dramatic changes in wood products have occurred over the past several decades. A recent tour of a new home under construction revealed those changes in great clarity. Less than 5% of the wood in the house was traditional solid wood framing lumber. Instead there were finger jointed and oriented strand studs, both floor and roof trusses, laminated veneer lumber headers and carrying beams, pressure treated oriented strand posts, insulation board wall sheathing, and oriented strand board roof sheathing. This is not to mention the wood plastic composite decking and rail systems as well as the fiber-cement based siding and trim. This is dramatically different than the traditional stick built home of only 10-15 years ago.



Photo courtesy Dovetail Partners

There are several factors driving change and innovation in the wood products industry. The three most prevalent of these are:

- The changing resource from large long-rotational trees to smaller short-rotational species,
- The increasing use of “fiber” in a variety of end products from the siding above to the bio-fuels of the future, and
- The increasing influence of the green market on the design of construction projects.

Discussions of the impact of the changing resource base have been well documented in the literature for over twenty years, so this article will not attempt to rehash those points. In addition, a recent Dovetail Report “Biomass Energy – From Farms to Forests, an Emerging Opportunity for Rural America¹” discussed the role of wood fiber as a bio-fuel resource. Therefore, this article focuses on the impacts of the green movement on the design and construction industry and the opportunities offered to wood product manufacturers.

The Green Movement and Significant Consumer Trends in Building Design

It is highly likely that the future of the construction industry will be significantly influenced by the growth of and innovations from the green building sector. It is also

¹ <http://www.dovetailinc.org/DovetailBioenergy0306.html>

likely that current energy trends and rising concern about water supplies will shift what has been slow adaptation of products such as water heater blankets, on-demand water heaters, low water usage toilets, and energy efficient appliances to a mode of much more rapid integration of similar products into building codes and lending practices. The emergence of a marketplace that appears more ready, willing, and able to accept environmentally driven change than at any time in the past offers an opportunity to truly integrate green concepts and creative design into the complete construction process. It suggests an increased need for customization, value-added products, and more fully developed relationships between the customer and supplier; all very good things!

Growth of Green

According to a report by McGraw-Hill Construction and the National Association of Home Builders, builders that consider themselves “green” grew 20 percent in 2005, and that number is expected to increase another 30 percent this year (Joyce 2006). Considering the provisions of a number of emerging green building standards and a nation focused on a possible energy crisis, building design has to respond. The emerging design trends include smaller home sizes, more prefabricated homes, more strategic placement of windows, more integration of outdoor and organic elements, more multi-family homes, more planned communities, increased interest in energy-efficient appliances and greater preference for materials that have low embodied energy, are low maintenance or recycled and recyclable, or have other environmental attributes.

Designing Smaller Homes

In 1944, the G.I. Bill of Rights led the way to what is known today as the suburbs of America. Loans backed by the federal government provided an opportunity for many people to purchase housing that previously they could not afford. Demand during and since this time for the “American Way of Life” has raised housing sizes and also the number of single-family homes. According to the National Association of Home Builders, the average home size in the United States was 2,330 square feet in 2004, up from 1,400 square feet in 1970 (NAHB 2006). The programs started in the 1940s also turned out to be more successful in encouraging home ownership than even the most optimistic might have anticipated. Today, home ownership in the United States is higher than at any time in history, with the average size of new homes also at record levels. Increasingly, today’s homeowners are finding that these large homes are difficult to maintain and especially expensive to heat and cool. But even this hasn’t stopped home designs from getting larger and larger; until now.

Building Survey Shows 20% Growth in 2005, 30% in 2006

Source: GreenBiz.com

NEW YORK, May 3, 2006 - Preliminary results of a McGraw-Hill Construction/National Association of Home Builders (NAHB) survey indicated that there was a 20% increase in 2005 among those in the home building community who are focusing their attention on green, environmentally-responsible building, which is expected to increase by another 30% this year.

http://www.greenbiz.com/news/news_third.cfm?NewsID=30948&CFID=14465690&CFTOKEN=15252380

Green Communities is the Enterprise Foundation's five-year, \$555 million initiative to build more than 8,500 environmentally healthy homes for low-income families². One objective of the initiative is to build smaller homes because they are more cost-efficient to build and less expensive to operate and maintain – all key factors in producing truly affordable housing. Building a house for less is a great achievement, but if the tenant cannot afford to heat and cool the house upon occupancy, there's really no point.

Smaller homes use less material, and from an environmental standpoint, this is a very good thing. The smaller building footprint takes up less space and has less impact environmentally. Recognizing these benefits, the US Green Building Council's (USGBC) green building standard for residential buildings, LEED-H, gives preference to smaller home sizes. For example, a 3-bedroom home that is 1,300 square feet receives 6 points, while a 3-bedroom 1,900 sq.ft. home receives 0 points. A 3-bedroom home that is 2,300 sq.ft. is penalized -4 points (USGBC LEED-H).

Sarah Susanka, author of the best-selling book *The Not So Big House*, points out that smaller spaces are cozier and more "human-centric" than over-sized investment-based living quarters. She notes that "a house in which every space is designed for everyday living is far more satisfying than one with unused formal spaces for formal guests who never show up." This idea is one being celebrated by many, as the book spent more than two years as one of the top five best sellers on [Amazon.com](http://www.amazon.com)'s home-and-garden list, and has since generated a number of "Not So Big" spin-off's.

Smaller housing footprints per family unit are common for affordable housing, increasingly likely for an aging population, and possible for the population at large. With energy concerns at the forefront, and environmental concerns beginning to drive change in fundamental approaches to building design and construction, we may see a growing trend toward this type of design. That a general trend toward smaller homes could develop in the U.S. is suggested by trends among aging baby boomers in some regions toward slightly smaller, single level homes but with all the "bells and whistles;" meaning significantly more cabinetry, trim work, and specialty products such as wood inlays in the floors (e.g. medallions). This group is actually often spending more on a "nicer" smaller house than they might have on a larger home. Should upscale but smaller become more common this could translate to lesser demand for commodity products but increased opportunity for specialty products. In this kind of environment, manufacturers capable of flexible production and customization would likely have a significant advantage over single product dominated commodity manufacturers.

Open Floor Plans

The ability to create open floor plans has facilitated the creation of comfortable small homes with an expansive feel to them. Initially common in the design of condominiums, open floor plans have become more common in single family dwellings as well. Open floor plans maximize small amounts of space. They also feel more comfortable because they utilize natural light better, promote interaction between people and rooms, and are

² For more information, <http://www.greencommunitiesonline.org>.

easier to heat and cool than closed-floor plans. They also use fewer materials than a house with a lot of walls (although depending on the plan they may require more structural support).

The implications to the housing industry are apparent in the increased usage of composite structural panels and structural support components in the house, including trusses. These allow for greater openness than traditional construction methods. In the future, adaptation of these methods to allow for greater individuality amongst homebuyers and builders may include an increased use of laminated beams that can be curved, shaped, or similarly customized. Access to technology such as new CNC software and equipment can provide each homeowner with beautiful expanses at competitive costs.

Prefabricated Buildings and/or Components

Today, for many structural segments of a building the use of prefabricated components such as trusses is the norm and fully prefabricated buildings have been growing as a segment of the construction industry for the past thirty years. This growth is occurring in part because the building shell can be erected in much less time than conventional framing allows. Installation of prefabricated panels can take 50% less time than it takes to stick frame a home.



Photo courtesy Talor Building Systems
<http://www.talorbuildingsystems.com/>

The use of panelized components can also increase the efficiency of materials use. According to the USGBC, “conventional framing techniques use about 15 to 20 percent more framing material than is structurally needed.” Not only do panels take less time to build, but they also generate less waste. Technology makes it possible for a home to be custom-designed and plans generated through a computer program, which helps a factory make these pre-fabricated panels to whatever custom size is needed, all the while still using fewer materials and generating less construction waste. Panel production optimizes use of lumber through the computer-generated models, and because the floors, walls, and ceiling arrive as pre-built panels, there is also virtually no cutting waste on site. Site waste is reduced and the job site is much cleaner in general. Some prefabricated panels even come with insulation already installed. These technologies can change how homes are designed and influence the entire construction process.

A key additional advantage to prefabrication is also the ability to control the environment within a factory setting for the application of certain finishes such as “stucco” and the complex insulated wall systems of today. Some of these systems are sophisticated enough to require “certification” of application.

Strategic Placement of Windows

A very wise window executive once said, “We must always seek to understand why people take a perfectly good wall and put a hole in it.” Today, technology makes that discussion more pertinent than ever before.

Depending on the way you look at it, windows either help or harm the energy efficiency of a house. Between 1/3rd and 2/3rds of heat loss typically occurs through the windows of a house. On the other hand, windows help with solar passive heating by allowing heat to transfer into the house. Windows with low-e glazing are also effective at keeping the captured heat inside the home. Today many windows come with low-e glazing or are filled with argon to help deflect any heat loss. Also, having windows to help with cooling in the summer can be very beneficial and more energy-efficient than other cooling methods. More windows also mean more natural light, which in turn transfers into less need for artificial lighting. Besides saving in energy costs, a home with a lot of natural daylight has been proven to be more comfortable than a house without (Susanka).

Because of the potential impacts of windows and growing concerns over energy-efficiency, careful positioning of windows to maximize the energy gains and minimize the energy losses will likely be increasingly considered in building designs. Innovations in window design and function may also be important for serving market interests. Also, the basic concept of the location of the home and how it is positioned on the site may be considered more carefully.

Improved building performance and durability

Perhaps the most important need in the building construction industry and in the residential sector in particular is to find ways to improve building performance and durability. All buildings require inspections before inhabitation, but still many houses get by with ducts that are not completely sealed, or with insulation that barely fills the wall cavities, with vapor retarders that are torn or improperly sealed, or with windows that leak. It is not uncommon for a worker to tear off wall portions and discover mold, rotting wood, or incompletely insulated cavities. The Federal Trade Commission says that 7 out of 10 homes are under-insulated.

Green Building Standards are helping to raise the bar regarding building performance and durability. These programs offer additional opportunities for homeowners to have their property inspected and the building performance verified. The Energy Star program, for example, requires that a complete evaluation of a structure be completed before credit is awarded. A new program of the federal government has also given priority to energy efficiency in the home. The program, Federal Tax Credits for Energy Efficiency, offers a \$2,000 tax rebate for new homes that exceed 2004 building codes for energy efficiency by 50 percent. Again a home inspection is required to verify attainment. The program also offers tax credits for energy efficiency improvements to existing homes, manufacturers of energy efficient appliances, and commercial building owners or designers.

Besides the federal rebate program, many local utility companies offer incentives for building a more energy-efficient home. Some offer an energy consultation at a reduced rate and tips on how to improve your current home. For larger new construction projects, Xcel Energy offers their Energy Design Assistance program, which is free and includes an energy audit and design strategies for making the building as energy efficient as possible (Energy 2006). Utility companies also offer programs to encourage homeowners to purchase new, more energy efficient appliances. For example, Xcel Energy offers a \$350 rebate for a 15+ SEER rating on an installed Energy Star air conditioning unit (Rebates 2006).

While each standard and program is a little bit different, many people attempt to meet more than one. A homeowner may be interested in the federal guidelines, the Energy Star program and maybe another local program as well. Many Energy Star testers realize the potential for multiple programs to be part of a single project and are already working closely with construction crews to achieve both Energy Star and the federal standards in an efficient way. Until these tests and review practices become more standard, the builder may find them inconvenient or disruptive at the job site. However, this collaboration creates an important partnership and opportunity for serving the customers.

Besides energy efficiency, consumers are also interested in indoor air quality, and it has become a large focus in the building industry. This demand has begun to affect ventilation systems in homes, and the types of materials used indoors. Tightly sealed homes can translate into stale indoor air. Quiet running fresh air intake systems designed to achieve specified levels of air exchange are more and more common. In addition, people with chemical sensitivities or asthma are increasingly interested in paints, adhesives, and construction materials that contain no volatile organic compounds (VOC's). Some of these trends have a direct impact on wood products, whether it is lower VOC materials or greater interest in specialty framing products that better accommodate the higher volume of in-wall technology and airflow systems.

Builders and construction related industries that understand these trends and the testing requirements of the various programs are in a better position to accommodate them and thereby serve their customers' interests. This kind of dynamic should also help to raise building quality standards.

More integrated design

Through many of the emerging green building standards that are now gaining recognition, builders are discovering that collaboration with the project partners at all stages of the construction process is increasingly important to the success of a project. In other words, a static approach to building is no longer as effective. As project designers and customers require greater environmental performance from their buildings, a robust process of planning and construction management is needed to ensure the entire spectrum of environmental attributes and opportunities are accounted for and addressed. As more and more people begin to request healthy, energy efficient homes, the design method itself will need to change. The most likely trend is toward a more collaborative and inclusive design planning process. From the beginning, expect to see some sort of

certifier, from Energy Star for example, to sit down in the initial meetings and follow through during the entire process. Even a client wanting to build her own single-family home may be asking for tips on energy efficiency, design, and materials, and will very likely benefit from some sort of integrated design process in order to achieve her goals.

The trend toward a more inclusive planning process may mean that wood product suppliers may be asked to participate in early design meetings or to answer questions of how their products may help meet specific project objectives. Companies that have the ability to respond to these requests, participate in these planning sessions, and constructively address the customer's questions may benefit from this trend.

Integration of Outdoor and Organic Elements

The natural environment has always been an important complement to the built environment. Design and construction trends in recent years indicate a growing use of natural elements, such as increased gardens and landscaping, water features, and tree plantings. The design of the landscape is also linked to meeting the goal of energy efficiency. Coniferous trees may be planted to block winds during the winter months; deciduous trees planted on the south side to shade the home in the summer and allow solar heat gain in the winter.

Well designed landscaping not only has the potential to influence energy usage, it also provides habitat for wildlife and assists in stormwater control. In the world of green building, water management is very important. To reduce the need for an extensive irrigation system to maintain the landscaping, drought-resistant vegetation and plants that are native to the area can be



Photo courtesy Dovetail Partners

effective and are increasingly popular. The use of rain gardens to capture runoff from rooftops and other surfaces can help manage stormwater and reduce the transportation of pollutants or nutrients from the site. Landscaping to reduce the area of lawn or turf grass can help minimize the air quality and environmental impacts of mowing and reduce maintenance requirements.

Incorporating more nature into design is one area that has the potential to become extremely innovative in the future. One aspect of this innovation, the green roof, is continually gaining attention, even though this idea is not new. For centuries, humans have covered their roofs with dirt and planted wild grasses and other hardy vegetation on top of them.

There are different types of green roofing systems. An ‘extensive green roof’ uses a small amount of soil – about 3 to 8 inches, and is only for vegetation – meaning that it doesn’t have the amount of support needed for humans to walk upon, and only holds smaller plants. An ‘intensive green roof’ requires more structural planning in the design phases. It holds between 8” to 4’ of soil and usually can be walked upon. Both extensive and intensive roofs require some type of waterproof membrane, and an anti-root system to keep roots from puncturing the membrane, and some sort of drainage system. This, in addition to the soil and the plants themselves, can be very costly. For this reason, alternatives such as “white” roofs and “modular” green roofs are now being used.

Instead of the typical dark-colored heat-absorbing roof, “white” roofs help to keep the building cool by reflecting light. This less-expensive alternative to a vegetated roof can also be applied directly over the existing roof (Tatum 1999). The “modular” green roof can also be applied directly over the existing roof. Modular grid systems usually consist of trays of plants lined up and spaced appropriately over the roof. This should work in the same way as a normal vegetated roof, and is less expensive. Although not as heavy as an installed green roof, roof load still needs to be assessed. One drawback to note is that placing something over a roof will often void the roof’s existing warranty.

Besides its obvious aesthetic qualities, these approaches to alternative roofing help keep a house cool in the summer and insulated in the winter. Green roofs also absorb many of the sun’s rays. Because of the “urban heat island effect” (a phenomenon where the city’s temperature is higher than surrounding rural areas due to solar energy radiating heat off of urban surfaces, such as pavement and typical roofs) governments have begun looking at green roofs as a way to keep their cities cooler. Germany, Japan, and Canada, just to name a few, all have government initiatives to introduce green roofs into their cityscapes (Dawson 2002). In New York City, *Greening Gotham*³ is championing the same type of initiative and many nationwide programs have been developed as well. Besides combating the heat island effect, green roofs still do what they did centuries ago – help maintain a building’s interior temperature. Today, they also help keep energy consumption and costs down.

Wood product companies interested in serving clients with interests in green roofs will need to be familiar with these technologies and understand how their products perform in these applications.

Becoming More Innovative

Successful innovation can be described simply as “serving customer wants and needs in new and creative ways.” It is important to note that innovation can be industry specific, so that what is innovative in one industry may be extremely common in another. One of the simplest ways to attain innovative ideas is to gain a broader and/or deeper understanding of another industry (preferably one more on the leading edge – e.g. cell phones, IPOD’s or freight) and apply those concepts to your own business. For example,

³ www.greeninggotham.org

for those trying to ship small volume, low cost goods to local customers – Domino’s pizza delivery system might be the example.

The challenge for the wood products industry is in recognizing when innovation matters. A key example is a comparison between oriented strand studs and fingerjointed studs. The question is, whom is the innovation dominantly designed to serve.

In the case of the fingerjointed stud, the original primary goal in their development was to improve production efficiency and reduce waste. The fact that fingerjointed studs stay straighter is a feature of the end product that has potential as a benefit to consumers. Yet for some buyers, the appearance of a fingerjointed stud is such that it connotes poorer quality (you still have wane, knots, size variation, etc in a fingerjoint) and thus carries much of the baggage of the worse qualities of traditional framing plus all the concerns over the joints themselves. Alternately, an oriented strand stud has none of those issues and has the benefit of products like oriented strand board (OSB) already breaking the ground for them in terms of customer acceptance. For oriented strand studs the result is not whether or not customers are willing to buy them; the question becomes how much more they are willing to pay for the better product. The result is, for many builders, they are using the oriented strand studs in critical areas where straight consistent material is the primary need. Oriented strand products have real benefits to users that are defined by the user, e.g. consistently sized and stable parts for doors, and are a material that is almost infinitely flexible in its usage. As a result it is a highly innovative product/material from the market’s point of view and serves the customer’s interests. This approach contrasts with a fingerjointed stud that is dominantly good as a.... stud which is basically developed as a way to get rid of cut pieces of lumber and primarily serves the industry’s interests.

The greatest opportunities for innovation in the coming decades will be in identifying products and services that primarily aim to serve the customer’s interests.

Green, Innovation, Design, and Wood Products

The key benefit that green brings to the construction industry is that for the first time in a long time architects, builders, homeowners, and code developers are rethinking the “whys” of how design and construction choices are made. The status quo is no longer sufficient and a more integrated approach is being considered. Under this light, wood stands out as a unique material, infinitely flexible and renewable as well. The opportunity arises for the industry to partner with those with needs and provide innovative solutions.

The key is for the wood industry to participate in these trends and understand what the new design elements are trying to achieve. By gaining a greater understanding of where design trends are going, companies will be better able to anticipate customer’s needs. Wood is infinitely flexible and creative, but people are not. Finding partnerships that link manufacturers closely with the needs of the marketplace and working with individuals that welcome change and innovation is critical.

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