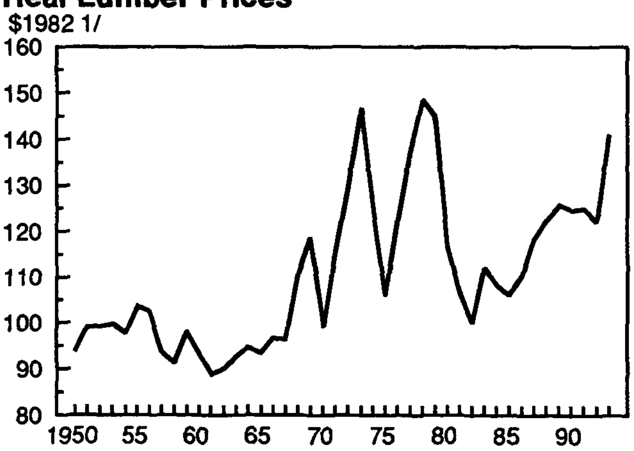
# As Longrun Lumber Prices Rise, Industry Shifts To Engineered Wood Products and Explores Other Materials

*Real lumber prices are volatile but trending upward in the long run, reflecting lower public timber harvests, speculation, and other supply and demand factors. In response, engineered wood products and wood substitutes are becoming more attractive. Steel framing is making some inroads into traditional lumber use, but wood remains the predominant building material for residential construction in the United States.*

The residential construction industry, which is dominated by individual builders and its associated supply industries, accounts for 12 percent of U.S. Gross National Product. Over 60 percent of all lumber, plywood, and other wood-based building products is used to build, repair, or alter homes. Wood is the primary building material for most residential construction in the United States. Nearly all single-family houses and most multi-family housing units are built of wood. Recent reductions in timber harvests from federal lands and environmental concerns about timber harvests in world rain forests have led to questions about the adequacy of timber supplies.

Concerns about the availability of wood products for homebuilding have occurred before. Often, these concerns are triggered by violent fluctuations in lumber prices. The real (adjusted for inflation) price of lumber has risen rapidly in response to short-term supply and demand imbalances (figure 8). In the 1970's, real lumber prices increased 50 percent, and nominal prices more than doubled. After declining sharply in the 1980's, prices remained relatively stable until 1993, when increased housing construction, combined with reduced harvests in National forests and other factors, led to a dramatic rise in prices. Although the price of some lumber products nearly doubled, the real price of lumber is still less than the 1970's peaks.

Figure 8
**Real Lumber Prices**




1/ Nominal numbers deflated by the Producer Price Index.

**Wood Framing Still on Top**

Efforts to industrialize the housing industry have led to promotion of alternative materials and construction methods that are more amenable to factory mass production. These efforts were particularly strong during the housing shortage after World War II and during the Operation Breakthrough housing program, which was sponsored by the U.S. Department of Housing and Urban Development's (HUD) in the early 1970's. However, wood-framed housing has stood the test of time and remains the dominant technology for home construction in the United States.

Since the late 1920's, people have tried to industrialize homebuilding by using new materials, such as concrete products, metals, and even plastics, to replace wood as the basic building material. Two of the most noteworthy alternative systems used metal as the basic building material. They were Buckmeister Fuller's Dymaxion House and the Lustron House. The Dymaxion house used advanced engineering principles and metal stress-skin like aircraft construction. The Lustron house used porcelain-enameled steel panels as the basic building material. Both were financial and market disasters for the developers and their investors.

Other attempts were made in the 1950's and 1960's to use nonwood materials, but none were a lasting success. A number of houses were built with concrete or cinder blocks, but they lost popularity because of problems with insulation and alteration. In 1969, HUD established Operation Breakthrough to encourage greater efficiency and the use of new technology in housing. Of over 20 projects, only two reached commercialization and both used wood framing.

Wood-framed housing systems are successful because they can be adapted to components, such as doors, windows, or trusses, that are manufactured and shipped to the site. Greater use of prefabricated housing components, and even entire housing units, generally has made wood-framed housing competitive with other materials. In addition, most houses use roof trusses and many use floor trusses that conserve on wood use.

## Engineered Wood Products Increase Their Market Share

Engineered wood products have evolved in the last 30 years to provide replacements to traditional wide-dimension wood that have durability, strength, and consistent performance characteristics. These products combine wood veneers and fibers with adhesives to make wide-dimension lumber, beams, joists, headers, and other structural products. Advances in adhesive technology have made these products possible. For example, waterproof phenolic resins allowed the development of composite products for exterior use. Engineered wood products also make use of lower quality wood resources, which may come from smaller trees or from species that have not been fully utilized. These products can be substituted into wood building systems using the same general techniques of construction, thus having the advantage of fitting into the existing technological and distribution system.

One of the most promising innovations are wood I-beams, which are typically made from 2- by 4-inch, machine-stress graded lumber or laminated-veneer-lumber (LVL) flanges that are grooved to receive oriented-strand board (OSB). I-beams can be used to replace wide-dimension lumber for headers, rafters, floor or roof joists. A number of manufacturers are commercially producing I-beams with a wide range of characteristics, designs, and materials standards. For example, Boise Cascade Corporation has developed a new framing system utilizing the firm's I-beams and other engineered wood products: BCI Joist wood I-joists, Wersa-Lam vertically laminated veneer lumber, and Versa-Lam Plus horizontally laminated lumber. Several I-beam manufacturers have received HUD approval under the auspices of the Department's Technical Suitability of Products Program.

The advantages of I-beams are uniformity, light weight, dimensional stability, length of span, speed of construction, installation with conventional tools, and low cost. The estimated cost of a 2- by 12-inch I-beam is about $1.50 per linear foot. Based on 1993-average prices, 2- by 12-inch-dimension lumber costs about $2 per linear foot.

A new type of engineered wood product called parallel-strand lumber (PSL) became commercially available in Canada in 1988. PSL was developed by MacMillian-Bodel Ltd. of Canada, which now makes the product in the United States under the name Trus Joist MacMillian. The PSL manufacturing process uses veneers cut into 1/2-inch strands, which are then aligned and pressed into blocks with adhesives and cured under pressure with heat from microwaves. The blocks are cut into various sizes, depending upon the application.

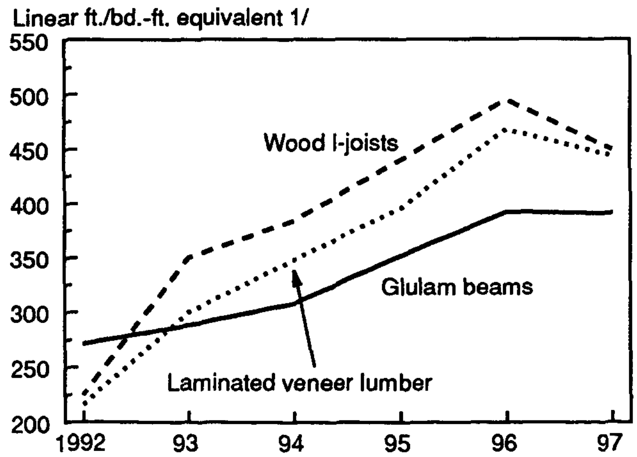
The main advantage of PSL is its strength and design flexibility. PSL products are three times as strong as conventional sawn timber and could challenge steel and concrete as a building material. The products also have an attractive appearance and can be used for exposed applications. Costs of 4- by 12-inch PSL products range from $6 to $7.50 per linear foot.

Glue-laminated (glulam) materials consist of 1- or 2-inch lumber that is glued together in stacks to a desired shape and size. The individual, laminated pieces may also be joined at the ends with adhesives for longer lengths. Glulam products emerged in the 1950's for use as beams, columns, and arches for heavy timber-framed structures, such as churches, park shelters, and outdoor pavilions. Curved glulam beams that span over 500 feet have been used in sports and multi-purpose arenas. Presently, glulam materials are used for load-bearing beams and conventional wood construction, especially when the beam is exposed for aesthetic purposes.

The demand for engineered wood products is growing dramatically. The market for wood I-joists and beams, LVL, and glulam is expected to double between 1992 and 1997, according to the American Plywood Association. Wood I-joists are projected to double from 225 million to 450 million linear feet (figure 9). High lumber prices could further boost I-joist use. LVL sales are expected to grow from 216 million board feet in 1992 to 444 million in 1997. Use of glulam beams is expected to increase from 271 million board feet to 391 million during the same period. Although new to the market, PSL use is also expected to climb. The expected decline in demand between 1996 and 1997 shown in figure 9 is due to a projected decrease in housing construction.

A study by George Carter and Affiliates estimated that the number of builders using some type of engineered wood product rose from 38 per cent in 1989 to 77 percent in 1992. Carter predicted that LVL usage would rise by 137 percent by the year 2000, I-joist and beams by 140 percent, and glulam by 30 percent.

Figure 9
**Projected Use of Engineered Wood Products**




1/ Linear feet for I-joists and board-feet equivalent for glulam beams and laminated veneer lumber.

Source: American Plywood Association.

Wood panel composites, such as particleboard, OSB, and waferboard, have also replaced lumber and softwood plywood in a number of construction applications. The next generation of composite materials, made with recycled wood and newspaper fibers and straw and other biomass fibers, are now appearing on the market. These composites will be discussed in further detail in the December 1994 issue of this report.

**Alternative Building Systems Are Evolving**

Steel, concrete, and plastic-containing materials have made inroads into nonresidential and residential construction. Steel is strong, durable, noncombustible, and versatile. It is already used for many commercial lodging structures and high-density, multi-family, residential buildings, where fire codes are an important consideration. A large construction company in Hawaii announced that it would use steel framing in its new projects. Steel framing is used in a substantial proportion of Japanese multi-family home-building. Steel also has advantages for light-weight, prefabricated housing systems, which could be used worldwide because of low weight-to-strength properties.

The disadvantages of steel systems are that special tools and fasteners are needed for construction, and residential construction workers are not accustomed to working with steel. Also, local officials are unfamiliar with steel framing's capability. More engineering analysis is needed for builders to adopt steel systems. There are also problems with noise transmission and heat conductivity. Nevertheless, if wood prices continue to rise rapidly, steel framing may become more competitive with wood systems.

Nu-Steel (Suwanee, GA) has successfully marketed steel framing systems in Australia and hopes to establish 500 marketing outlets in the United States in the next 10 years. Mitek Industries (Chesterfield, MO) has developed cost-effective steel and truss framing systems that compete with wood in light-frame construction, and the firm offers computer design and engineering assistance. Tri Steel Structures, Inc., (Corinth, TX) plans to triple its production of steel-framed houses from 500 units in 1990 to 1,500 in 1994. The National Association of Home Builders estimates that the share of steel-framed houses could expand from less than 1 percent to 5 to 15 percent in the future if lumber prices continue to rise. Other systems combine steel and wood in integrated systems to take advantage of the best properties of both materials.

Concrete systems have been used for many years for nonresidential building and for large, residential buildings. Concrete has been used for single family houses in moderate climates, such as in Florida. However, several new systems have been developed to increase the insulation value of concrete and masonry walls by incorporating foam insulation into the building systems. Light-weight ceramic/concrete systems have been developed and used in Japan for manufactured housing.

Another system for residential construction utilizes foam-core structural panels, which are a sandwich of OSB outer panels separated by a light-weight, thick, low-density core, such as polystyrene or polyurethane foam. Sandwich panels were originally developed by USDA's Forest Products Laboratory in the 1930's. Work on the concept continued in the 1950's and 1960's, until an established system for building was developed. A number of buildings, including homes, are now constructed using the foam-core system. Foam-core structural panels can be used in conjunction with heavy-timber framing that does not have load-bearing stud walls. The advantages of this system are speed of construction, high insulation value, wood conservation, and compatibility with existing wood products.

The National Association of Home Builders Research Foundation is studying three demonstration foam-core homes built in Desert Hot Springs, CA, by Banter Building Products, Inc., (Santa Anna, CA). The 1,987-square-foot houses were built with wall and roof panels, so there are no rafters or trusses and, consequently, there is room for a 250-square-foot loft. The panels themselves are the structural load-bearing system. They are 2.5 times as strong as conventional construction, which makes them more resistant to earthquake damage. The foam acts like a web and the OSB skin like an I-beam. The foam-core construction also offers superior insulation efficiency. The panels themselves have high insulation values, plus they reduce air infiltration because they fit so tightly together.

Researchers from the Massachusetts Institute of Technology's Innovative Housing Constructions Technology Program recently designed and constructed a demonstration house that uses a net-shaped-roof component system using foam-core panels. Tests indicate that the fairly complex roof system was easy to construct in a factory and could be installed in 3 or 4 hours. The demonstration house has performed well through two New England winters. Foam-core panels show real promise as an alternative housing system that eliminates the need for wide-dimension lumber and is yet compatible with standard wood-building techniques.

Additional tests of wood-frame versus foam-core-panel construction are being conducted for the National Renewable Energy Laboratory, the Structural Insulation Association, and the Modular Building Institute by Modular Building Systems (Arlington, TX). The objective is to compare identical modules for energy efficiency and performance. In another project, Shell Building Systems (Valley Ford, CA) completed a California winery building in 79 hours, compared with 4 to 6 weeks required for conventional construction. The company had already completed a 49,000-square-foot apartment and office complex for $2.20 per square foot less than conventional construction costs, with heating and cooling expenses cut in half. [Thomas C. Marcin (608) 231-9366]