LAMINATED VENEER LUMBER: A UNITED STATES MARKET OVERVIEW

Richard P. Vlosky

Ph.D. Candidate
Wood Products Marketing Program

Paul M. Smith

Assistant Professor
Wood Products Marketing Program

Paul R. Blankenhorn

Professor
Department of Wood Technology

and

Michael P. Haas

Research Assistant
Wood Products Marketing Program
School of Forest Resources
The Pennsylvania State University
University Park, PA 16802

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ABSTRACT

Laminated veneer lumber (LVL) is an all-veneer engineered wood product that has appeared in the marketplace as a replacement for increasingly scarce high quality solid-sawn lumber in structural applications. As one possible response to increasing environmental pressures, LVL is considered to be superior to recycled steel and plastic, concrete, stone, and brick in terms of energy requirements to produce. Because this product is a relatively new entrant in the family of engineered wood products, its rapid technological changes and/or new product-market development opportunities are discussed in the context of the product life cycle (PLC). Market growth for LVL is expected to increase, resulting from increased product awareness and acceptance and increasingly attractive in-use price/performance factors.

Keywords: Laminated veneer lumber, engineered wood products, U.S. market overview.

INTRODUCTION

Laminated Veneer Lumber (LVL) made its first appearance in the United States marketplace in the early 1970s under the name MICRO=LAM, developed by Trus Joist Corporation (now Trus Joist-MacMillan) (TJ International 1991). It took more than ten years before the next North American company entered the market. These first production lines had small production capacities but quickly created demand niches that outstripped supply. Increases in production capacity have grown quite slowly, with only the second half of the 1980s bringing a significant increase in supply due to expansion by existing companies and new players entering the marketplace. Today, Trus Joist-MacMillan produces the majority of LVL marketed in North America.

LVL is an all-veneer structural engineered wood product composed of thin veneers oriented in the same longitudinal direction for

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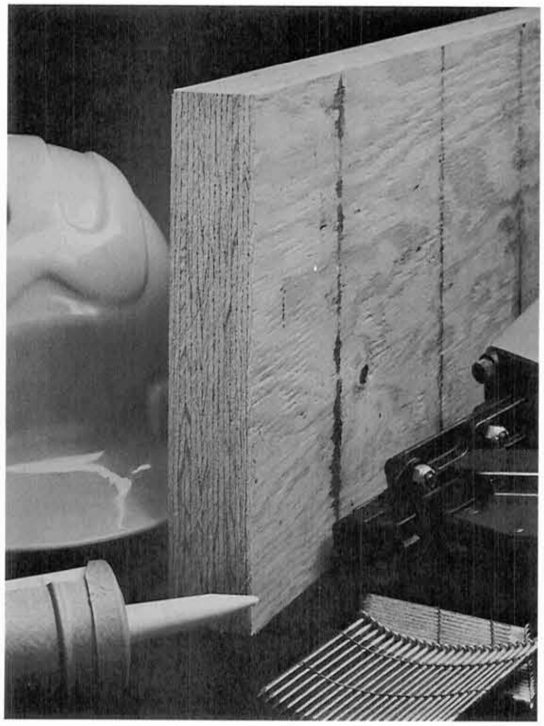

FIG. 1. Typical LVL member (photo courtesy of Trus Joist MacMillan).

maximum strength and stiffness. In the past fifteen years, considerable volumes of LVL have appeared in the marketplace as a replacement in structural applications for increasingly scarce high quality solid-sawn structural lumber (Youngquist 1985). In industrial applications, LVL, unlike glulam beams, is generally recommended for nonvisual applications that are concealed or wrapped to achieve a desirable appearance (Fig. 1). Youngquist and Bryant (1979) suggested that the motivating incentives that existed at that time for commercialization included: 1) the diminishing supply of large logs suitable for manufacturing lumber of large dimensions; 2) the economic feasibility of using a larger percentage of the forest biomass at the harvest site previously considered forest residue; and 3) the cost advantage of complete utilization of all materials entering processing. The potential for using smaller logs was particularly attractive where log size was likely to diminish in the future (Koch 1976), a projection that has become reality.

LVL has been identified as superior to recycled steel and plastic, concrete, stone, and brick in terms of energy requirements to produce (Anon. 1993). According to a study supported by the National Science Foundation and conducted by the Committee on Renewable Resources for Industrial Materials (CORRIM), steel floor joists and framing members were found to consume 50 and 13 times as much energy, respectively, compared to wood (Boyd et al. 1976). Moreover, aluminum framing materials require 20 times as much energy compared to wood framing members, and brick veneer siding is about 25 times as energy-intensive compared to wood-based siding materials (Boyd et al. 1976). Procedures such as lifecycle environmental accounting (LEA), also called life cycle analysis (LCA) are being used to compare the environmental impacts of solid wood and other building materials, such as engineered wood products, including net resource depletion, net energy consumption in manufacture, and energy efficiency in end-use (Mater 1994). Clearly, the environmental advantages of wood, a biodegradable renewable material, are evident. The ability to utilize forest resources better via reconstituted wood composite technology provides further arguments supporting optimistic market share projections (Boyd et al. 1976; Leonard Guss Associates 1993).

The majority of LVL is made by continuously laminating rotary-peeled veneer in thicknesses of either $\frac{1}{10}$ or $\frac{1}{8}$ in. Like plywood, it is produced from 8.5-ft logs peeled to create sheets that are clipped to 54-in.-wide plies. Green veneer is dried, and sorted to conform to minimum C and D veneer grades described in Product Standard PS-1-74 for softwood plywood (Kunesh 1978; Youngquist and Bryant 1979). At this point, the veneer is shipped in bundles to an LVL production facility. Individual plies are successively stacked to achieve the desired billet thickness. Plies within this billet are coated with a waterproof adhesive, then consolidated with a hot press configura-

TABLE 1. *Summary of typical design values for commerical lumber composite products.*

Lumber composite	Modulus of elasticity (E)	Design value for extreme fiber in bending (F_b)	Design value in tension parallel to grain (F_t)	Design value in horizontal shear, on edge[a] (F_v)	Design value in horizontal shear, flat[b] (F_v)	Design value in compression perpendicular to grain, on edge[a] ($F_c\perp$)	Design value in compression perpendicular to grain, flat[b] ($F_c\perp$)	Design value in compression parallel to grain ($F_c^{\parallel}$)
LVL products[c]	2.0×10^6	2,900	1,800	190	285	525	880	3,035
Parallam PSL	2.0×10^6	2,925	2,400	210	290	525	880	2,900
TimberStrand LSL	1.2×10^6	1,500	1,250	150	285	335	570	1,450

[a] Edge refers to load application parallel to the wide face of the strands (LSL, PSL) or parallel to the gluelines (LVL).
[b] Flat refers to load application perpendicular to the wide face of the strands (LSL, PSL) or perpendicular to the gluelines (LVL).
[c] Design property values of LVL are based on the Trus Joist MacMillan Registered Product Southern Pine Micro=Lam. These property values will vary slightly for LVL products manufactured from Douglas-fir or other species and other composite manufacturers.
Source: Janowiak 1993 (12).

tion. A block or billet emerges from the press, which is generally up to a maximum 2-¾-in. thickness, and a maximum practical 80 ft long and 54 in. wide. The billet is then cut into standard sizes or customer specified dimensions. LVL is commonly manufactured for header stock by combining 1.75-in. thicknesses into a 3.5-in. header to match 2 × 4 framing applications. Because LVL is made from rotary-peeled veneer, increases in yield of 25 to 50% can be realized from each log since losses due to squaring round logs and to sawdust generated in the sawing operation are eliminated (Kunesh 1978).

An alternative method of production is batch processing, where smaller billets are produced in single or multi-opening presses as opposed to a continuous press. Batch processing is typically done in plants producing 12–32-ft-long members or in refurbished plywood mills that produce thin billets up to 4 × 8 feet. This process lends itself to producing specialty products and pre-sized members for ease of installation as headers and small beams (Janowiak 1994).

SPECIES USED IN LVL PRODUCTION

Because LVL is generally purchased for its structural qualities and not visual characteristics, the species used is not of critical importance to the end user. While Douglas-fir (*Pseudotsuga menziesii*) has historically been the predominant species used in United States LVL production (Leonard Guss Associates 1991), southern pine (*Pinus* spp.) is also a commonly used species. Studies have been conducted examining the potential for using hardwood LVL as a substitute material for solid wood parts in furniture manufacture. Northern red oak (*Quercus rubra*), sweetgum (*Liquidambar styraciflua*), and yellow poplar (*Liriodendron tulipifera*) were species researched for applicability in the production of bed frames, shelving, sofa frames, bookcases, bedrails, and other applications that require parts at least 46 in. in length. (Eckelman et al. 1987; Hoover et al. 1987). Research is also being conducted at the Pennsylvania State University on possible LVL applications using red oak, yellow poplar, and red maple (*Acer rubrum*) (Janowiak et al. 1993).

LVL PRODUCT CHARACTERISTICS AND END USE MARKETS

LVL is a versatile product with numerous applications that take advantage of its unique and predictable structural characteristics. Given LVL's predictable strength and reduced variability, this material has excellent working design stress values. Lumber laminated from veneer can be manufactured in longer desired lengths and greater widths and thicknesses from short or small diameter logs.

The product is tested on a manufacturer specific basis for targeted structural properties and requires code acceptance for specific building applications. Independent testing organizations provide product evaluations to determine conformance to industry standards, thus maintaining building code approvals. The

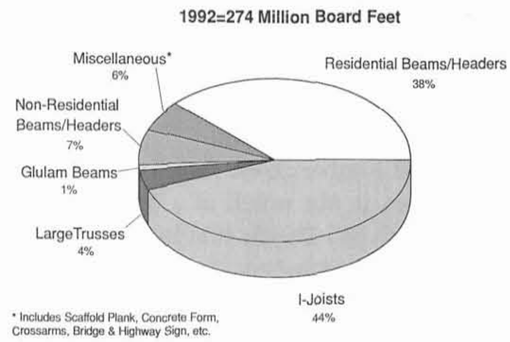

FIG. 2. Major markets for structural LVL—1992 (Leonard Guss Associates 1993).

product has been tested extensively since making its first appearance commercially in 1971. Historically, the early development of LVL can be traced back to 1944 when the product was experimentally examined for laminating Sitka spruce aircraft parts (Youngquist 1985). Table 1 compares the typical design values of LVL with other wood composite products.

LVL is used in many applications in conjunction with other wood products such as glulam, lumber, plywood, and OSB; but in other instances it competes directly with these products. In the construction industry, it is used in light construction applications where high load bearing and minimal height requirements are important. Its most common use is in interior residential/commercial building applications including I-joists, truss chords, headers, and beams (Fig. 2). The prefabricated housing and the mobile home industries are new markets that are reported to be increasing their use of LVL in applications where strength and dimensional stability are of primary importance. Other uses are also being targeted including truckbed decking, kiln stickers, concrete forms, and scaffolding.

As previously mentioned, the product has been used by the furniture industry for many years to produce curved furniture parts and now is being considered as a large-scale replacement for materials currently being used by the furniture industry. Recent increases in the cost of solid lumber make LVL attractive as a structural component in furniture. When engineered to meet necessary requirements for strength, dimensional stability, and appearance, it can be used almost interchangeably with solid wood in the construction of tables, upholstered furniture frames, chairs, kitchen cabinets, shelving and bookcases, beds, and drawer sides. Since LVL can be engineered for high grade appearance on the exposed faces, it can be used in the construction of high or low-end visual or nonvisual pieces. Table 2 summarizes current LVL end uses (Eckelman 1993; Kunesh 1978; Youngquist 1985; Youngquist and Bryant 1979).

ADVANTAGES/DISADVANTAGES OF LVL

LVL possesses a number of qualities that position it favorably relative to solid-sawn wood products. These characteristic advantages can be divided into two main categories: 1) strength and physical properties, and 2) economic factors. Each will be discussed further.

TABLE 2. *Summary of LVL end-uses.*

Industrial	House & hall construction	Other products
• Long-span trusses • Manufactured housing • Scaffold planking • Concrete forms • Decking and liners for trucks and rail cars • Cargo container liners • Stadium seating	• All roof systems • Structural frameworks • Headers and beams • Decking systems • Multi-story systems	• Ladder rails • Furniture components • Structural decorative columns • Crossarms and tower parts for utility poles

Strength and physical properties

A major advantage for the small custom builder is the uniformity of veneer lumber. Because the products are composed of layers of veneer, defects in the wood are dispersed. Natural defects such as knots, holes, cross-grain, cracks, and splits, common in sawn lumber are distributed randomly among the many veneer plies. As a result, there is much less variation in strength, with corresponding allowable design stresses and higher dimensional stability than sawn lumber (Hsu 1988). Each piece of LVL, whether in an I-beam or header, has been engineered to meet specific and stringent design requirements. The closest analogy in solid lumber is machine stress rated (MSR) lumber with which LVL compares favorably with regard to physical strength characteristics (Kunesh 1978). Echols and Currier (1973) found that 1- by 6-in. boards fabricated from Douglas-fir veneers compared favorably with clear vertical-grain, solid boards for modulus of elasticity, modulus of rupture, and maximum load at failure. Because the manufacturing process is so tightly controlled, product performance is very predictable.

Depending on the intended end-use, additional advantages of LVL over solid lumber have been identified. For example, because the product is available in 60–80-ft lengths, joists can often reach from one side of a foundation to another without the need for a center support. Another advantage is the fact that lengths of LVL I-beams are relatively light in weight, so one person can often handle a length that would be too cumbersome to maneuver if it was solid lumber. A potential disadvantage of a lightweight flanged shape is that it makes an effective wind catcher, which may cause framing crews to encounter problems in windy conditions.

Compared to solid lumber, wood I-beams are relatively easy to run plumbing and electrical lines through. Pre-scored knockout holes are typically located every 12 in. along the web, and it takes only a hammer blow to create a uniform ½-in. diameter hole for wiring and water lines. An additional advantage of LVL is that a contractor does not need to sight down the length of a wood I-beam to spot a crown; I-beams and laminated headers are designed to be straight in any length.

Like solid lumber, LVL shrinks and swells, although this is not much of a problem with products such as I-beams that use the product only for flanges. However, "solid" LVL products commonly used for headers have surprised some contractors expecting complete stability. An 18-in.-wide piece of LVL header stock is typically 17-⅞ in. wide when it leaves the mill at 8% moisture content. But it can easily swell as much as ¼ in. or more by the time it is ready for use at the job site, making it ⅛ in. over its nominal dimension. The reason for this is that LVL is laid up unidirectionally and therefore has many of the physical properties of solid lumber. However, in contrast to sawn lumber, engineered wood products tend to swell and shrink uniformly between pieces. If one piece of LVL product at a site is "wide," all pieces of similar dimension will be of equal width, so adjustments are easier to make.

Economic factors

A perceived disadvantage of LVL is its high per unit price relative to alternatives. One approach to overcoming this perception is for suppliers to educate buyers in applications where strength is required and where the installed costs can be shown to be lower. A 1990 study by Durand-Raute supplied the following comparative market values (F.O.B. mill) for LVL and other wood products (Fig. 3) (Durand-Raute 1990). LVL clearly has the highest market value which, given its competitive cost structure and present non-commodity status, generates higher than average industry profit margins.

Some LVL manufacturers tout the cost advantages of their products, particularly wood I-beams. But actually, on a lineal foot basis, wood I-beams are more expensive than solid lumber and LVL has almost a 3:1 ratio in price compared to kiln-dried softwood lumber (Fig.

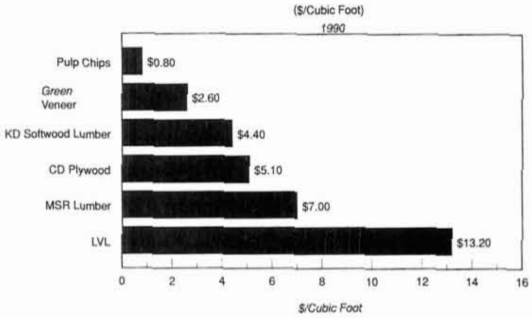

FIG. 3. F.O.B. mill market values for various wood products (Durand-Raute 1990).

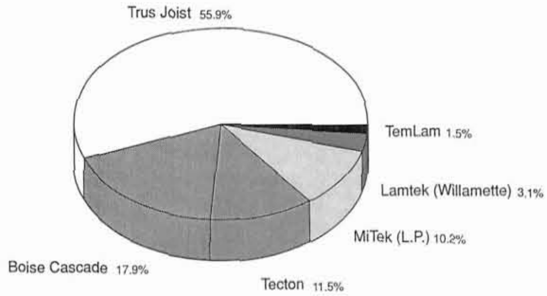

FIG. 4. 1992 U.S. LVL manufacturers (Leonard Guss Associates 1993).

3). In this context, the rationale for using higher price substitutes is the value one receives. Value can be defined as the relationship of price to performance as perceived by buyers. One source of value enhancement from substituting LVL for solid wood occurs during installation because less time is typically spent in handling the product, including time required to drill for water and electrical lines. This savings most likely is accrued to builders who specialize in speed and quantity installations. An additional value advantage for custom builders relates to lengths purchased. Whether a 6-ft length or a 60-ft length is purchased, the price per lineal foot often remains the same. The price point is considered high enough to justify transportation costs from manufacturing regions to distant demand markets (Durand-Raute 1990). The following additional cost factors favor LVL over solid wood: 1) prices have exhibited greater price stability relative to dimension lumber due to the ready availability of small diameter logs; 2) customer complaints are reported to be less frequent; 3) worker injuries are reduced with lighter product installations; and 4) job site waste is typically reduced from approximately 11% with lumber to less than 1% with LVL (Anon. 1993).

UNITED STATES LVL SUPPLY

In 1986 there were only two companies producing LVL in the United States, Trus Joist and Gang-Nail. Estimated production was about seven million cubic feet (212 MMSF $^3/_8$ in.). By 1992 the number of companies involved in production had grown to six, with industry production estimates of 275 MMBF or 48% of industry capacity (Leonard Guss Associates 1993). Estimates provided by Leonard Guss Associates (1993) place 1993 industry production near 340 MMBF, or just under half of the industry's nominal capacity of 690 MMBF. The following four equipment manufacturers have supplied machinery for these companies: Trus Joist built their own lines, Rauma-Repola, Cremona, and Durand-Raute. The six LVL manufacturers comprised 100% of U.S. capacity in 1992 (Fig. 4).

UNITED STATES LVL DEMAND

Probably the major problem associated with the use of LVL comes from the fact that products are being accepted in the marketplace slowly. In 1990, demand was considered to exceed available supply in markets positioned at that time (Carter 1990). In 1993, North American production was estimated to be slightly less than half of nominal capacity, thus indicating an excess of potential supply (Leonard Guss Associates 1993). Industry production can be used as an indicator of what demand might be at any given point in time, but because of a presumed ongoing imbalance in the LVL supply/demand equilibrium, theoretical demand can not be calculated with available published information. LVL's position (in many applications) in the early stages of the product life cycle (PLC) (which will be discussed in a subsequent section) and a lack

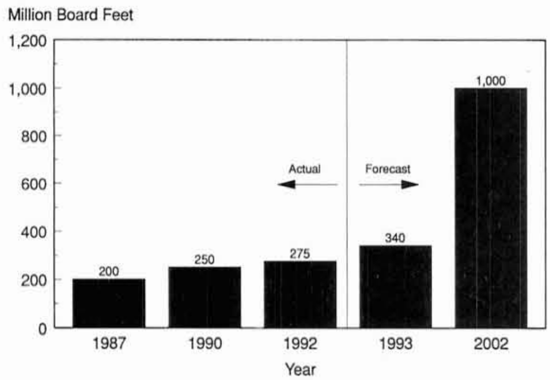

FIG. 5. Structural LVL North American production (Leonard Guss Associates 1993).

TABLE 3. *Estimated consumption of structural LVL by major region (MMBF).*

Region	Year 1992	Year 2002
South	55	200
Northeast	60	220
Midwest	75	250
West	70	255
U.S. total	260	935
Western Canada	5	25
Eastern Canada	10	50
Canada total	15	75
Total	275	1,000

Source: Leonard Guss Associates, 1993 Market Report.

of historical price and production data also make demand projections difficult to assess. Figure 5 shows one estimate of LVL production for 1987, 1990, and 1992 with projections for 1993 and 2002 (Leonard Guss Associates 1993).

One method of establishing a point of view on the pattern of potential demand is to examine historical structural wood member usage (Standard Industrial Classification 2439) as an LVL proxy. Figure 6 shows structural wood member value of shipments from 1972–1990 (the last year for which data are available) (U.S. Industrial Outlook 1986, 1990). The consumption for LVL and other engineered wood products should parallel projected increases in demand for structural wood members as both new applications are exploited and substitution for wide dimension lumber continues.

An additional demand proxy for consumption is wood I-joist production as LVL is in-

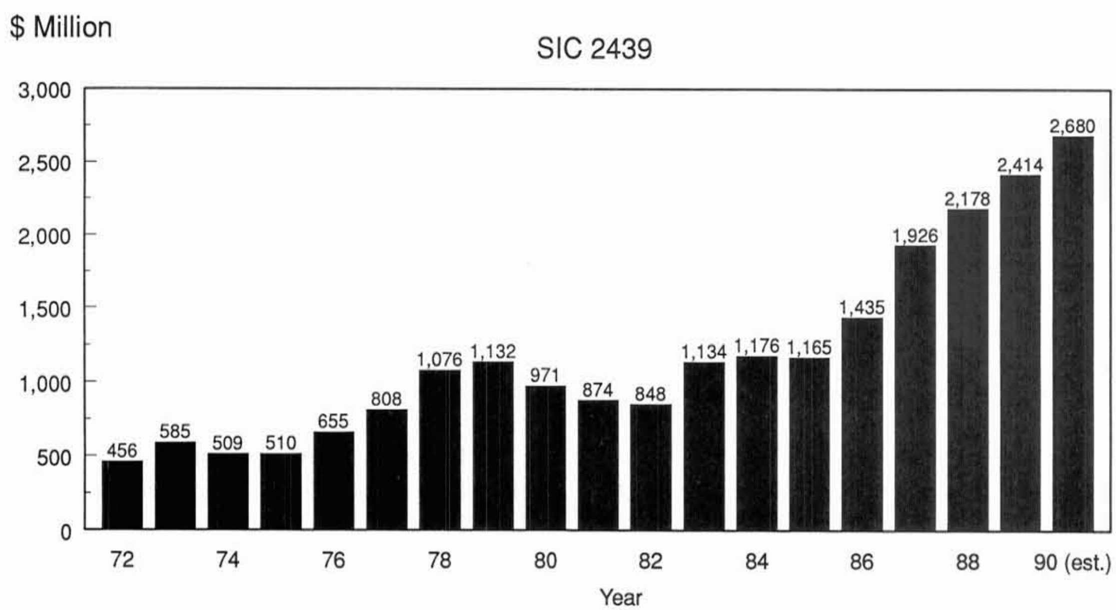

FIG. 6. Structural wood member value of shipments 1972–1990 (U.S. Industrial Outlook 1986, 1990).

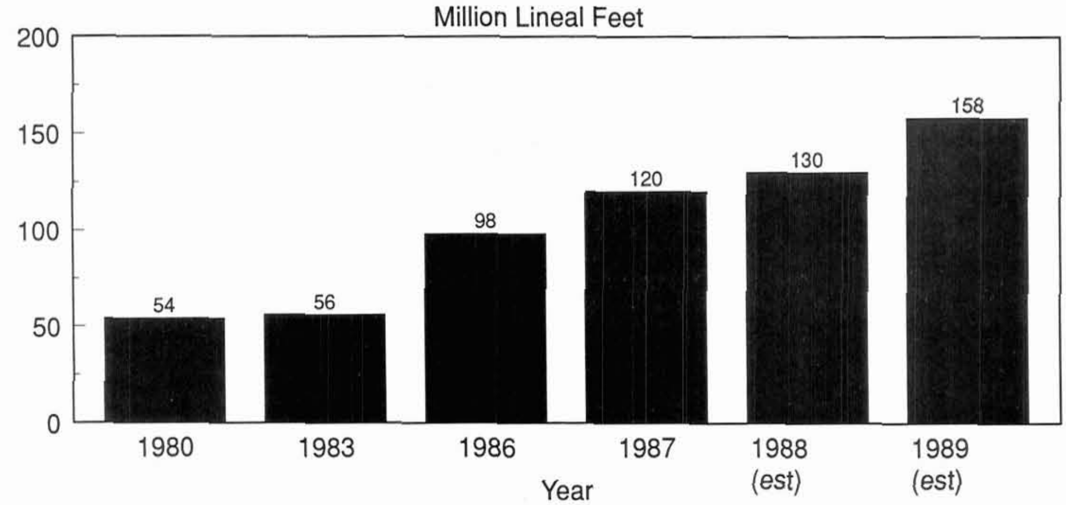

FIG. 7. North American wood I-joist production (Leichti et al. 1990).

creasingly replacing solid wood as flanges. Wood I-joists comprised about 38% of LVL demand in 1990 in the United States and, as seen in Fig. 7, wood I-joist production has also been increasing over the past decade (Leichti et al. 1990).

An additional indicator of market potential is that in 1984, about 25% of the U.S. market for lumber consisted of wide-width dimension and structurally graded specialty items (Leonard Guss Associates 1993). Opportunities to substitute LVL for these products appear to be significant.

LVL MARKETS

The most developed markets for LVL are in North America and Finland. Although the world's largest market is North America, Finland has much greater production and consumption per capita. An indicator that demand in North America exceeds existing supply is the continued importation from Finland, which is estimated to be under 5 MMBF annually or about 2% of 1992 U.S. consumption of LVL products (Leonard Guss Associates 1993).

According to a 1989 McGraw-Hill/LSI report (McGraw-Hill/LSI 1989), engineered lumber had a 9.2% market share (based on lineal feet installed) of the new residential structural beam and header market in the United States. The report projected future growth of engineered lumber in these and other applications to be robust. Acceptance by builders is growing rapidly, particularly for use in I-beams. For example, Trus Joist experienced compounded annual growth of over 20% in sales between 1986–1990 (TJ International 1991). In markets where dealer support has been strong, growth has been more than twice the company average.

Table 3 shows the consumption of structural LVL by region in Canada and the United States for 1992 and the projected consumption in 2002. Consumption in the South should remain disproportionally low, due to the prevalence of slab foundations in housing (Leonard Guss Associates 1991).

At a 1990 Forest Products Research Society conference on engineered wood products, Steve Winistorfer, Regional Engineer for Trus Joist, projected that the western region of the United States would be one of the strongest engineered wood product markets, particularly in multilevel structures with basements (Winistorfer 1990). At the same conference, Bill Alexander from MacMillan Bloedel projected that the South would play an important role in LVL demand in the future as hurricane-resistant structures will be included in building codes

	Distributor/Contractor	End User
Headers/Beams	**Inventory Management** - Short turnaround time - Large common stock, few Stock Keeping Units (SKUs) **Sales Support** - Literature - Availability of field personnel to train sales people **Competitive price and high margins on LVLwith low inventory turns**	**Product Features** - Strength - Cut-to-size - Workability **Benefits** - Little or no scrap - Outperforms dimension lumber **Price** - Lower installed cost than dimension lumber
I-Joists	**Technical Field Sales & Service** - Local representatives - All other attributes for headers/beams	**Product Features/Benefits** - Silent floor - Fewer pieces/area - Competitive installed cost

FIG. 8. LVL customer service requirements.

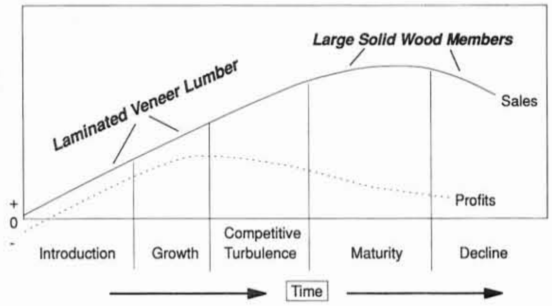

FIG. 9. Product life cycle (Day 1984).

and the Northeast will be a factor where heavy snow loads require structural strength (Alexander 1990).

LVL MARKETING STRATEGIES

As part of the marketing strategy for LVL, manufacturers offer installation guides that show details of proper blocking, hanging, and nailing of their products. In addition, a broad array of special hardware for hanging and attaching the product is usually available from stocking LVL distributors and dealers, who also provide strong technical support. Figure 8 summarizes some of the various customer services offered by manufacturers for I-beam and header products, the most important demand sectors.

Rapid technological changes and/or new product market development opportunities are often managed in the context of the product life cycle (PLC) concept. For many products, time and market growth (sales) are correlated as are time and profitability (first directly and then inversely) (Day 1984; Thorelli and Burnett 1981). The stages of the PLC, as seen in Fig. 9, include introduction, growth, competitive turbulence, maturity, and decline.

The PLC is particularly important as a tool for strategic market planning concerning the "4 P's" (product, place, promotion, and price) that comprise a marketing mix—that is, the four major parts of a firm's marketing strategy. A firm's marketing mix for a product typically evolves throughout progressive stages of the PLC as a response to competitive opportunities and threats.

The length of time products spend in each stage of the PLC may vary greatly. The diffusion of new products into their potential market in the introductory stage depends on the perceived comparative advantage, the perceived risk (of product failure, availability, acceptance by end-use buyers, and conformance to codes), the barriers to adoption (compatibility with existing systems), and the availability of information regarding technology and its benefits (Day 1984). External factors, such as general economic cycles, interest rates, and housing starts may affect PLC duration and shape for construction materials such as LVL products.

Growth, the second PLC stage, is characterized by a sudden increase in sales and profits as product knowledge is disseminated, repeat purchases occur, and production bottlenecks are eliminated. High profits attract competitors, often with improved products, thus causing a decline in overall industry profits as products move to maturity (McCarthy and Perreault 1987). A favorable price/quality or price/performance ratio is a critical impetus for products to transition into the growth stage. LVL products are poised to move into the growth stage but are experiencing difficulty making this transition due to perceived cost and lack of sufficient product knowledge specifically with regard to total installed costs. A continuing rise in alternative wood product costs should expedite the required transfer of knowledge to buyers and speed the transition of LVL to the growth stage.

SUMMARY

LVL is a high value reconstituted engineered wood product that is experiencing growing demand resulting from a myriad of factors such as product substitution, substitute product raw material constraints, growing acceptability, and other supply and demand dynamics. Current research includes the development of improved manufacturing techniques and the adoption of new species as raw materials. Because of its unique distribution and selling requirements, LVL is a distinct and separate building material product category and not simply a line extension for lumber or plywood. LVL is a product with historically high profit margins and, as a result of improvements in manufacturing and subsequent production cost reductions, margins should remain attractive.

The product life cycle concept (PLC) suggests that the average profitability per unit increases through distinct and recognizable stages (Day 1984). As LVL products transition from the introduction to the growth stage of the PLC, reluctant buyers will be attracted and production capacity will be added by existing and new competitors. Derived demand from new home construction and repair and remodel activities will further influence the rate of diffusion of LVL products into the U.S. market. Current and potential manufacturers can benefit by careful planning throughout each stage of the PLC.

Over time, prices of LVL products should decrease, sales will increase, new competitors will participate in production, and supply will match (or even exceed) demand. Current producers must strive to provide market coverage and brand recognition to encourage loyalty from repeat purchasers. Late entrants will have lower start-up costs, will benefit from a rapidly growing market, and will not be burdened with intensive customer education.

Exogenous variables affecting wood supply, demand and price, could be the determining factor in influencing the potential for LVL products in the United States. Builder acceptance appears to hinge on perceived value. Market growth for LVL will occur as timber harvesting pressures increase and in-use price/performance factors are clearly demonstrated.

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