LUMBER PROCESSING EFFICIENCY, YIELD AND VALUE

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The Importance of Lumber Processing Efficiency

After lumber has been kiln dried, sawing it into rough sized components, parts, or blocks is often the next step in the value-added process. This is the function of the rough mill. Rough mill yield is a measure of the rough mill's efficiency at converting rough sawn lumber into useful parts. In manufacturing these parts, the rough mill removes undesirable wood characteristics or defects. The sawn parts may then be sent to the moulder for profiling or laid up to be glued as a panel. In this article we will examine yield to understand the influence it has on profitability and its limitations as a management tool.

What is a satisfactory yield in the rough mill? This question is difficult to answer. The many process factors that affect rough mill yield include lumber species, mix of lumber grades, lumber drying quality, lumber size, cutting bill sizes, part quality, operator experience, plant layout, machinery, processing sequence dictated by plant layout, and production scheduling. These factors interact in such a way that a slight change in any one factor may have a large impact on yield—and hence on the profitability of the rough mill department. In fact, with the exception of the kiln department, no other department has the concentrated potential for savings that exists in the rough mill.

Over the past two decades, the supply of upper quality lumber has consistently fallen short of demand, and lumber costs are higher than ever. In 1999, lumber costs averaged 50% of total manufacturing costs in a sample of U.S. dimension plants that produce parts for furniture or cabinet manufacturers (Figure 1). For the typical furniture plant, lumber

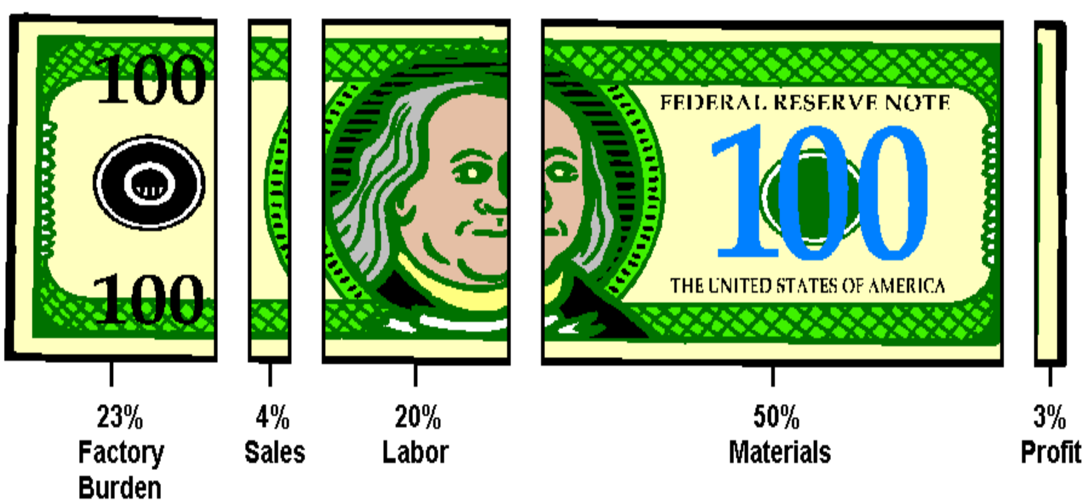

Figure 1. Where do the dollars go in rough mill manufacturing? Source: 1999 Wood Component Manufacturers Association Cost of Doing Business Survey.

is generally the largest material cost item and may exceed 12% of the total production cost (U.S. Department of Commerce, 1999).

The cost of native hardwood lumber continues to outpace the price of furniture. This price differential has widened in the past decade (Figure 2; U.S. Department of Labor, 2000) making it more important than ever that the lumber cut-up operation be as efficient as possible.

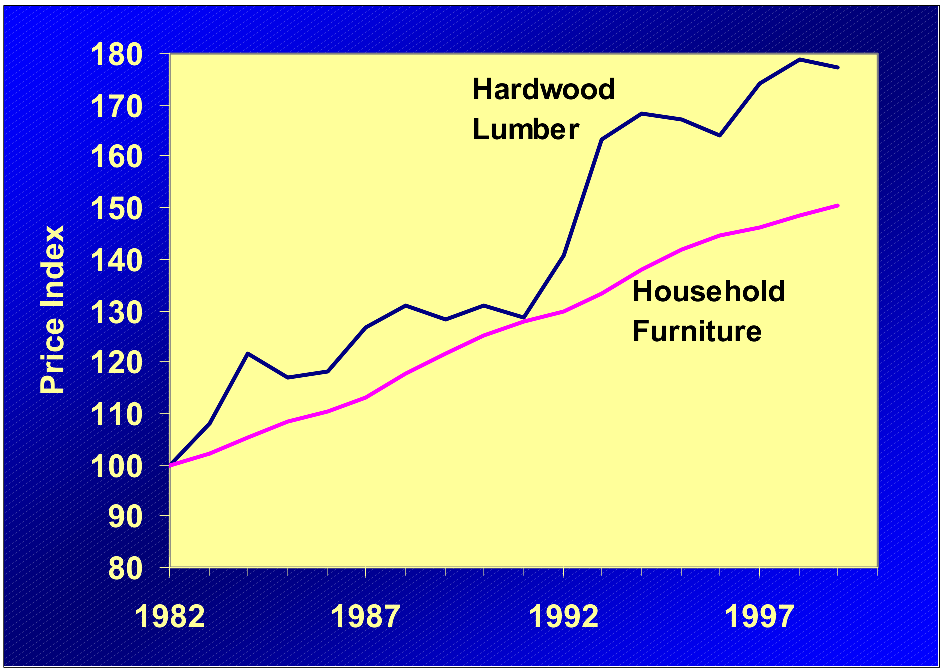

Figure 2. Producer price indices for hardwood lumber and household furniture, adjusted to 1982=100 (from U.S. Department of Labor, 2000).

As lumber is processed, value is added at each operation as illustrated in Figure 3 (adapted from Pepke and Kroon, 1981). A rough mill processing 12,000 board feet of dried lumber per day valued at $900/MBF can save approximately $58,000 per year by improving rough mill yield by just 1 percent. (Calculations showing how to estimate savings will be discussed in more detail later). The high value of dried lumber justifies an extensive effort to maximize yield!

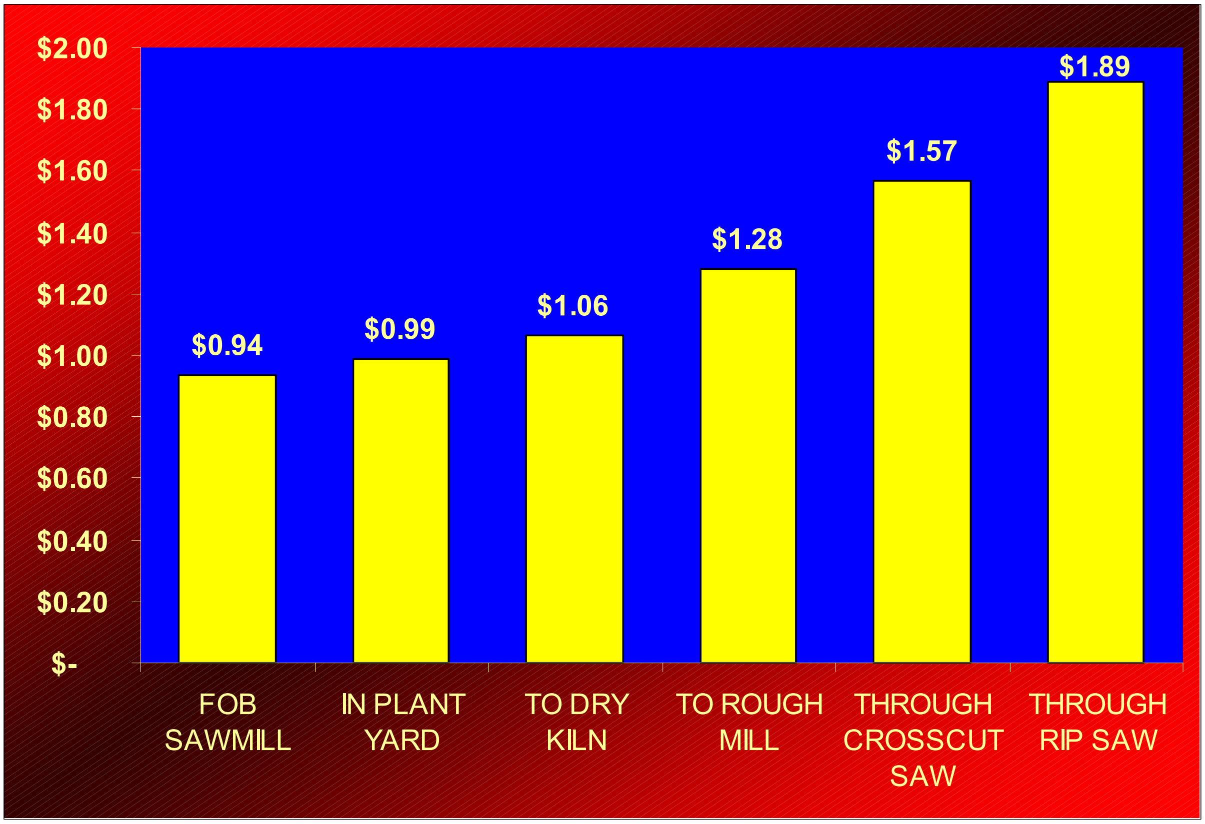

Figure 3. Approximate value increase of one board foot of lumber as it is processed by each operation through the rough mill (adapted from Pepke and Kroon, 1981).

Measurement of Yield and the Value of Parts

Defining Yield

Our first task is to define yield and describe its measurement. The most basic definition of yield in a manufacturing plant is the ratio of the amount of primary product output to the amount of raw material input, expressed as a percentage. We can further refine the definition for a rough mill: yield is the amount of useable parts cut from a given quantity of lumber. Yet even this more precise definition allows variation in the manner in which rough mill yield is calculated. The result is that yield numbers between companies, between plants of the same company, and even between departments of the same plant often cannot be compared because of differences in how yield is calculated.

Some of the issues that need to be established in defining how to calculate yield in your rough mill include:

- Will green or dry (gross or net) lumber volume be used? (dry volume is recommended)
- Will only parts that meet the cutting bill be tallied? (yes… recommended)
- Will defective parts or setup parts be tallied? (no… not recommended)

- Will parts cut to meet the overage allowance be counted? (yes… recommended)
- Will nominal or actual thickness be used? (actual is recommended)

It is recommended that yield be fully defined within the business unit. For example
"Percent rough mill yield is defined as the sum of the volume of wood parts that are needed to satisfy the cutting bill, (this will include parts of all fixed lengths and widths, panels made up of random width parts, and specified overages), divided by the volume of dry lumber used."

In equation form this can be expressed as:

$$\textbf{\% Yield} = \left[\textit{Volume of Rough Parts and Panels (bf)} \,/\, \textit{Volume of Rough, Dry Lumber (bf)}\right] \textit{X 100}$$

(Equation 1)

A more traditional method is to use the surface area rather than the volume, which works well in most situations. It should be recognized, however, that using surface area instead of volume will neglect yield losses that occur when thicker lumber is used because the specified thinner lumber was not available (for example, using 6/4 lumber when 5/4 lumber was required).

Only parts that satisfy the cutting bill should be tallied as product volume. This means that short lengths that are not on the cutting bill but that are salvaged and set aside for later use should not be counted until they actually fulfill a cutting bill part request (sometime in the future). Known defective parts passed along as setup pieces should not be counted as part of yield. Rough mill yield, however, should be credited with parts cut to meet an overage allowance. Finally, the actual part sizes should be used to calculate part volume. Again, the most important point that needs to be re-emphasized, is that regardless of how you calculate yield, the method should be fully communicated, understood, and agreed upon throughout the business unit.

Yield: A Limited Performance Indicator

Yield can be used to measure the effectiveness of an operation in converting a raw material into a value-added product. Yield can directly affect manufacturing costs by the large impact it exerts on the material costs for parts, which in turn impacts profitability. However, the consideration of yield alone can be misleading since yield is not the only factor in the profitability equation. For this reason, care must be taken to insure that yield is not over emphasized in the production setting.

An example will illustrate this point. In two separate cases, consider the material costs required to produce 1000 board feet of parts (note that labor is not included in these calculations).

In Case 1, #1 Common lumber costing $900/MBF is used to produce 1000 board feet of parts with a yield of 53%. As shown in the following calculation, the cost of the #1 Common lumber required to produce 1000 board feet of parts is $1698.

Case 1: #1 Common:
1 MBF parts/53% yield X $900/MBF lumber = $1698/MBF parts

In Case 2, the same 1000 BF cutting bill is produced by cutting #2 Common lumber costing only $600/MBF but yields only 38%. The lumber cost to produce 1000 board feet of parts is $1578.

Case 2: #2 Common:
1 MBF parts/38% yield X $600/MBF lumber = $1578/MBF parts

In this example, we see that although the yield is lower with the #2 Common lumber, by paying 33% less for the raw material the cost associated with the decrease in yield is offset. The result is the material cost for the 1000 board feet of parts is reduced from $1698 to $1578, which equates to a 12¢ per board foot reduction in part cost (from $1.70 to $1.58). Of course, more labor will be required with the lower grade of lumber, and this will, to a greater or lesser extent, reduce the raw material cost savings achieved by using a lower grade of lumber.

The main conclusion to draw from this example is that yield alone does not provide a complete picture of profitability in the rough mill. This example also introduces the concept of evaluating the rough mill process based on the unit product cost—in this case, dollars per MBF of parts.

Thus, using yield alone to measure rough mill efficiency can lead to poor management decisions. <u>Yield improvement</u>, however, can strongly impact profit.

The Least Cost Concept: A Better Approach
For many operations, the rough mill processes nearly all of the raw material (lumber) used in their final products. This presents an opportunity for the rough mill to impact overall profitability by maximizing the value of the products produced and by minimizing manufacturing costs. The relationship between profit, product value, and manufacturing costs is straightforward:

Profit = Value of Parts Produced - Manufacturing Costs (Equation 2)

Let's examine the profit equation to determine what rough mill personnel can do to increase rough mill profit. First, manufacturing cost will be considered by reviewing its two major components. If only the direct costs are considered, ignoring the indirect costs associated with factory overhead, then an estimate of manufacturing costs can easily be obtained:

Manufacturing Costs = Lumber Costs + Labor Costs (Equation 3)

Of course, lumber costs change according to the species, grade, thickness, and the volume of lumber processed. Rough mill managers may be able to control the incoming lumber grade mix, which in turn will impact yield and lumber usage and consequently the lumber cost. For the most part, however, the rough mill manager's actions are constrained by the dictates of the product, the purchased lumber delivered to the rough mill, and the processing capacity of the rough mill. Considering labor costs, most rough mill operations in the United States do not have excess labor that can be trimmed without significant capital expense, so labor costs are not easily influenced. Thus, manufacturing costs are difficult to impact significantly without major changes in plant layout or product.

The other term in the profit equation (Equation 2) to consider is the value of parts produced. This is best illustrated by considering a component parts manufacturer. Assuming that all parts manufactured are sold, the value of the parts and panels produced can be equated to the total sales dollars received for those products. The per unit value ($/board foot of product) received for the rough mill product is largely determined by market forces that are beyond the rough mill's control. However, it is important to remember that *rough mill practices can influence the quantity or volume of product manufactured from a given amount of lumber and labor through yield gain (or loss)*. If the volume of product can be increased without increasing labor or lumber costs, then, assuming the product's market unit value remains constant, the total value of parts produced will increase, and consequently profit will increase.

Although the goal of the rough mill is to make a profit, the calculation of profit is difficult for the rough mill. The better method for measuring performance in the rough mill is the manufactured cost per unit (board foot) of product. To calculate the manufactured cost per board foot of product:

Manufactured Cost per BF of Products = Manufacturing Cost/ Product BF (Equation 4)

Obviously, the goal of the rough mill is to produce a product with the minimum manufactured cost per board foot of product—an idea often called the least cost concept. The way to reduce the manufactured cost per board foot of product, while keeping manufacturing costs constant, is to increase the volume of product.

A simple example will illustrate the calculation of the manufactured cost per BF of product using only lumber and labor costs. These two cases will demonstrate the use of the least cost concept, and highlight the approximate impact that yield improvement can have on the manufactured cost per board foot of rough mill parts.

The current situation is taken to be our base case (see Table 1, Case 1). We assume that our example rough mill currently processes 12 MBF of lumber per day during an 8-hour shift. The rough mill employs 16 people with an average labor cost of $14/hour per person. On average, the dried lumber value is $900/MBF at the rough mill infeed. The average rough mill yield is 53%, and therefore produces 6.36 MBF of parts per shift. The total lumber and labor cost per day is $12,592 (ignoring factory overhead). The total parts cost is calculated as $1,979.87 per MBF of parts, or $1.98 per BF for Case 1.

Table 1. The effect of yield improvement on the (estimated) manufactured cost of one board foot of parts, illustrating the least cost concept.

	Case 1 Current	Case 2 Projected
Parts Yield	53%	54%
Lumber Usage/Day	12 MBF	12 MBF
Lumber Cost	$900/MBF	$900/MBF
Costs/Day		
Lumber	$10,800	$10,800
Labor	$1,792	$1,792
Total Costs/Day	$12,592	$12,592
Parts Production		
Parts Produced/Day	6,360 BF	6,480 BF
Part Costs/MBF parts	$1,979.87	$1,943.21
Part Costs/BF parts	$1.98	1.94

Next, we ask the question "How much value would a 1% yield improvement over the base case be worth to the rough mill?" This leads to our second case (see Table 1, Case 2) in which it is assumed that an additional one percent yield of parts can be obtained from the lumber through improved operational procedures alone (using the same grade of lumber and the same amount of labor in the rough mill). Increasing the yield by 1% will increase the volume of parts produced by 120 board feet per day. This increase in output has occurred without an increase in the total manufacturing costs, so that the part costs have been reduced to $1,943.21 per MBF of parts, a reduction of $36.66 per MBF. On a per unit basis, the 1% increase in yield has decreased unit costs by almost 2%, and is worth $58,000 annually to the rough mill.

Using the same approach described in Table 1, Figure 4 illustrates the annual part savings associated with a 1% yield increase as a function of the current rough mill yield and lumber cost. For example, consider an operation that processes 12 MBF per 8-hour shift employing 16 people earning an average wage of $14/hour. Assuming this rough mill achieves a 60% yield using lumber that on average costs $1,100/MBF, Figure 4 indicates that the annual savings in part costs generated by raising the yield 1% will be approximately $61,000. (To find this value, locate the intersection of the solid green line that represents 60% yield and the projected vertical line from $1,100/MBF lumber cost, and read the annual part value from the axis at left).

Figure 4 also shows that a higher average lumber cost, a higher volume throughput, or a lower base case yield will produce an even greater savings in part costs due to yield improvement (assuming labor costs are constant). The dashed lines in Figure 4 represent a 10% increase in lumber throughput (from 12MBF to 13.2 MBF per day). If all factors are kept the same as in the previous example except for a 10% increase in throughput, the expected annual savings in part costs would increase to over $66,000.

In summary, the proper measurement to determine how well a rough mill operates is not yield, but the manufactured cost per unit of part produced. The objective is to minimize this unit cost, which is sometimes referred to as the least cost concept.

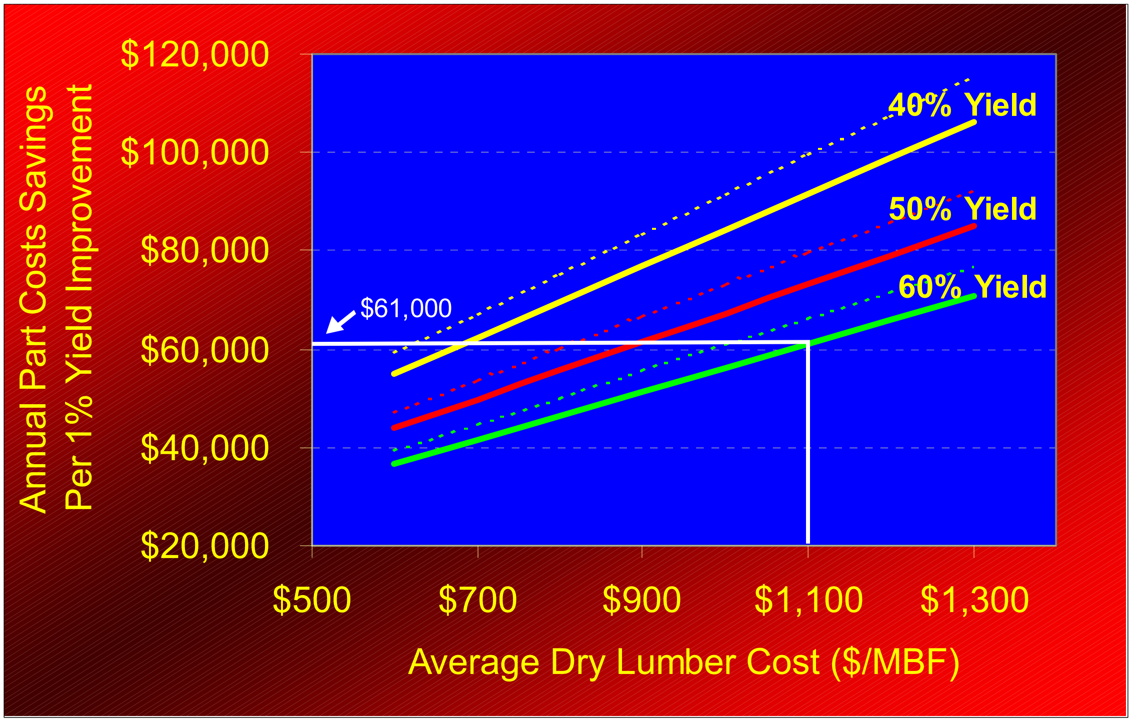

Figure 4. Annual part cost savings resulting from a 1% yield improvement for the rough mill processing 12 MBF per day with 16 employees (dashed lines indicate a 10% increase in throughput, or 13.2 MBF processed per day, with no increase in labor cost).

<u>*Literature Cited:*</u>

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