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Producing OSB Using Red Alder: A Feasibility Case Study

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Monograph Number 30
January 1989

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INTRODUCTION

The objective of this monograph is to illustrate how the elements of an investment analysis are brought together to form a basis for sound decisions on new plant investments. These elements include financial analysis, raw material analysis, and market analysis.

The financial analysis consists of determining the initial investment required for the plant, the initial working capital required, the investment tax credits available, the length of the investment period, the state and federal tax rates, the cost of capital, and the annual cash flows associated with the new plant. Using these figures, the net present value (NPV) and internal rate of return (IRR) of the proposed investment are calculated. The raw material analysis consists of determining the requirements, availability, and cost of raw materials and energy necessary to operate a new plant. The market analysis consists of determining the size and availability of markets for the product(s) produced by the plant, the channels of distribution, and the selling price of the products(s).

There are basically three steps involved in the evaluation of any investment opportunity. These are: estimate cash flows, calculate the figure of merit, and compare the figure of merit to a chosen criterion. The last two steps are relatively easy since they simply consist of performing calculations and comparisons. The first step is the most difficult because it involves estimating cash flows which are uncertain and not easily quantified.

Typically, methods such as the payback period, net present value, and the internal rate of return are used to evaluate the merit of an investment. But these methods fail to assess the risks associated with uncertain cash flows. Because most of the input values required to analyze an investment opportunity have a great deal of uncertainty associated with them, a more accurate picture of the true merit of an investment could be obtained by utilizing an analytical method that incorporates risk.

A probabilistic model using Monte Carlo simulation fits this requirement. This monograph demonstrates the use of such a model through a case study of the economic feasibility of locating an Oriented Strand Board (OSB) plant in Western Oregon.

CASE STUDY DESCRIPTION

OSB is a reconstituted structural wood panel produced by mixing flakes or strands of wood with resin and wax to form a mat which is then pressed into a panel under high heat and pressure. The flakes are oriented along the length of the panel in the face and back layers and across the panel in the core. Orienting the strands yields strength and dimensional properties very similar to those of plywood. The major advantage of OSB is that it can be produced from low-cost, under-utilized species such as red alder or aspen.

The plant proposed for the case study will produce an OSB panel with a density of 40 pounds per cubic foot (pcf). The panel uses alder with an average specific gravity of 0.41 and includes resin and wax contents of 5% and 2%, respectively. These figures were drawn from previous studies of the technical aspects of producing OSB from red alder (Zylkowski 1983). Based on a preliminary feasibility study by Murad (1985) and on raw material availability, the proposed plant will have an annual capacity of 75 MMSF (3/8-in. basis) and be located in a coastal county of Western Oregon.

The author developed a program which uses Monte Carlo simulation to perform investment analyses. The program is a LOTUS 1-2-3-based, menu-driven, probabilistic model that includes inputs such as revenues, fixed and variable expenses, depreciation, interest rate, state and federal tax rates, and investment tax credits to calculate an internal rate of return, a net present value, and the payback period of an investment.

Risk is represented by triangular and uniform distributions. The triangular distribution is used to model all the operating cash flows and the resale value of the assets at the end of the investment period. The uniform distribution models the initial investment, the depreciable and non-depreciable property, the plant capacity, and the initial working capital.

To calculate a triangular distribution, three values must be defined: the low, mode, and high values. The low value is such that there is only a 5% chance of obtaining a lower value, the high value is such that there is only a 5% chance of obtaining a higher value, and the mode is the value most likely to be obtained. A uniform distribution requires only two values -- low and high. The more certain the user is of the actual input values, the tighter the distribution and the smaller the range of net present values.

During execution of the program, the distributions are randomly sampled and the NPV, IRR, and payback period are calculated. This process is repeated 30-100 times and average NPV, IRR, and payback period figures are obtained. In addition, histograms of the NPV, IRR, and payback period are produced which represent their possible ranges for the given inputs. From these histograms, the probability of a positive NPV or an IRR greater than the cost of capital can be calculated.

RAW MATERIAL AND ENERGY REQUIREMENTS

Raw material and energy requirements for various OSB panel thicknesses using alder as the raw material (Table 1) include waste factors and all losses due to production. The waste factors for wood, resin, and wax were assumed to be 16%, 28%, and 7%, respectively, reflecting industry averages for OSB plants. The raw material and energy requirements for the case study were computed using a modified version of the Parvcost computer programs developed by Harpole and

Table 1

Raw Material and Energy Requirements for OSB Production

Specifications	LBS/MSF 3/8"	7/16"	1/2"
Gross board weight	1325	1544	1764
Weight of water	75	88	100
Oven-dry wt. of board	1250	1458	667
Wt. of resin (5% liquid)	63	72	83
Wt. of wax (2% solid)	25	29	33
Wt. of wood	1163	1356	1550

Ince (1977). Parvcost is a mathematical model of wood, chemical, and energy flows in a board plant. It calculates the requirements and costs of wood, chemicals, and energy per unit of finished board.

Using unit cost distributions for the raw material and energy requirements (Table 2), the gross variable cost distributions for 3/8-inch OSB were calculated (Table 3). The low, mode, and high estimates of total gross variable cost per MSF were $49.13, $56.65, and $64.67, respectively.

Table 2

Unit Variable Cost Distribution for Raw Material and Energy Requirements

Requirement	Low	Mode	High
Wood ($/ODT)	16.000	19.00	24.00
Resin ($/lb. liquid)	0.250	0.29	0.30
Wax ($/lb. solid)	0.180	0.18	0.18
Heat energy ($/MCF)	3.000	3.50	4.00
Electricity ($/KWH)	0.035	0.04	0.05

Table 3

Variable Cost Distributions for OSB Production in a 75 MMSF/Year Plant

	($ per PSF, 3/8-inch basis)		
Requirement	Low	Mode	High
Wood	20.00	23.75	30.00
Resin	17.14	19.89	20.57
Wax	4.95	4.95	4.95
Heat Energy	0.46	0.54	0.50
Electricity	6.58	7.52	8.65
Total Gross Variable Cost	49.13	56.65	64.67

The raw material and energy costs were obtained by surveying suppliers. The low value for the triangular distribution was set equal to the lowest cost obtained for the survey, the high value equaled the highest cost obtained, and the mode the average of the costs.

LABOR REQUIREMENTS

For the plant case study, four shifts operating 310 days per year with a total of 67 people were assumed. Table 4 shows the cost distribution for average wages and salaries of all personnel. All wages were based on union rates, and all wage and salary figures include a 30% factor for payroll expenses and fringe benefits. The low, mode, and high estimates of total wages and salaries per MSF are $45.30, $45.30, and $52.20, respectively.

Labor requirements were based on existing plants with similar capacities. Wages and salaries were obtained from surveys collected by the Employment Division in Salem, Oregon.

CAPITAL COSTS

The total capital cost for the plant (excluding land) was uniformly distributed between 15 and 28 million dollars. The capital cost includes buildings, machinery, and engineering and contingencies. The engineering and contingencies category includes initial working capital, project management, delays, and unforeseen cost

Table 4

Wage and Salary Cost Distributions

Item	Cost ($/MSF, 3/8-inch basis)		
	Low	Mode	High
Wages (per 8 hour shift)	36.56	36.56	42.83
Administration Salaries			
Office Manager (1)	0.40	0.40	0.43
Assistant Accounting + Purchasing (2+2)	1.07	1.07	1.17
Clerk/Typist/Receptionist (2)	0.37	0.37	0.40
Janitor (1)	0.19	0.19	0.21
Total	2.03	2.03	2.21
Payroll Charges (30%)	0.61	0.61	0.65
Total	2.64	2.64	2.86
Supervisory + Technical Salaries			
General Manager (1)	0.93	0.93	0.96
Marketing Manager (1)	0.67	0.67	0.69
Plant Engineer + Technical Director (1+1)	0.93	0.93	2.00
Shift Foreman + Woodyard Shipping Supply (4+1+1)	2.16	2.16	2.40
Total	4.69	4.69	5.05
Payroll Charges (30%)	1.41	1.41	1.46
Total	6.10	6.10	6.51
Grand Total Wages and Salaries	45.30	45.30	52.20

increases. The figures for capital costs were obtained from estimates by Columbia Engineering (1984). The initial working capital was set to equal three months operating costs.

PRODUCTION COSTS

Table 5 shows a summary of the production cost distributions for the proposed OSB plant. The low, mode, and high estimates for material costs are $42.09, $48.59, and $55.52, respectively; for energy and maintenance costs -- $17.54, $18.91, and $20.91; and for labor costs -- $45.30, $45.40, and $52.20. Advertising and sales expense and general administration costs are calculated as 7 and 1 percent, respectively, of the sales price. The low, mode, and high estimates of total production costs are $113.42, $121.83, and $138.23, respectively.

Table 5

Summary of Production Costs

	Cost ($/MSF, 3/8-inch basis)		
Items	Low	Mode	High
Material			
Wood	20.00	23.75	30.00
Wax	4.95	4.95	4.95
Resin	17.14	19.89	20.57
Total	42.09	48.59	55.52
Energy + Maintenance			
Electricity	6.58	7.52	8.65
Thermal Energy	0.46	0.54	0.50
Maintenance	7.00	7.49	8.00
Total	14.04	15.55	17.15
Wages and Salaries			
Wages	36.56	36.56	42.83
Supervisory Salaries	6.10	6.10	6.51
Administrative Salaries	2.64	2.64	2.86
Total	45.30	45.30	51.96
Advertising + Sales Expense	10.50	10.85	11.90
General Administrative Cost	1.50	1.55	1.70
Total Production Cost	113.43	121.84	138.23

The accelerated cost recovery system (ACRS) was used to calculate all depreciation. Assets were separated into 3, 5, 10, or 15 year property according to IRS guidelines. Full investment tax credits were taken on all 3 and 5 year property as provided in the 1981 Tax Recovery Act. State and Federal taxes were calculated using tax tables provided by the Oregon State Revenue Office and the IRS. Although the tax laws have changed since the completion of this program, the methodology for incorporating tax calculations into an investment analysis remains the same.

SALES PRICE

Predicting the sales price of a relatively new product poses a problem. But if the new product is a close substitute for an older one, prediction is less difficult. Price data for 7/16-inch OSB and 1/2-inch CDX western plywood (Figure 1) show that the two series track each other fairly closely, though OSB prices are 10-15% lower. This price relationship suggests that the two products respond similarly to price-determining variables, because they are in fact close substitutes. When a new product's price trend apparently mirrors past prices of a related product, then short-term forecasts, using appropriate methods and based on the new product's price history, should yield reasonable estimates of future price.

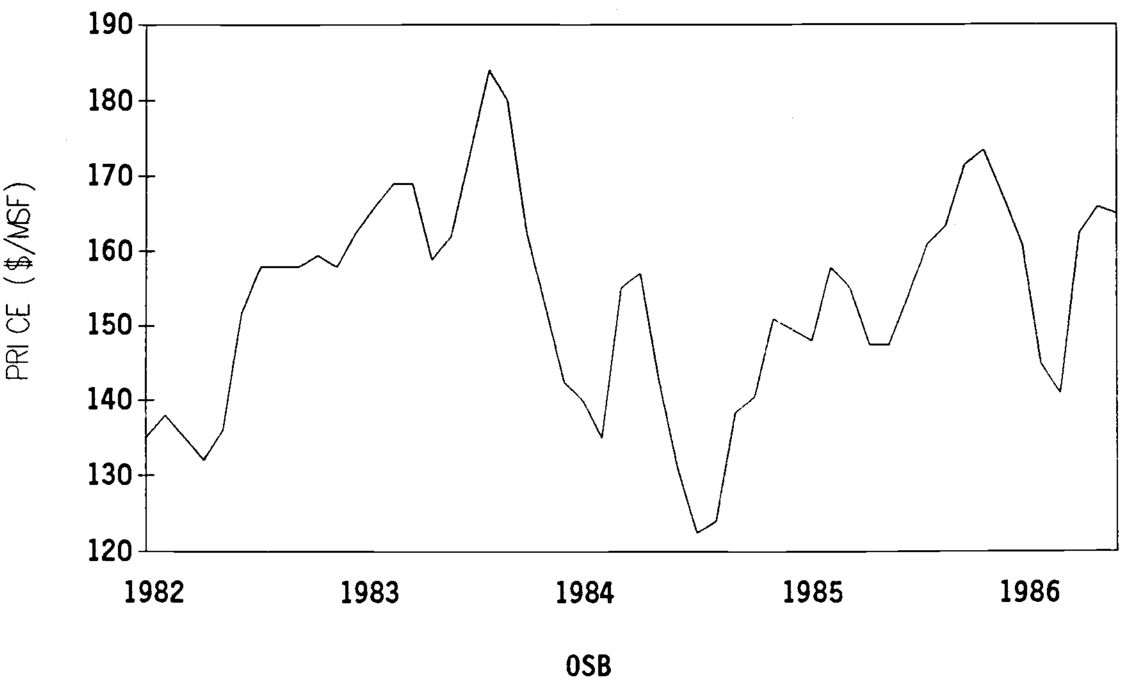

Figure 1. Selling Price of 7/16 inch OSB, 1982-1986
Source: Crow's 1982-1986

An estimated sales price for the 3/8-inch OSB, therefore, was forecasted using time series analysis. Historical price data from the past five years were compiled from Crow's weekly price reports, and Box-Jenkins Time Series Analysis was used to fit a model to the data. That model was then used to forecast a sales price for OSB. The low, mode, and high estimates were calculated to be $155, $155, and $170, respectively.

FINANCIAL ANALYSIS OF THE CASE STUDY

The input values used to analyze the proposed plant are summarized in the next three tables. Table 6 shows the inputs for depreciable and non-depreciable property. These values are entered as uniform distributions with low and high estimates for each item. Table 7 shows the initial assumptions. The program was run probabilistically with 70 iterations, assuming an 18 year life and an 11% risk free interest rate.

Table 6

Cost Distribution of Depreciable and Non-Depreciable Property

	Cost ($1,000/year	
Item	Low	High
3 Year Property	750	1,400
5 Year Property	7,500	14,000
10 Year Property	0	0
15 Year Property	5,250	9,800
Non-Depreciable Property	1,500	2,800

Table 8 shows the low, mode, and high estimates of the cash flows and annual rates of change. The annual rates of change do not represent the inflation rate, but are a measure of relative change among the various flows. For example, if labor costs were thought to be increasing more rapidly than raw material costs, then labor costs could have an annual rate of change of 2% and raw material costs an annual rate of 0%.

Several assumptions made during the execution of the program were: the risk free interest rate was taken to equal the prime lending rate plus 2%, full investment tax credits were taken on all 3 and 5 year property, the ACRS was used for all depreciation, and the initial working capital was taken to equal 3 months operating costs.

Table 7

Initial Assumptions

Item	Value	
Type	1	
Iterations	70	
Planning Period	18	
Interest Rate	11%	
	Low	High
% Capacity	95%	100%
Initial Investment	$15,000,000	$28,000,000
Initial Working Capital	$ 2,282,401	$ 2,638,990

Table 8

Cost Distribution of Cash Flows

Rate	Cost ($1,000/year)			Annual %
Item	Low	Mode	High	of Change
Revenues	11,250	11,625	12,750	2
Wood Cost	1,500	1,781	2,250	2
Resin cost	1,285	1,491	1,542	0
Wax Cost	371	371	371	0
Labor Cost	2,742	2,742	3,212	0
Electrical + Energy Cost	494	564	648	0
Other Variable Cost	787	813	882	0
Administrative Salaries	197	197	210	0
Supervisory Salaries	457	457	475	0
Maintenance Cost	525	562	600	0
Administrative Cost	113	116	127	0
Net Resale Value	2,000	2,500	3,000	0

RESULTS

The average NPV for the proposed plant was $1,670,842, the average IRR was 12.53%, and the average payback period was 8 years. Figure 2 shows the distribution of NPVs obtained, from which it can be calculated there is an 81% chance that the venture will have a positive NPV. While the venture is certainly feasible, it would only be modestly profitable.

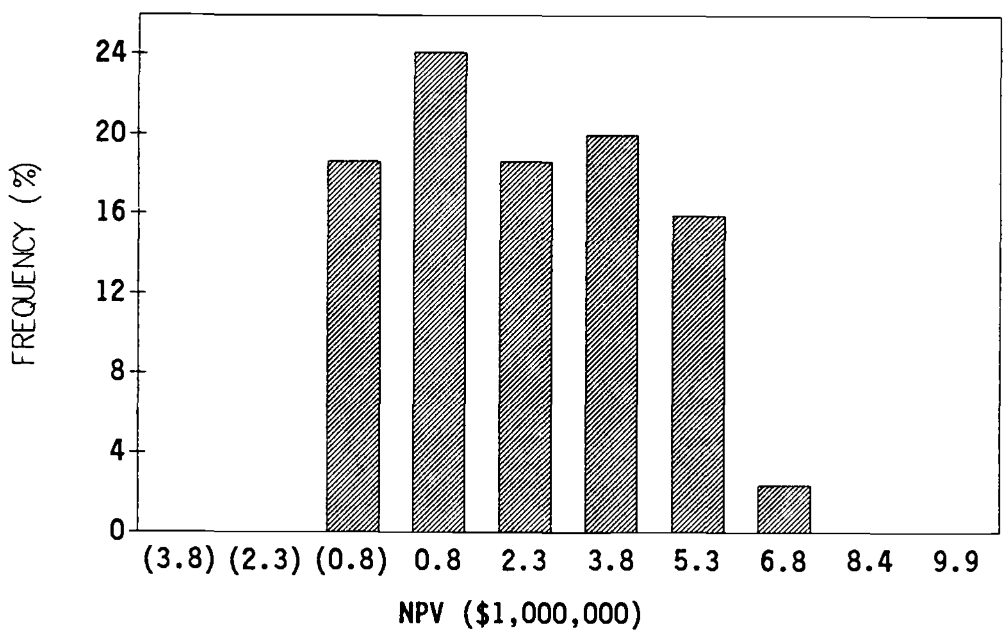

Figure 2. Histogram of NPVs for the base case.

SENSITIVITY ANALYSIS

A sensitivity analysis was performed on each of the important variables to determine their effects on the profitability of the venture. These variables were: wood cost, labor cost, capital cost, interest rate, and selling price. Table 9 shows the effects of each of these variables on NPV, IRR, and payback period at values 10% and 20% above and below the base case.

Figure 3 summarizes the effects of changes in the selected variables on NPV. Within the range examined, sales price had the greatest effect; next in decreasing order of importance were capital cost, interest rate, labor cost, and wood cost.

Table 9

Sensitivity of NPV, IRR, and payback period to changes in selected variables

Variable	Percent of Base Case 80%	90%	100%	110%	120%
			NPV ($1,000,000)		
Wood Cost	3.50	2.50	1.60	1.00	.49
Labor Cost	3.80	2.80	1.60	.69	-.27
Capital Cost	5.70	3.70	1.60	.16	-2.36
Interest Rate	5.50	3.80	1.60	.11	-1.07
Sales Price	-10.30	-3.40	1.60	6.55	11.71
			IRR (%)		
Wood Cost	13.99	13.14	12.53	12.08	11.69
Labor Cost	14.06	13.40	12.53	11.32	11.11
Capital Cost	16.63	14.47	12.53	11.42	9.41
Interest Rate	12.73	12.93	12.53	12.45	12.33
Sales Price	3.19	8.54	12.53	16.14	19.79
			Payback Period (Years)		
Wood Cost	7.30	7.70	8.00	8.30	8.60
Labor Cost	7.20	7.60	8.00	8.50	9.00
Capital Cost	6.10	7.00	8.00	8.10	8.90
Interest Rate	8.00	7.90	8.00	8.10	8.00
Sales Price	16.60	10.90	8.00	8.30	8.60

Figure 4 compares the NPVs obtained as functions of the selling price for OSB and wood cost at values 10% and 20% above and below the base case. Figure 5 similarly compares the NPV results when the selling price and the labor cost were varied over the same range. These two examples show that NPV is relatively insensitive to wood and labor costs for the range of values examined. However, NPV is highly sensitive to changes in OSB selling price: a 20% decrease in wood or labor costs causes a doubling of NPV, while a 20% increase in selling price causes a 5-fold increase in NPV.

Although wood and labor costs comprise the largest portion of production cost, selling price has a much greater impact on the overall feasibility of the project. Moreover, interest rate and capital cost also have greater impacts on overall feasibility than either wood or labor costs (Table 9 and Figure 3).

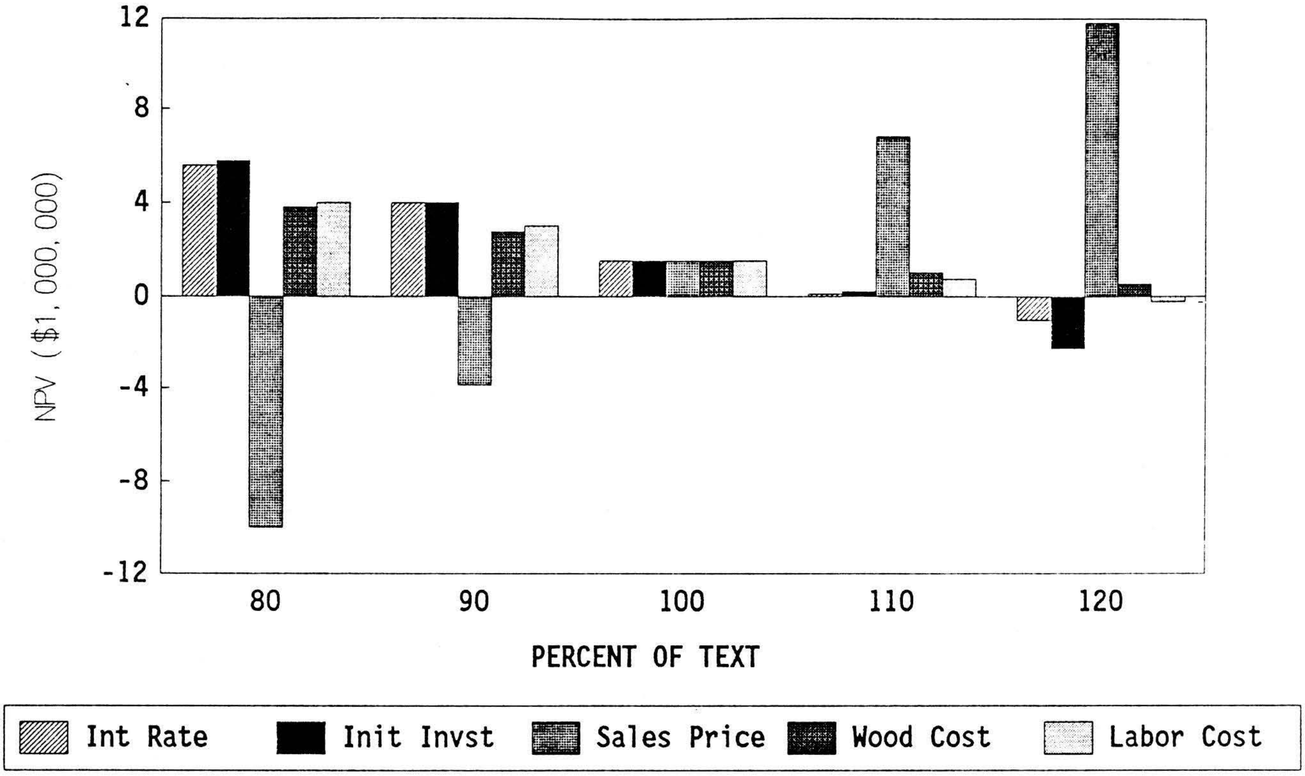

Figure 3. Sensitivity of NPV to selected variables

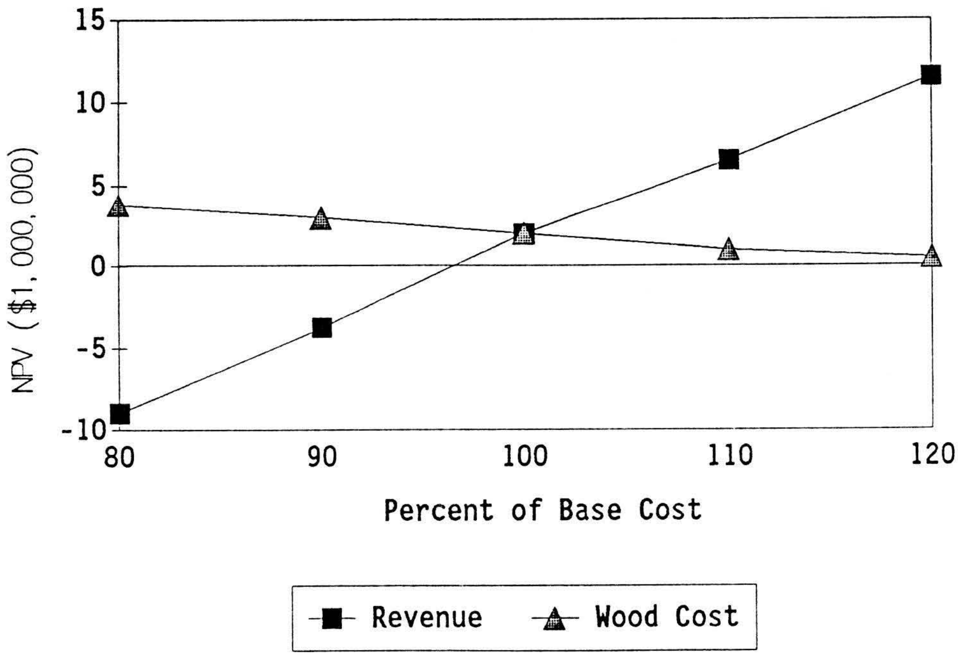

Figure 4. Sensitivity of NPV as a function of selling price of OSB and wood cost.

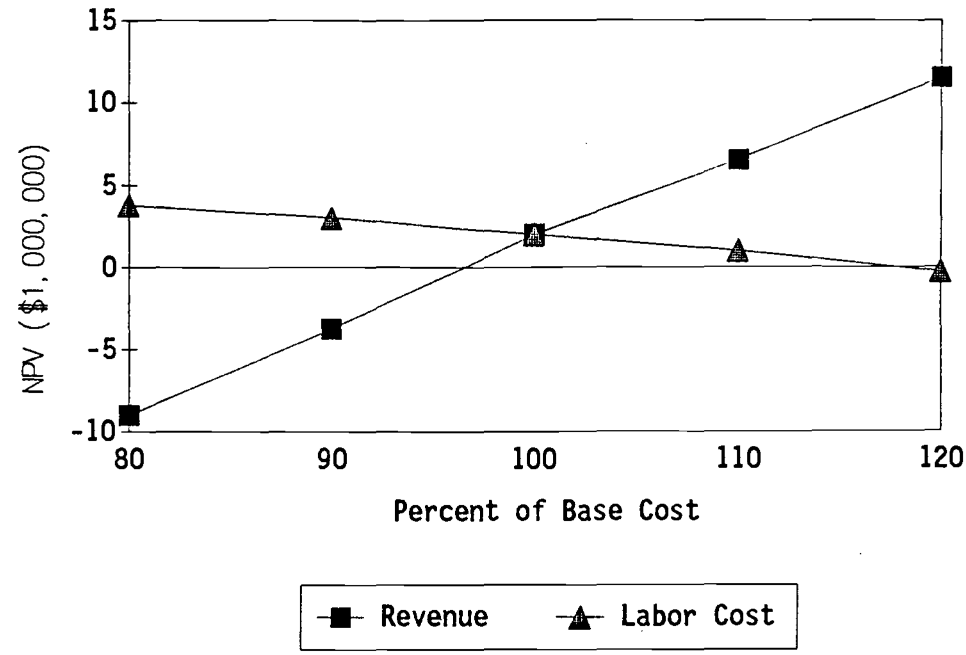

Figure 5. Sensitivity of NPV as a function of selling price of OSB and labor costs.

RAW MATERIAL ANALYSIS

A raw material analysis must include consideration of the raw material supply in terms of location, quantity, and ownership. Raw material availability was determined from timber inventory data collected by the U.S. Forest Service (Farrenkoph 1984) and compiled for the Pacific Northwest Biomass study being done by the Forest Research Laboratory of the College of Forestry at Oregon State University. Red alder was the only species considered in this study. The original data were sorted by individual species, ownership, and size class within each county to provide a database for this analysis.

The Oregon coastal counties containing most of the alder in the state were divided into three regions for analysis. Region I in Northwest Oregon comprises Clatsop, Columbia, and Tillamook counties. Region II, West-Central Oregon, includes Lincoln and Lane counties. Region III consists of Coos and Douglas counties in Southwest Oregon.

Although the volume of alder available in 1985 (Table 10), seems to indicate an abundance in each of the three regions, much of this volume is located on slopes greater than 35%. Cable logging systems are usually necessary on steep slopes, which means difficult and costly operations. Regions I and II each have 25 to 30% of alder volume located on slopes exceeding 35%; almost 50% of that in region III is on such slopes. Because logging costs are a relatively large portion of total cost, the attractiveness of region III is diminished greatly by its high percentage of stands on steep slopes.

The plant in this case study has an annual capacity of 75 MMSF (3/8 in. basis). Figure 6 contrasts the raw material requirements of a 75 MMSF plant with the raw material supply available in each region. The raw material supply consists of the net annual growth after subtracting the annual mortality rate, the annual harvest rate, and the volume of material located on slopes greater than 35%.

All three regions are capable of supplying at least one 75 MMSF plant. Region I has the largest raw material base and is thus best able to support an OSB plant. However, over 60% of the volume in region I is privately owned, which means that

Table 10

Volume and Growth of Alder by Region in Western Oregon, After Subtracting Annual Harvest and Mortality, 1985

Region	Volume Growing Stock (MMCF)	Net Growth (MMCF)
I	718	29
II	963	10
III	540	11

Source: Farrenkoph 1984.

a sufficient raw material supply may not be available from public sales alone. But it might be possible to negotiate long-term raw material contracts with one or more private owners or enter into some type of joint venture to secure an adequate wood supply. In fact, these solutions may be more desirable and stable than depending on public sales.

In addition, it is possible to use hemlock or a mix of species to help overcome raw material shortages. However, a mix of species poses problems with board properties and production parameters if the proportions of each species in the mix change. Therefore, it would be important to ensure that the mix from suppliers be controlled and kept fairly constant so that board quality standards could be met.

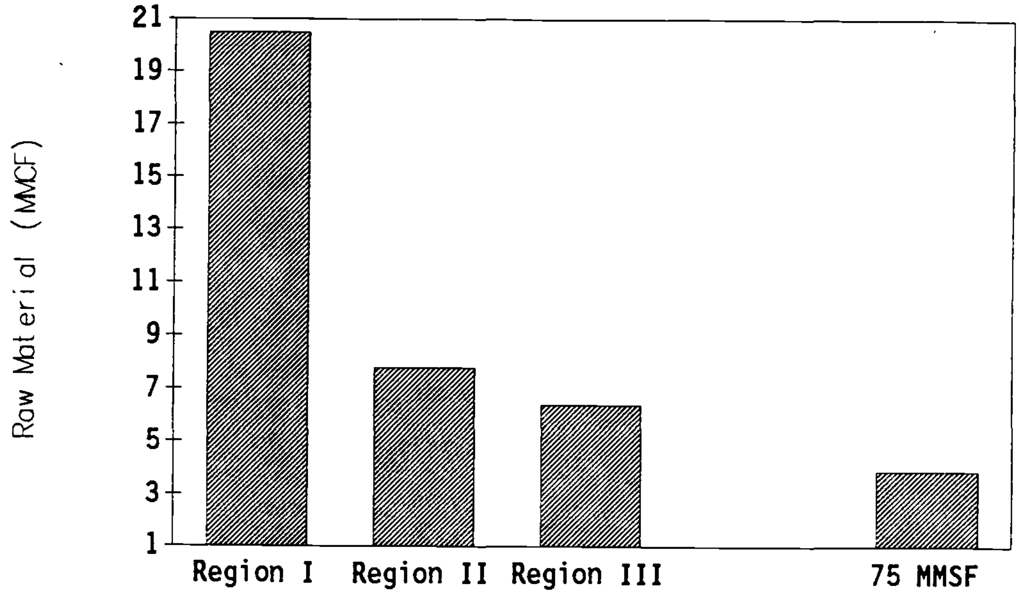

Figure 6. Comparisons of net annual growth of alder in each of the proposed regions with raw material requirements of a 75 MMSF plant.

MARKET ANALYSIS

OSB has had rapid growth in the past few years, mainly because of a large supply of low cost wood from which OSB can be produced. This supply is usually located near major markets, allowing OSB plants to be located near the end user and thereby reducing transportation and distribution costs.

The total Western market for structural panels is about 5.0 billion square feet annually (American Plywood Association 1986). Table 11 shows recent total shipments of structural panels to five major western trading areas.

If a 20% market penetration is assumed, which OSB has achieved in other regions, a 500 MMSF annual market share is potentially available for OSB. This shows there would easily be enough demand to support a 75 MMSF plant located in Western Oregon.

Because of the weight of the panels and the high transportation costs, OSB has almost exclusively regional markets. OSB produced in Oregon would be positioned to serve the Western market and would therefore enjoy an advantage over OSB produced in the South or Northcentral.

Table 11

Total Shipments of Structural Panels to Five Major Western Trading Areas, 1985

Trading Area	Western Region Shipments (MMSF, 3/8-inch basis)	Percent of Total From Western Shipments
Los Angeles	731	71.2
San Francisco	720	91.3
Portland	664	81.9
Seattle	244	67.5
Phoenix	190	76.3
Subtotal	2,549	
Total Western Shipments	5,057	

Source: APA 1986

In addition, the export market currently has great potential for OSB. In a recently released economic report ( ), the APA predicts that the export market is on the verge of a large expansion. Demonstration projects using wood construction are currently stimulating interest in South America and the Caribbean. In addition, Japan reduced tariffs in 1987 and China has demonstrated interest in a wood construction demonstration project. According to APA estimates, the international market could double by 1991.

For any producer willing to make an effort to market OSB products overseas, there is great potential. The availability of water transportation would give an Oregon OSB plant an advantage over those in the Midwest with regard to the Pacific Rim markets.

SUMMARY AND CONCLUSIONS

The objective of this monograph was to demonstrate the use of a probabilistic investment analysis model to analyze new plant investments. A case study was analyzed to determine the economic feasibility of locating an Oriented Strand Board (OSB) plant in Western Oregon.

The plant used in the case study has an annual capacity of 75 MMSF (3/8 inch basis) and produces an OSB panel made from alder with a density of 40 pcf.

The author developed a program which uses Monte Carlo simulation to perform investment analyses. The model uses inputs such as revenues, fixed and variable expenses, depreciation, interest rate, state and federal tax rates, and investment tax credits to calculate net present value, internal rate of return, and payback period of an investment.

Risk is represented by triangular and uniform distributions. The triangular distribution models all operating cash flows and the resale value of assets at the end of the investment period. The uniform distribution models the initial investment, the depreciable and non-depreciable property, the plant capacity, and the initial working capital.

The financial analysis of the proposed plant showed an average NPV of 1.6 million dollars, an average IRR of 12.5%, and an 81% chance of producing a positive NPV. Sensitivity analyses indicated that the NPV and IRR were highly sensitive to the selling price of OSB, moderately sensitive to the interest rate and initial investment, and only slightly sensitive to wood cost and labor cost.

While the results obtained are specific to the case study, the type of analyses that can be performed with the model, the level of detail possible, and the procedure for using the model are applicable to any other new plant investment opportunity.

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