CASE STUDIES IN LUMBER DRYING
THE MEASURABLE IMPACT ON PRODUCTIVITY

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INTRODUCTION

I'm George Lowe, President of Matrix Northwest. The mission of Matrix is to increase profitability for our customers by introducing them to energy conservation products and services. Matrix has been marketing the Enercon orifice condensate removal unit primarily in the Northwest, California, Idaho, Montana and Wyoming.

BUSINESS CASE STUDIES PROGRAM

When Matrix began to convert plants to orifice systems, we knew that we were going to produce savings for the plant – less fuel use, elimination of maintenance costs, a reduction in make-up water, and a reduction in chemical costs for treating water through the boiler.

In 2003, Hampton Lumber converted all of its 6 Washington plants to Enercon's orifice system despite hearing that orifices wouldn't work with varying loads. C&D Lumber converted its plant in Oregon. Hampton reported reductions in drying time and improvements in drying consistency, as well as savings in fuel, water, chemicals and maintenance. C&D Lumber reported improvements in drying consistency along with fuel and maintenance savings. Following these successful conversions, 47 plants in the U.S. installed orifices on one or more kilns in 2004.

As more plants installed orifices in kilns, we began to get more reports and anecdotal evidence that orifices impacted variables of production and quality, but we couldn't quantify them precisely. One business owner challenged us to produce a good business case for converting all of his plants to orifice units. The Business Case Study Program was launched. We wanted to find out, what is the relationship between the savings element and the production impact? If a conversion impacted productivity (measurable), what is the resulting impact on a company's profitability?

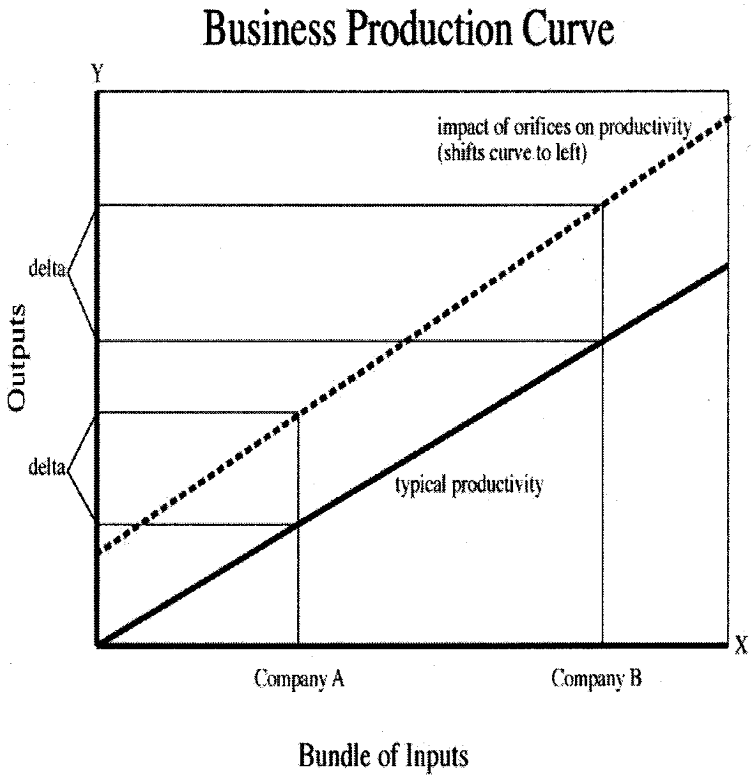
Could we use reduction in charge time as a proxy for increased production capacity? (We did for the purpose of this presentation). Could we establish a unique causal relationship between converting all of the kilns and an increase in production? We kept hearing from people in the industry, that "consistency" was important and was improved, that "capacity" was increased and that "Uptime" was increased. But how do we measure what impact these three variables have on increased productivity?

One thing we realized is that we had to begin to systematically start collecting data on production and quality and try and answer some of these questions. We have included a copy of our one page questionnaire in Appendix 1.

Since we are embarking on what amounts to a full-scale economic analysis of each plant, let's look at the basis economic theory. Every company has a production curve which is a bundle of inputs – labor, staff, raw materials, production structures (kilns), steam distribution system, etc. How these are all managed together is the company's production curve profile and each company's will be different and unique.

The results of data coming in to date indicate that the process of converting is an external event outside of the normal bundle of inputs to the production curve and actually has the effect of shifting the entire production curve. This is demonstrated in Graph 1.

Graph 1



So we began the collection and analysis process and we found what everyone in this room already knows, that everyone is extremely busy and doesn't have a lot of time to go into old reports and dig up baseline data. So our data set was incomplete with lots of gaps and we couldn't do very much in the way of company comparisons. Here's what we've got.

The data presented in this paper is the result of collecting data in the Timber Industry from sawmills. By April 31, 2005, Matrix had the following results:

- 25 Complete Plant Conversions
- 12 Partial Plant Conversions

For this initial and preliminary study we have compiled data from 15 plants.

We have two graphs to show you.

Graph 2 outlines the fifteen plants and an outline of the various production factors that go into the drying process. Many of these factors we have identified as perhaps being part of what influences the productive capacity in the kiln drying process. We were looking for a pattern that would help us make apples to apples comparison and allow us to see the impact of converting to orifices. So far we think our sample is too small but as we get more and more data in we can build up the matrix and see if any patterns emerge.

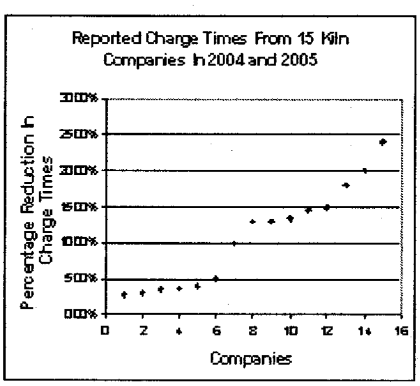
Graph 2

Factors In The Drying Process

Plant	Drying	Hog Fuel	Nat Gas/Propane/Diesel	Steam reduction	Structural improvements	Auto controls	Accu-dry	1 or 2 zones	>3 zones	<50psig	>51psig	1 or 2 species	3 or more species	Pre-kiln species sort	automated grading / MC	Full conversion	Stacking/ schedule Change	
A	2.77%	1	0	1	0	1	0	0	1	0	1	1	0	1	1	1	0	
B	3.00%	1	0	1	0					0	1	1	0	0		1	1	
C	3.50%	0	1	1	0	1	0	0	1	0	1	1	0	1	1	1	0	
D	3.60%	1	0			1		0	1	0	1			1		1		
E	4.00%	0	1	1	1	1				1	0					1	1	
F	5.00%	0	1	1	1	1	1	0	1	0	1	0	1	1	1	1		
G	10.00%	1	0	1	0	1	1	0	1	0	1	1	0	1	1	0	0	
H	13.00%	1	0	1		1	1			0	1	1	0	1		1		
I	13.00%	1	0	1		1	1			0	1	1	0	1		1		
J	13.40%	1	0	1	0	1	1	0	1	0	1	1	0	1	1	0	1	
K	14.50%	1	0	1	1					0	1					1		
L	15.00%	1	1	1	0	1	1			0	1	1	0	1		1		
M	18.00%	1	1	1		1	1			0	1	1	0	1		1		
N	20.00%	0	1	0	0	0				0	1	1	0	1	0	1	0	
O	24.00%	0	1	1						0	1					1		

Looking at Graph 3, we simply plotted the range of percentage charge reductions and we noticed a very distinctive overall trend in charge time reduction. Certainly there was a wide range from 2.5% to 24.4%.

Graph 3

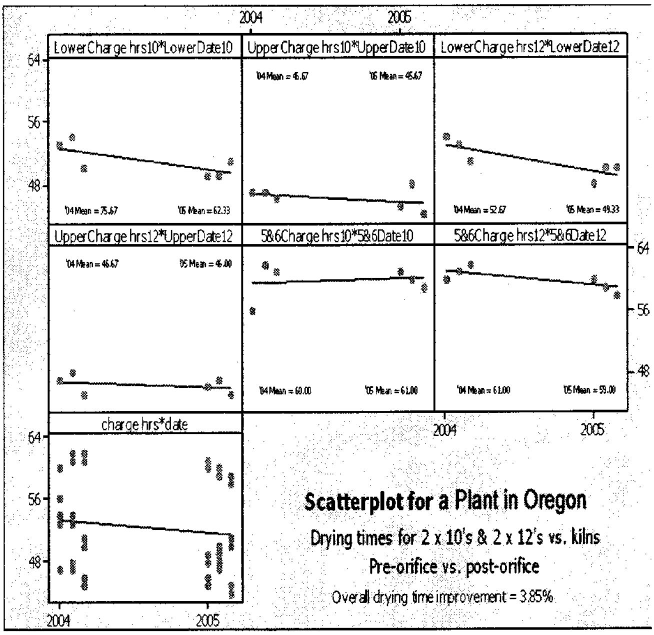


When we looked at, from one particular company that gave us more complete data, some of the three month baseline data (before installation) from 2004 with the same period of time post-installation the trend was generally down but in a few cases in some kilns it went up and tended to reduce the system average when we ran it through our statistical software package.

We began to compare charge times with particular kilns and with different timber sizes.

If we look at this from the perspective of production control, this is where the big story is. There is less variation in the process and the output data is grouped much tighter. We can see this in Graph 4, which shows a scatterplot for a variety of kilns and timber from a sawmill in Northwest.

Graph 4



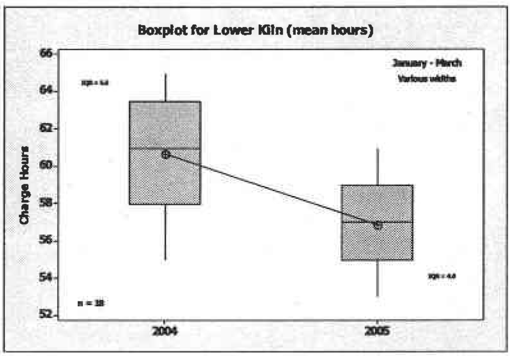
This graph represents a comparison of charge times by lumber widths between kilns. The mean-reductions are shown on the graphs. Notice the actual increase in Kiln 5/6. Apparently, there is still some variation that we did not account for and, thus could not isolate. The chances are, this isolated variation is having an effect on 2x12's run in that kiln, as well. The last "All Widths" graph shows individual data points plotted for a total cumulative mean reduction of 3.85% for all widths and kilns for 2005.

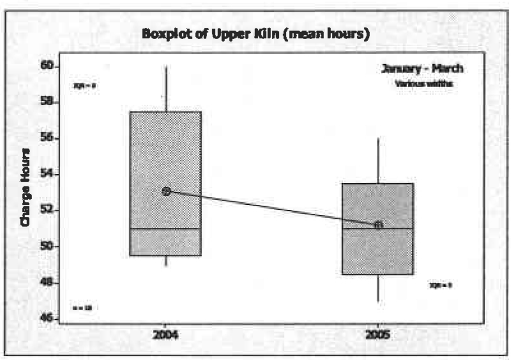
We get an even better look at the issue of variation and grouping in the three boxplots from the same company in the Northwest as shown in Graphs 5a through 5c.

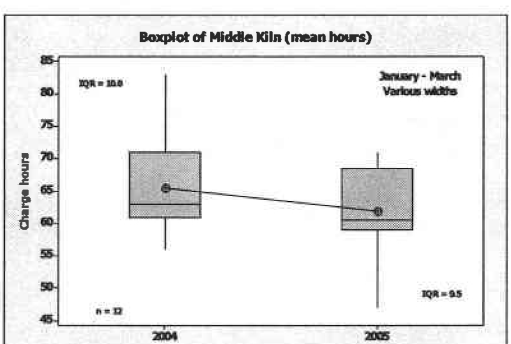
Upper Kiln boxplot shows both a mean reduction (with a 3.56% drying time improvement) and a process variation improvement with an Interquartile range (IQR) reduction from 8 to 5. This says that kiln charge times are and will be more predictable than in the past.

The same holds true for the lower kiln. IQR goes from 5.5 to 4.0. The boxes represent the interquartile range. The vertical line is the total range with the means connected. Drying times are reduced 6.23% for the lower kiln in January-March 2005 over January –March 2004. The summary of this is: not only do we see lower drying times in the comparison periods, but the up and down of charge time variation is less, too.

Graphs 5A, 5B, 5C







The Middle kiln plot shows that the mean drying time improvement trend continues. The gains on process variation, seen with the other kilns, aren't as great here, as shown with an interquartile drop of 10 to 9.5. This is probably due to the as yet, undiscovered variation. However, the mean drying time reduction is still a robust 5.47%.

WHY WOOD DRIES FASTER

Faster drying with orifices is mostly due to improved heat transfer in the coils. Mechanical traps produce inconsistent temperatures, where heat transfer capability at the bottom of the coil is lower than the heat transfer capability at the top of the coil. With orifices, there are more btu's per pound in the coil throughout the coil. To a lesser extent, faster drying times are due to wood drying evenly, so you're not waiting for wood at the bottom of the coil to dry when the wood at the top of the coil is already dry.

OTHER VARIABLES REGARDING PRODUCTIVITY

Other variables that impact productivity are:

(A) More uptime – this is an important factor to many plants to keep up productivity

(B) More supply capability – plants have reported additional supply capability which translates to more consistent steam flow. Some plants have reported the capacity to run an additional kiln.

(C) Improved drying consistency and grade recovery – we have anecdotal reports of improved grade recovery. The kinds of things we hear about improved drying consistency are:

"The top layers of lumber are drying flat instead of twisted."

"Before, one side of the kiln came up slower, now both sides dry the same."

"My wood is drying a little more evenly."

In some cases, improved drying consistency could lead to better grade recovery and this is something we are starting to investigate.

For some plants that use natural gas or other fossil fuels, saving on fuel costs per board foot is still the most important factor. The average reported fuel savings among kiln operations has been about 12%, which is similar to other industries. Orifices are better than steam traps at 1) holding back steam and 2) letting out the water. If the mechanical trap is closed, it is not letting the water out. If it is open, it is letting out enough steam to cause a pressure gauge to drop. With an orifice neither of those will happen so an orifice does a better job on both sides of the trap.

Many people at the plants we work with say it makes a big difference to them that they no longer have to constantly check to see if steam traps are working properly and no longer have to repair or replace them. The Enercon orifices start out more efficient than new mechanical steam traps and retain their initial efficiency indefinitely. (They have a lifetime warranty). This means kiln and maintenance personnel can spend their time on other issues.

CONCLUSIONS

Productivity Results

As we collect more data we'll be able to see more clearly what the improvement in drying times is for kilns, and why the drying time reduction is greater in some plants than others. The data collection process has been messy and varied. Nevertheless, the data does reveal an across the board average increase in potential output caused by reduced charge times.

In Appendices 2 and 3, we have included drying time reductions reported to us by Stimson Lumber in Gaston, Oregon and Hampton Lumber's Cowlitz division. Their results are significant and they have given us permission to share their results with you. Hampton's Cowlitz division has had the benefit of being able to look at drying times over a year.

For many customers, the improvements in drying time and drying consistency have greatly outweighed the benefit of orifices saving money in terms of fuel efficiency and maintenance elimination. Many plants have already reported having several paybacks in a year from reduced drying times, additional supply capability or fuel savings, or a combination of benefits.

Quality Improvement Results

Regarding the increase in quality due to increased grade recovery percentages, the little evidence we have so far is mixed. High increases in grade recovery were reported by three companies (1.5% -6%) while others (three companies) reported closer to an average of no change in the grades recorded. Our preliminary conclusions are that the impact so far in grade recovery ranges from neutral to positive. As more data comes in we will refine the results.

APPENDIX 1

Matrix Northwest, Inc - Business Case Study Worksheet

Your Plant

Baseline Data and Assumptions Used in Business Case Study

May 4, 2005

	Before Conversion	After Conversion		
Name of your company	Your Plant			
Did you have a steam trap maintenance program before?			yes / no	
How many steam traps did you have? Then/Now			units	
How often is a complete check of all traps done? (months)			months	
When was the last time you repaired all the steam traps? (months)			months	
How many boilers do you have?			boilers	
at pressure did you run thru your pipes? (average if several) Then/Now			psig	
What type fuel do you use?			Gas/Oil/Hog/Liquor	
What is your cost per 1,000 lbs of steam?			$ (gas)	
How many days a month do you run your steam system			days	
If you use injected steam, what percent is injected?			%	
What is your start up time?			hrs	
Is water usage Critical to your company?			yes / no	
What is your cost of water? (include dimensions or attributes - cubic feet, gallons per minute, etc.)			$ <- use your rate $0.00199 is Seattle's rate)	
How much feed water makeup did you add to you system daily?			gals shared make-up	
Monthly bill for Chemicals for your steam system			$ shared again	
Daily Rate of Maintenance Staff			$ <- use your rate	
What is your rated boiler output?			hp - #/hr - kW/hr - Btu/hr circle on	
What is your average annual profit margin?			% <-- use your estimate	
Is there anything special I need to know about your steam system?			e.g. 30 day cycle	
Does your company have cogen or are you considering it?			yes / no / already have	
Is a reduction in emissions important to your company?			yes / no	
Do you have remote sensing capabilities to monitor your system			yes / no	
Timber Industry Only				
What percent of your wood do you dry?			% <-- use your best estimate	
What percentage of your wood produced is green?				
What species do you dry?			list wood species and percentages e.g.: - douglas fir 30%	
Describe your production			dimensional lumber or specialty?	
Annual Throughput through kilns in Bd Ft per Year			**second specie**	
What percentage of your kiln dried product is Grade 1				Grade 1
What percentage of your kiln dried product is Grade 2				Grade 2
What percentage of your kiln dried product is Grade 3				Grade 3
What percentage of your kiln dried product is Grade 4				Grade 4
What average price do you earn from Grade 1				Grade 1
What average price do you earn from Grade 2				Grade 2
What average price do you earn from Grade 3				Grade 3
What average price do you earn from Grade 4				Grade 4
How many kilns do you operate			<-- use your number	
How many kilns do you run through winter?			If you lose any days in winter	
Are you operating your planar at reduced production levels to accommodate kiln drying limitations?			reduce the operating kiln count to reflect that	
Are the coils ganged?			yes / no	
If ganged, how many coils total?			<-- use your best estimate number	
Do you run a set schedule or variable based on moisture content?			set / variable	
What is your typical cycle time on your kilns?				
CO GEN ONLY				
How much Power do you currently CoGen?				
What are your turbines Peak capability?				
What percentage of your steam goes to CoGen?				
How much income do you generate with CoGen? Monthly)				

Appendix 2

Stimson Lumber – Gaston, Oregon

Drying Times Before and After Orifice Installation

TYPE	KILN	HOURS BEFORE	HOURS AFTER	IMPROVEMENT
FIR				
2x4 Fir	2	32	29	
2x6 Fir	2	34	28	
2x8 Fir	2	31	27	
Averages		32	28	13.40%
HEMLOCK				
2x4 Hem studs	4	61	50	
2x4 Hem studs	4	62	50	
2x4 Hem studs	4	57	51	
Averages		60	50.33	16.11%

Appendix 3

Hampton Lumber – Cowlitz Division

Kiln Performance Gains

Kiln time improvements

Morton:	13%
Randle:	13%
Packwood:	18%
HDC:	15%
Division:	15%

10 hour improvement average division wide

(measured over approximately one year)