Profit is an elusive target in the forest products industry yet it is a must for your continued success. Each person must look at their area of responsibility to constantly seek out new ideas to improve their operation, which then contributes to product quality and the profitability of the company. Since our focus here today is lumber drying, I would like to help you improve your drying operation. We will also look briefly at statistics and the benefits to you as a kiln operator.

First, I would like to relate a story that should put our quality goals in perspective. A retailer placed an order for lumber from a new supplier. The purchase order had the usual information plus information on target moisture content and grading allowances which specifically stated that only 2 percent was allowed for off-spec product. The supplier filled the order promptly and included a small unit with a note attached. The note read as follows: "Our goal is to provide you with a consistent, uniform product every time. We don't know why you want 2 percent off-spec product but for your convenience we have packaged it separately." Our goal must be to provide a uniform product to our customers every time.

Lumber markets and product requirements have changed dramatically over the past decade. The customer expectations and end use requirements of lumber have changed requiring a more uniform product and in the case of shop grades a brighter, higher yield product. Moisture content is still important however as time pressures have increased, you do not have the luxury of gentle schedules as you try to maximize kiln productivity. It has been estimated that 80% of the "problems" with wood in service are the result of wood moisture relations.

Years ago, most hardwood lumber was air-dried, perhaps under a roof but often in the open. It was quite common to have a multi-million board foot lumber inventory on the air drying yard waiting for the kilns. Yard pine was often put in the board yard to air dry to 12-15% before being dressed in the planer mill. Dimension lumber often dried "in service" after the house was framed but before it was closed in.

Today, the markets are quite different. The price of lumber is high which means that the inventory costs are high. New technology and alternate products have increased competition thereby giving your customers more choices for lumber or lumber substitutes. Many manufacturers have adopted a "just-in-time" system, which adds further pressure for a variable resource such as wood. Raw material supply and lumber quality have changed dramatically, we now must look at the drying aspect differently. The trend in Western lumber production is to produce a higher volume of kiln dried product, especially in the framing grades. The dry kiln can no longer be viewed as a tool to help the company "finish off" the lumber but rather as an integral part of the manufacturing operation.

Lumber preparation before the kiln now becomes critical, as production requirements increase there must be a closer watch over the basics of yard operation such as stacking and yard layout. Kiln performance audits that reflect lumber moisture
content uniformity will help ensure quality kiln drying. Proper storage after kiln drying will maintain the lumber at the desired target moisture content. There are many challenges facing the kiln operator today, some of which you can control and others that you do not have any influence.

Consistent quality control procedures will help you look at your drying operation and improve the product so that your customer has a better product. Depending on your operation, the customer could be your planer mill or a company off site that uses your rough, dry lumber. Ultimately, a consumer you and I could use this product, but not everyone understands the process of producing lumber. Regardless of where the product is going, it is your responsibility as a kiln operator to know what target moisture content is required, operate your kiln to achieve these results and then monitor quality to make sure that you are on target. If you do your part to produce a consistent product, your customer will know that they can count on your quality and that their business will prosper by doing business with you.

This change creates "opportunities" for the kiln operator who often is forced to push his/her kiln equipment beyond what it was originally designed for in order to produce a quality product in a timely manner. The goal of your drying operation should be to produce a consistent quality product, at a profit, that meets or exceeds customer requirements. I would like to focus now a few tools and techniques that can help you better manage your drying operation.

There are two basic functions of any dry kiln; create a controlled temperature environment for lumber drying and circulate this temperature and humidity controlled air uniformly through the lumber packages. If this is done correctly then you have the opportunity to produce a uniform product assuming that all of the incoming material is fairly uniform. This is one of the challenges for the kiln operator since much of the incoming material has a wide range of initial moisture contents yet you are working to bring this product down to a tight target moisture content range with minimal deviation.

The performance characteristics of your kiln may not always produce a uniform product due to ongoing maintenance needs. While there are a few of us fortunate enough to have relatively new equipment, many of us must rely on equipment that has been in service for a number of years and was often installed to dry a different product. You may have limitations on warm up time, air velocity or vent capacity or have boiler issues. Whatever the situation, you have the responsibility to produce a uniform product in a timely manner.

One important key to maintain and improve quality for the kiln operator lies in moisture content management. Your goal is to produce a product of superior quality and consistent uniformity, charge after charge. While some of you may view your product as a commodity, there are market niches and reputations that are made when you provide products that are dependable board after board. The challenge to deliver this uniformity is no small task when you consider the variability within a piece of wood. The same traits of a piece of wood that make it attractive also give us challenges when we are charged with the task of drying uniformly.

One of the first steps in moisture content management is measuring the uniformity of your lumber. In addition, if you know the drying characteristics of your kiln you will be better able to monitor the load. The oven and scale sample method is a very accurate way to monitor moisture content however it is time consuming and often impractical when you require a large amount of information. You will hear more about this weight-based method as an industrial testing tool on Tuesday morning. A
dependable alternative is to monitor the moisture content by using technologies such as moisture meters and/or in-kiln moisture measurement systems. These tools can be used to check the drying uniformity of the kiln and monitor kiln performance.

Moisture meters are indispensable tools that allow you to take a number of accurate measurements very quickly. These tools will allow you to determine the core moisture content and depending on the meter you could also measure shell moisture content. When you know both the shell and core moisture content you are able to establish the drying gradient and use that information to improve your process. The meters will give you accurate information quickly and in certain models allow you to download the information into a computer for data management. You will get the most out of your meter when you follow the instructions that came with your meter, observing all operating guidelines. Of course, if you have inherited a meter from your predecessor without instructions, contact your meter supplier for a replacement copy. If any of you need this information for our Delmhorst products, please let me know.

Your moisture meter can give you a wealth of information regarding kiln performance and moisture content uniformity with proper use. Before you use your meter, take a minute to check the calibration of the meter using internal or external calibration tools. Check the battery and replace if necessary. Operate your meter according to the instructions. For example if you are using a Delmhorst pin type meter you would drive your pins parallel to the grain and take your reading. Depending on your meter and species, you may have to adjust the reading for your situation. Generally, resistance meters work best in the range from 6 percent fiber saturation point (25-30 percent) on a corrected basis.

In-Kiln data collection systems such as the Kil-Mo-Trol allow you to measure moisture content remotely and automatically, helping the kiln operator manage his/her time better. These remote measurement systems provide you with flexibility and depending on the system can provide you with crucial moisture gradient information. In fact many kiln manufacturers are using this technology as part of their dry kiln control systems or they could be used on a stand-alone basis. These systems allow for complete flexibility with probe assignments and come with a modular design for field expansion.

The collection of moisture content information on a real time basis allows you additional flexibility and provides you with important information. You now have the tools to look at moisture content and kiln schedules to optimize your kiln performance. For example, many kiln suppliers now provide kiln history reports that show you the kiln conditions and moisture content on the same graph. You can use this information to review the drying performance of that charge and make the necessary changes for schedule improvement.

Dry kiln control systems have also improved dramatically over the last few years allowing you the flexibility to manage your operation better. Several features available now include multi-zone control, the ability to monitor and control multiple kilns from remote locations, real time moisture content measurement either probe based or weight based and customized software to suit your drying needs. The additional information provided by these state of the art systems allows you to operate your kiln with confidence. You have heard in a previous meeting about the LoadmasterTM weight based kiln control as a new kiln control and moisture measurement tool. The
Loadmaster system allows you to accurately, continuously measure moisture content using sample boards placed in the kiln and control your kiln automatically. While this technology is not for everyone in this room, it does provide you with accurate moisture content information from "green" all the way to your final moisture content.

Both the handheld moisture meters and the in-kiln data collection systems allow you to measure moisture content at a large number of locations accurately and efficiently. When you have a large pool of sample data you can then use it to develop statistical projections about your lumber charge and also help you improve kiln performance and lumber quality. Both of these items will affect your bottom line. Quality control is not another department but rather the responsibility of everyone in the company as they do their job so you can use this information to improve your operation. For example, the information shown in Figure 1 summarizes moisture readings from a charge of shop grade pine having a target moisture content of 10%. These readings were taken throughout the kiln to establish final moisture content distribution as a quality control check.

FIGURE 1. Histogram of moisture meter readings for shop grade lumber.
The information gathered shows a sample size of 96 readings. The average moisture content is 9.7% with a standard deviation of 0.94%. From this information we can say that 68% of the boards in the charge will fall between 8.8% and 10.6% and that 95% of the boards will fall between 7.8% and 11.6%. We can see that the kiln is operating well with uniform drying characteristics. If the average was the same but the standard deviation was 2.0%, there would be a greater spread between the readings and you would have less confidence that your lumber will meet acceptable limits.

By comparison, Figure 2 has a different story to tell. The target moisture content is 18% with these readings taken from lumber in the dry storage warehouse. From this information, you see that the average is 18% but the standard deviation is 2.97%. What does this mean to us? We can say that 68% of the lumber is between 15.0% and 21.0% and that 95% of the lumber is between 12.1% and 23.9%. There is an opportunity at this mill to improve quality and produce a more uniform product. The low moisture content results in overdrying and degrade due to overdrying while the high moisture content lumber will continue to dry in the field.

![Histogram of moisture meter readings for shop grade lumber.](image)

**FIGURE 2.** Histogram of moisture meter readings for shop grade lumber.
At this point, I want to comment briefly about statistics. Statistics can be very useful when you are evaluating material if you use common sense and understand basic guidelines. For example, if you could not swim and fell into 10 feet of water, there is little comfort in knowing that the average depth is only 4 feet. For your readings to be useful, you must be careful to take a significant number of readings from a variety of pieces. A typical 100 MBF kiln drying 2" dimension lumber will have over 11,000 pieces per charge. You will also be removing a tremendous amount of water in a short period of time during the course of drying. You are only fooling yourself if you just recognize readings that are on target and ignore the other information.

Wise use of moisture content information can help you with kiln schedule improvement, kiln performance evaluation, scheduling and kiln optimization. You will recall that 80% of wood problems have been attributed to wood-moisture relations; understanding how to respond to this challenge is critical for your success. The competition is keen in the marketplace, everyone is trying to improve their quality, reduce costs, increase production, and become more efficient. When you understand the nature of wood, you are better able to respond to the challenge and use technology for your benefit. Tools such as moisture meters and in-kiln moisture measurement systems can be used effectively to improve your drying operation. I trust that this information has helped you look at your operation and challenged you to take a proactive approach to moisture content management. After all, if you can manage your drying operation as a profit center then you have contributed to the overall success of your company.

Should you have any questions or wish to discuss specific problems, I would be pleased to meet with you later for a personal discussion. Thank you for the opportunity to address this meeting and share my experience with you.