Maximizing Performance of Linear Edger Systems, Rev 4

Alignment and Calibration of Linear Edgers

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Dec 7, 2011, Rev 3
(Revision 4, May 11, 2020)

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Preface

This paper is intended for sawmill personnel who are tasked with ensuring the optimum performance of their linear edger system, whether it was manufactured by McDonough Manufacturing or not.

The paper has been prepared in two sections, the first focusing on the underlying principles of linear edger operation. Those principles being fundamentally the same for all linear edger systems and ones that must always be respected if any linear edger system is to run properly. It was not my intent to present an all inclusive list, rather a basic guide and explanation of what I feel are the most critical and fundamental principles behind the design, manufacture and operation of these machines that must be understood in order to properly maintain their alignment and subsequently their performance.

The second section will present methods that I have learned to use over my years of installing, starting up and maintaining these systems for my customers. I do not mean to portray it as the only way to do the job as I expect there may be better methods out there. Rather it is what I have found to work the best for me while working on the machinery that I have installed and helped customers to maintain.

May 2020 Edit: The second section has been updated in this revision to reflect new techniques we have implemented at McDonough for linear edger infeed and outfeed belts construction and alignment.

Principles of Linear Edger Operation

How Does a Linear Edger Work?

Throughout this document the terms skew and slew will appear quite often. With respect to linear edgers and gangs the term “skew” refers to the rotation of the machine’s arbor about a pivot point typically on the machine center line. In other words a skewed arbor will no longer be sitting 90 degrees to the machine centerline and therefore the path of the board or cant. The term “slew” refers to motion of the saws along the machine’s arbor, most typically referring to that motion which occurs while the saws are in the cut. A linear edger or gang is one which is designed to cut a piece which is travelling in a path parallel to the machine centerline but that is skewed at a small angle (typically less than five degrees). The arbor will “skew” to match the planned cutpath and the saws will then “slew” as the piece passes through the machine in order to follow the planned cutpath.

A linear edger operates on the basic principle that we can scan a piece of lumber while it is in one location and then “edge” it when it reaches another, ***without handling it in between***, as long as we can accurately predict where it is going to be throughout the process. As opposed to the premise behind the operation of a transverse edger, a linear edger system does not try to physically manipulate the piece after it has been scanned in order to line it up with a non-skewing/slewing saw (fixed angle, variable position across the boards width). Instead a linear edger is designed to move the piece through the scanning system along a known reference line (it is typical for linear edger systems to use the machine center line as this reference line) and then saw the piece immediately afterward and before the piece is handled or moved relative to that center line.

Advantages

It is known that every time we try to grab and position a piece of lumber in a transverse edger system we introduce error into the edging system. Edger systems that “grab” or “place” flitches after they have been scanned have introduced a number of opportunities for error before the piece ever reaches the saw itself. Was the board exactly where it was supposed to be when we grabbed it? Did we grab it where we were supposed to? Did we place it where we were supposed to? Did it slide around when we placed it on the infeed mechanism? Did we physically damage or modify the board during placement?

A linear edger system eliminates all of that potential error by simply scanning the board “as it sits” on the belt that will feed it into the edging device. In this way the intermediate handling is eliminated and the sources of error are reduced to our ability to predict the exact location of the planned cut path as the board passes through the edger and our ability to place a saw exactly along that path.

Another important advantage of a linear edger is the simplicity and cost of a typical linear scanning system. As each board is scanned while it passes longitudinally through the scanners the scanning window is much smaller and requires only a fraction of the scanning hardware that would be required for a typical transverse system.

McDonough’s newest linear edger system however combines the compactness of a transverse edger system with the accuracy, performance and simplicity of a linear edger system. This is accomplished by utilizing a multi-line scanning system typical of many transverse edgers to capture the piece image practically “in place” on the edger infeed belt. Combining this with fast optimization times, our linear edger control system and extremely fast electric servos has allowed us to fit our OptiFit linear edger system in the footprint where a typical manual board edger would sit in most mills.

In addition to the advantages of accuracy, linear edger systems can be designed to be much simpler mechanically than a transverse edger system of similar capability. Infeed mechanisms or board loading devices are typically much simpler in a linear edger system, eliminating most of the complex mechanics that make up the "grab and place" type edger infeeds that are required of transverse systems.

As piece counts increase the advantages discussed here only grow for a linear edger system as board placement becomes harder and harder with increased speeds, accelerations and decelerations of transverse edger board placing systems. Not only does the accuracy start to suffer but mechanical systems are asked to do that much more, driving up the maintenance costs of these systems while accuracy and therefore yield deteriorate. Efforts have been made to offset this by doubling up on the number of board "fetchers" in a transverse system required to run at high speeds but it isn't hard to see how this only adds to the mechanical complexity and therefore maintenance considerations of these systems.

Disadvantages

Perhaps the single biggest disadvantage of a linear edger system is the perceived difficulty or even inability for a mill to properly measure, tune and maintain the edger systems performance. I say "perceived" because I also believe that this problem can be fairly easily managed by mill staff if they have the proper tools and training and are willing to perform regular checks on the system. Also, with relatively few potential sources of error as compared to a transverse system, irregularities with linear edger system cutting accuracy are typically much easier to troubleshoot.

The trouble is that without proper training on a relatively simple way to measure and tune the performance of the system, many linear edger systems that I see in operation are leaving available recovery on the table. This document is part of

McDonough's aim to provide tools and training that allow mill staff to properly maintain their linear edger system with regular simple checks. In this way the linear edger can easily maintain the accuracy advantage that it inherently gains from its simple design and function.

Traditional edger systems, including all transverse edger systems, align the board to be edged with the centerline of the machine so that the saws will make a straight cut through the piece as it passes through the edger. This seems to make it much easier for the human brain to watch the machine operate and get a relatively good feel for whether or not the edger is doing a good job. Boards that are skewed on the infeed table are easier to pick out when they are momentarily still as compared to a linear edger system where boards are travelling at speeds sometimes over 1000 fpm and are cut on the fly. However, with a good understanding of linear edger theory and operation it should be relatively easy for mill staff to quickly spot problems with linear edger performance and correct them.

Components of a Linear Edger System

Any linear edger system must have the following critical components in order to function properly.

1. Edging Device with at least 2 cutting tools (the saw)
2. Lumber transport system (the belts, rolls or chains)
3. Scanning System and Optimizer (creates the sawing solution)
4. Control System (executes the solution by controlling machinery)
5. Edging Separation Device (separates the board(s) from the edgings)
6. Machine Alignment (not a physical device but a critical component)

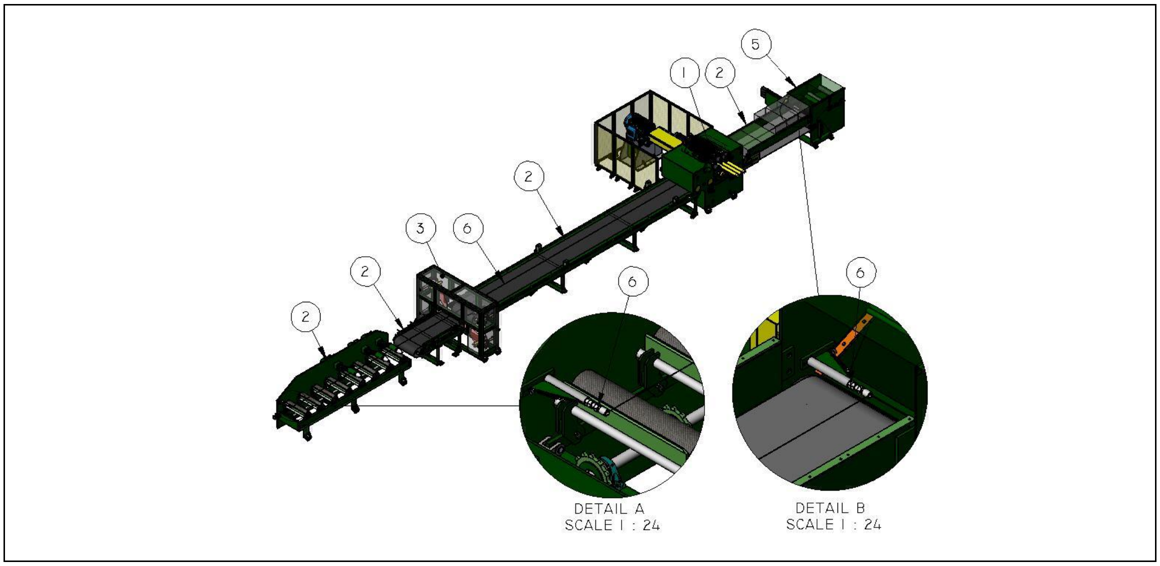

Figure 1: Typical linear edger system layout

Each of these components plays a critical role in the operation of a linear edger and without any one of these devices the system would not function at all.

Additional devices that are very often part of a linear edger system but are not necessarily critical to making the system edge a board include those listed below. This is not an all-inclusive list but includes some of the most common pieces of additional equipment most often seen as part of linear edger systems in today's lumber industry.

A. Operator interface (consoles, touch screen, pedals etc.)
B. Lumber singulation and loading systems
C. Solution display systems (McDonough's ValueMax laser system)
D. Thickness sizing machinery

What follows is a brief discussion of the role that each of the critical components plays in the operation of the linear edger systems. Also, some important characteristics of each that should be carefully considered in their selection and utilization within an edging system.

1. Edging Device

The edging device or “edger” is the heart of the linear edger system and is the machine that will remove the wood fiber designated for removal by the optimizing system. The linear edger must be capable of doing so very accurately at the optimum angle (relative to the system centerline) as established by the optimizer and also at the speeds required by the feed system. This capability is established by the design of the saw skewing mechanism, the saw positioning mechanism, and the board feeding mechanism.

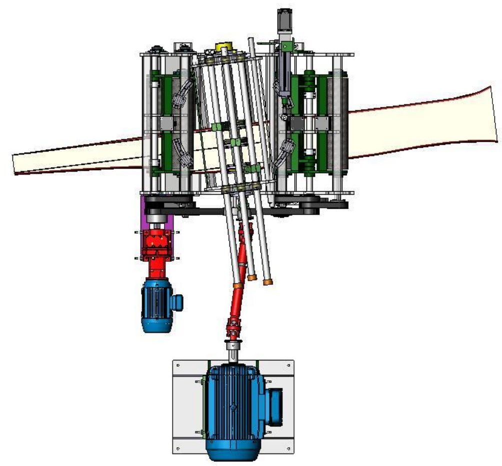

Figure 2: Linear edger plan view showing skewed sawbox and angled cut path.

The design and component specification for each of these systems will determine how much sawing variation is introduced to the sawing process by the edger itself. The edger must position cutting tools accurately to the established preset angle and positions, gear those same cutting tools along the planned cut-path as a board passes through the sawbox, and also feed the board consistently along its planned path.

2. Lumber Transport System

The most common lumber transport method seen in the front end of linear edger systems today utilizes high quality conveyor belting that is fitted in a carefully designed frame which allows for detailed alignment of the belt along its entire length. Often times these “infeed belts” are preceded by a rollcase section where the boards to be scanned are loaded and then feed onto the end of the scanning/infeed belt. The infeed belt then typically hands the boards off to the edger itself which usually has at least a single knurled roll between the belt and the saws themselves on both the infeed and outfeed sides. Downstream of the edger the outfeed belt, often similar in design to the infeed belt, is designed to ensure the leading end of a board that is being sawn continues to travel parallel with the reference line (machine center line).

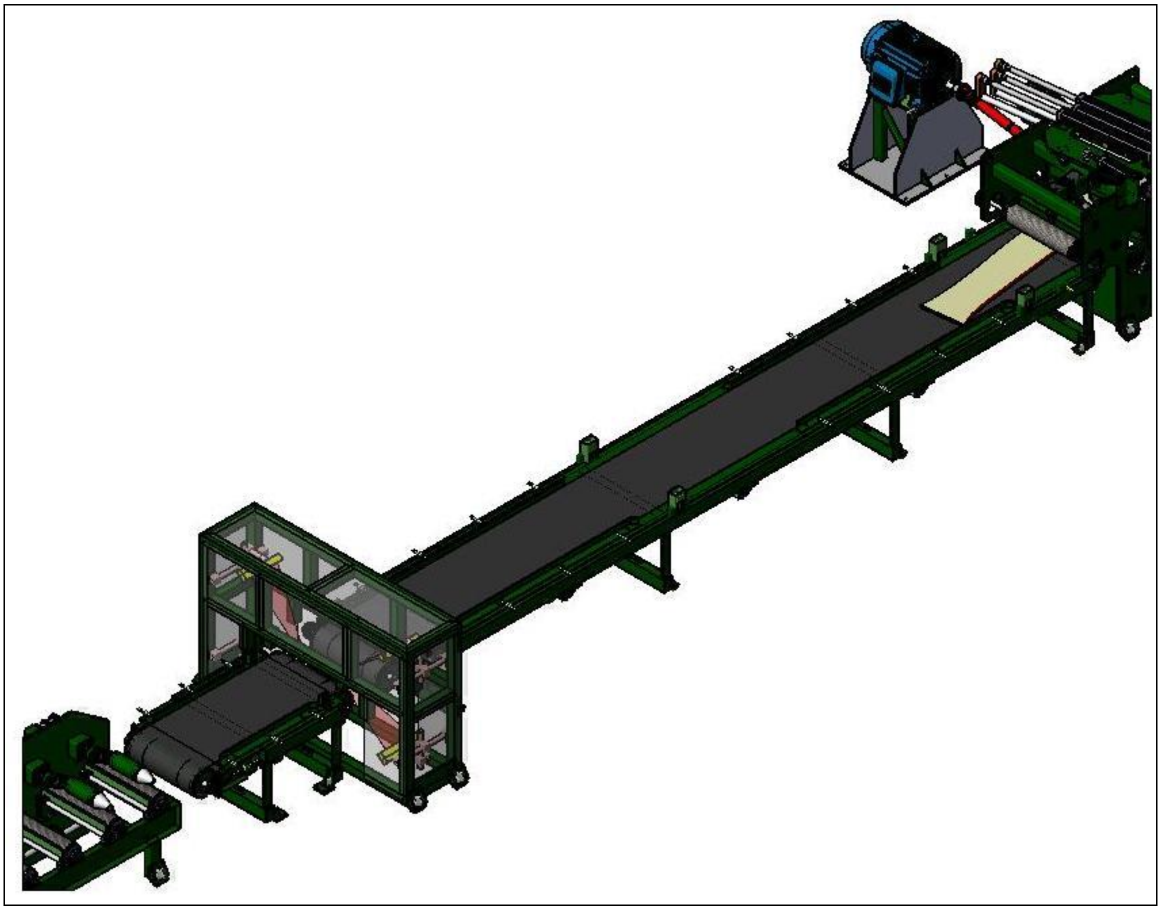

Figure 3: Typical Single Line Linear Edger Infeed Configuration

Systems with splits in the belt conveyor system are sometimes used to allow for both top and bottom scanning of boards on the infeed. While this eliminates the need to be concerned with wane orientation (wane up/down) it does introduce an opportunity for pieces to move relative to the machine center line during the scanning operation. This consideration will be discussed in more detail later.

No matter how it is configured the lumber transport system serves the purpose of carrying boards through the scanning system, through the sawbox and then delivering them from there to the edging separator. The critical part of this job is that the boards must stay exactly on the same path relative to a reference line from the point where they are scanned to the point where sawing is complete and the edgings are separated from the finished product. If this is accomplished then saws that are being placed relative to that same reference line can be accurately placed on the board as it travels through the sawbox and the edging separator can do its job properly.

3. Scanning System and Optimizer

The scanners used in modern linear edger systems are designed to capture an accurate image of boards as they pass through a scanning window while travelling down a conveyor. They can be arranged in single or multiple zones (with each zone scanning a portion of the boards length) depending on the length restrictions placed upon the system design. The data from the scanners in each zone, and there can be several, is then used to create snapshot cross sections of the boards as they pass through each scan zone. These 2D cross sections are then put back together to make a 3D model of the board using data from the encoder that tells the optimization computer how far the board travelled (along the reference line or machine center line) between each one.

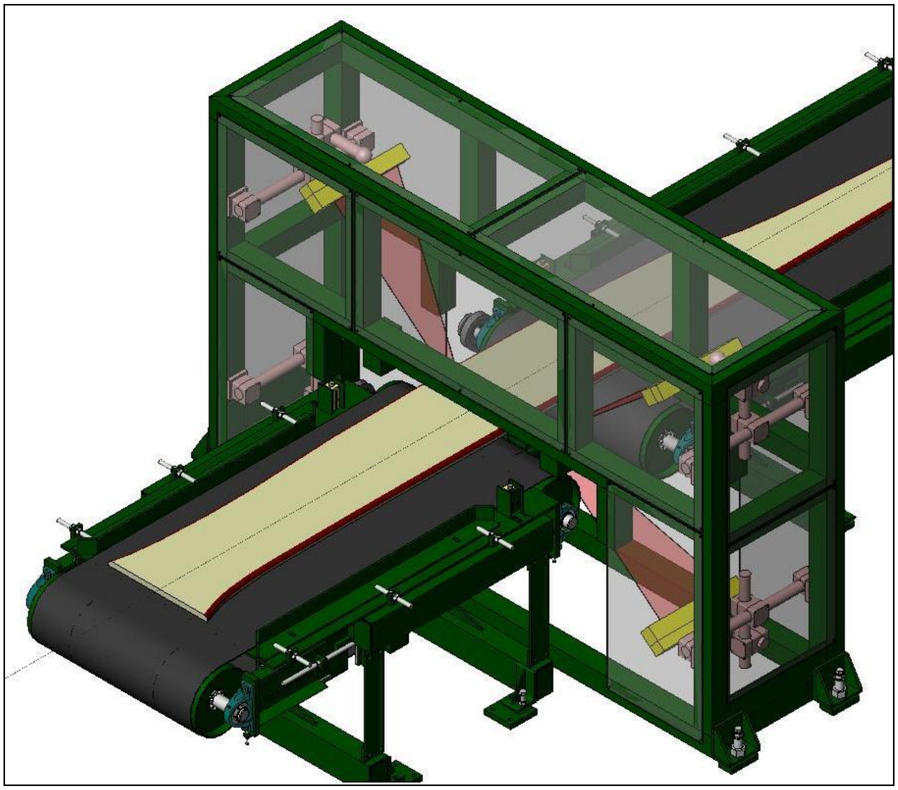

Figure 4: Typical Linear Edger Scanning Congifuration (Top and Bottom Scan)

From the description of the scanners functionality it should quickly become obvious why encoder performance and board stability on the conveyor are both critical to optimization modelling accuracy and therefore overall system performance. A poorly calibrated encoder will make length modeling inaccurate as the spaces that the modeling software places between the 2D cross sections to build the 3D model will be incorrect. This will lead to solutions being either stretched or compressed if compared to their actual length and will in turn compromise recovery as sawing angles will not be accurate.

Poor piece stability through the scanning system is equally critical as the optimization for linear edger systems is based on the assumption that the piece being scanned is moving perfectly parallel to a reference line (machine center line) throughout the duration of its scan. It is also assumed that there will be no rotation or translation of the piece during or after scanning so that any chosen point on the board will be the same distance from a reference line before, during and after the scanning operation right up until it is sawn. This should be true for all points on the board and is made more and more difficult as feed speeds increase to meet demands for higher piece feed rates.

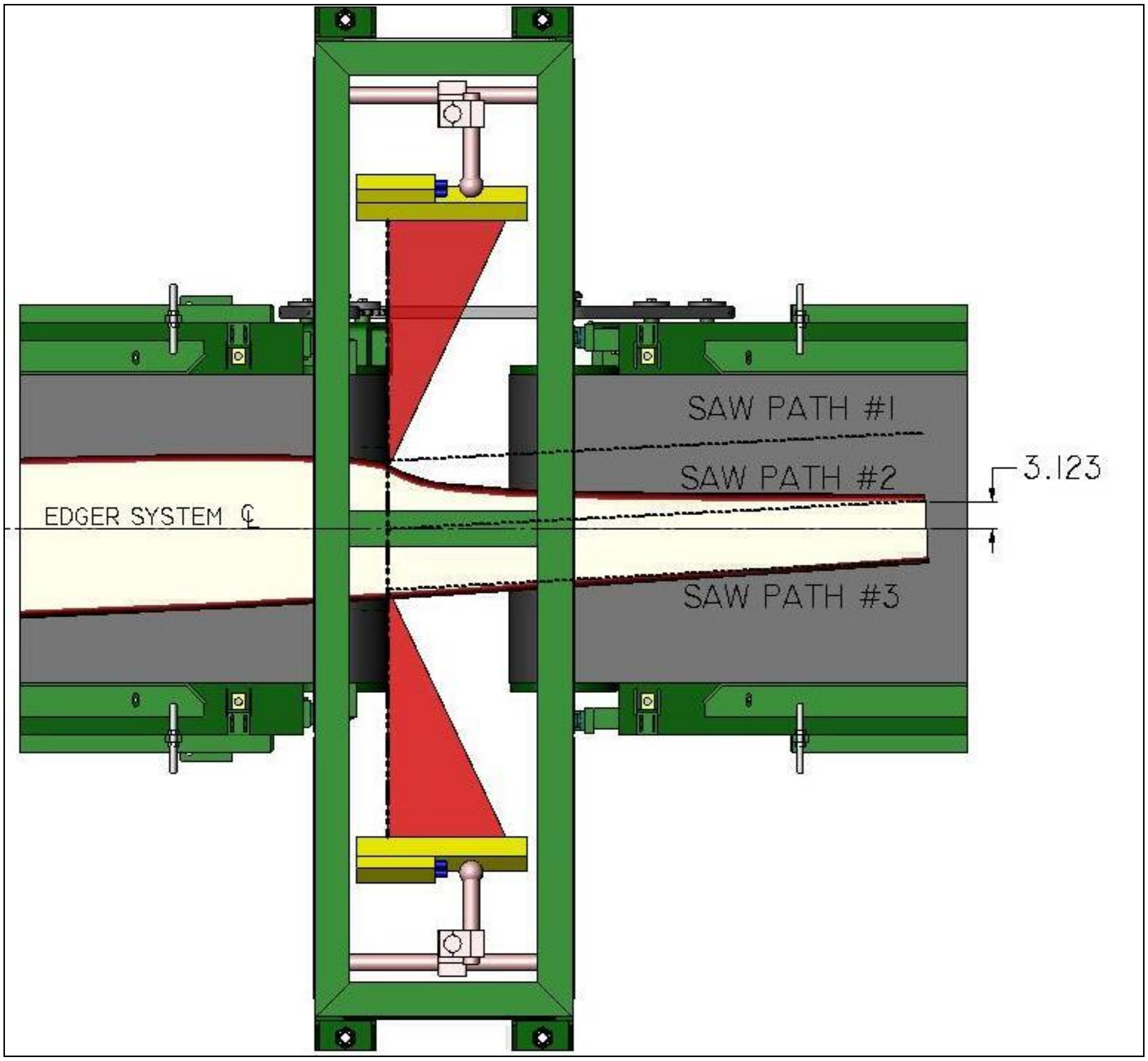

Figure 5: The optimizer will locate saw entry points relative to the machine C/L

Once a good image has been captured and the optimization system has modeled the piece then the optimizer must fit onto that model, according to the values assigned to different grades of product, the combination of saw cuts that will return the greatest value of finished lumber after the edging operation. This is a gross simplification of the process and different optimization providers have different ways of reaching the end product but the purpose for all should be the same. The optimizer should provide saw locations for each piece that will result in the highest value of product downstream of the edger. Each mill can help to determine the outcome by providing tables of product values and a number of different decision making parameters for the optimizer to use in its solution generation. Modern systems can usually handle just about any possible downstream processing scenario so that decisions are based on what the mill is really able to do with the pieces after they leave the edger.

Recent developments in edger optimization include the use of vision technology to edge the board based on visual defects in addition to the geometric information that is captured by the traditional “3D” optimization system. While this technology is in its infancy with respect to hardwood it is becoming fairly common in higher piece count softwood mills. The variability of species and their colours, combined with the complexity of the grading rules and defect types in hardwood make this step a particularly big challenge for optimization providers. However it is almost certain that production demands, the need for reduced production costs and the benefits of consistent product quality will continue to drive the need for vision optimization systems in the hardwood sector.

Since this paper was originally written 10 years ago we are now starting to see vision optimization systems go into green hardwood mills although they are still rare.

4. Control System

The edger’s control system is what will control all of the moving parts of the machinery by following a program of logical commands that is stored in the systems PLC (Programmable Logic Controller). In layman’s terms the PLC is a type of industrial computer that is physically wired into all the input (photo-eyes, buttons, encoders, limit switches, etc.) and output devices (valves, motors, servo controllers etc.) that are part of the edger system. Based on the gathered inputs, current operating conditions and the logical conditions that make up the stored program the PLC can cause different actions such as turning on or off all of the various output devices and motors, starting/stopping servo motion or exchanging messages with the optimizer.

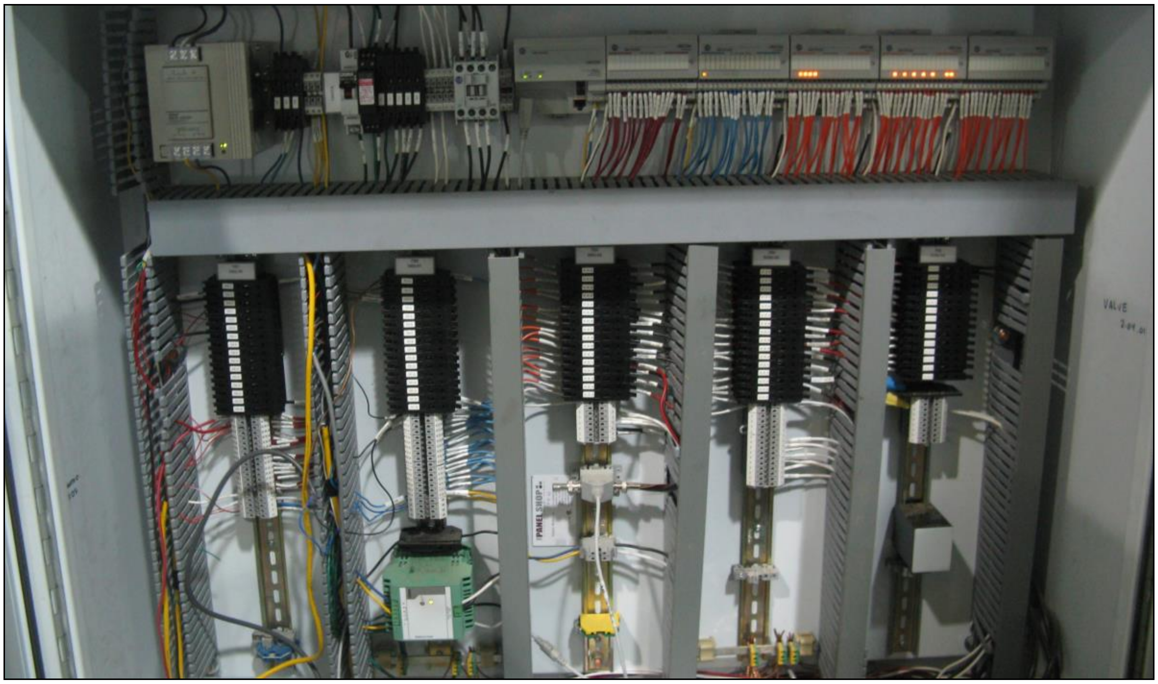

Figure 6: Typical Optimized Edger PLC cabinet

In high speed linear edger systems the controller must be capable of handling tremendous amounts of input and output data simultaneously and without delay. There can be hundreds of different input and output signals going to and from the PLC at any instant and the controller must be able to look through its entire program (a scan) from start to finish very quickly (the PLC scan time). The scan time needs to be short enough that there will not be changes in operating conditions significant enough to sabotage the system performance between two consecutive scans. For example, a McDonough tandem arbor edger system with 15 servo axis or more and several hundred other inputs and outputs might have boards moving at over 1300 fpm towards the edger. A scan time of 0.020s equates to nearly 6" of board movement along the infeed belt. Without a work around, that much movement in a linear edger system could compromise cutting accuracy as saw motion needs to start precisely according to the boards position and orientation on the belt. If the saws move late then they will be "behind" the desired cut path and can leave too much wane along one edge of the boards.

One common method for solving the problem outlined in the previous paragraph is to have a “trigger” device that is located very near to the saws wired directly into the motion controller for the saws themselves. This method allows the controller to setup the motion system with all of the parameters of the required move and to set it in a “ready” mode, awaiting a signal from the trigger to start its motion. The instant the trigger is activated the motion will start without having to wait on a PLC scan to say that everything else is ready to go. That condition has been set in advance and the motion controller is simply waiting on the light to turn green so that it can go!

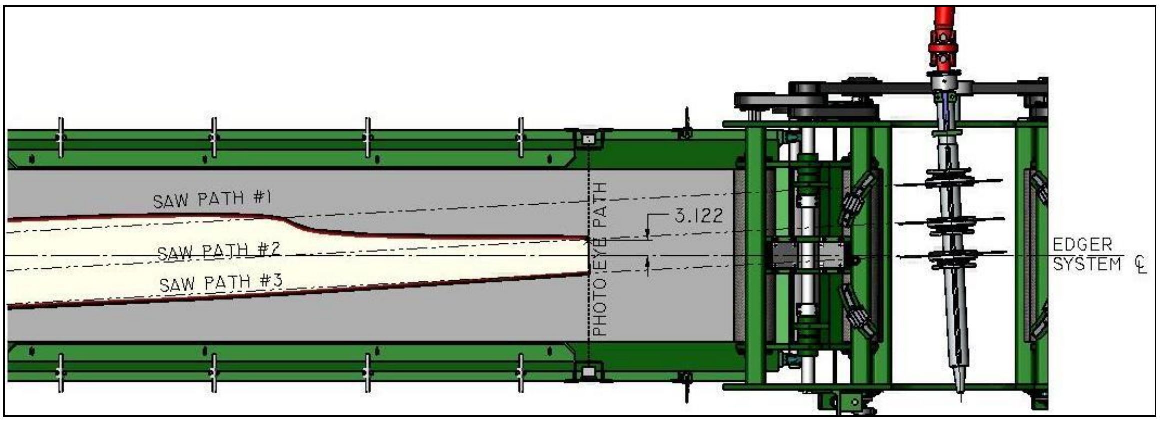

Figure 7: Typical linear edger "trigger" photocell arrangement.

PLC’s give us the ability to quickly change the timing of different events (i.e. hook up/down) without having to physically change a device in the field. Combined with motor controllers like VFD’s they allow us to change motor speeds according to different operating conditions (hook fill %), a tool that allows us to only run as fast as we have to. Modern HMI (Human Machine Interface) devices allow operators to quickly monitor inputs and make changes to output parameters without leaving their operators station. They can also be a tremendous tool for troubleshooting as they can provide detailed “alarms” and information about field devices that would otherwise require physical checks by maintenance staff.

5. Edging Separation Device

The edging separation device is designed to separate the finished boards from the edgings at the outfeed of the linear edger sawbox. The widely accepted method for separating these pieces is to "pick" the good boards off of the outfeed belt with a picker finger located at the end of the outfeed belt, allowing the edgings to pass beside the picker finger and fall to the waste system below.

Different edging separator designs have been developed over the years, based on operational conditions and criteria such as space restrictions, product sorts and lumber dimensions. Servo motion of the picker finger is now commonly used to keep the picker finger hidden under the board (which might be angled on the belt) as it passes over the outfeed. In this way the picker finger will not end up picking up the edgings from the trailing end of a board that is skewed on the belt.

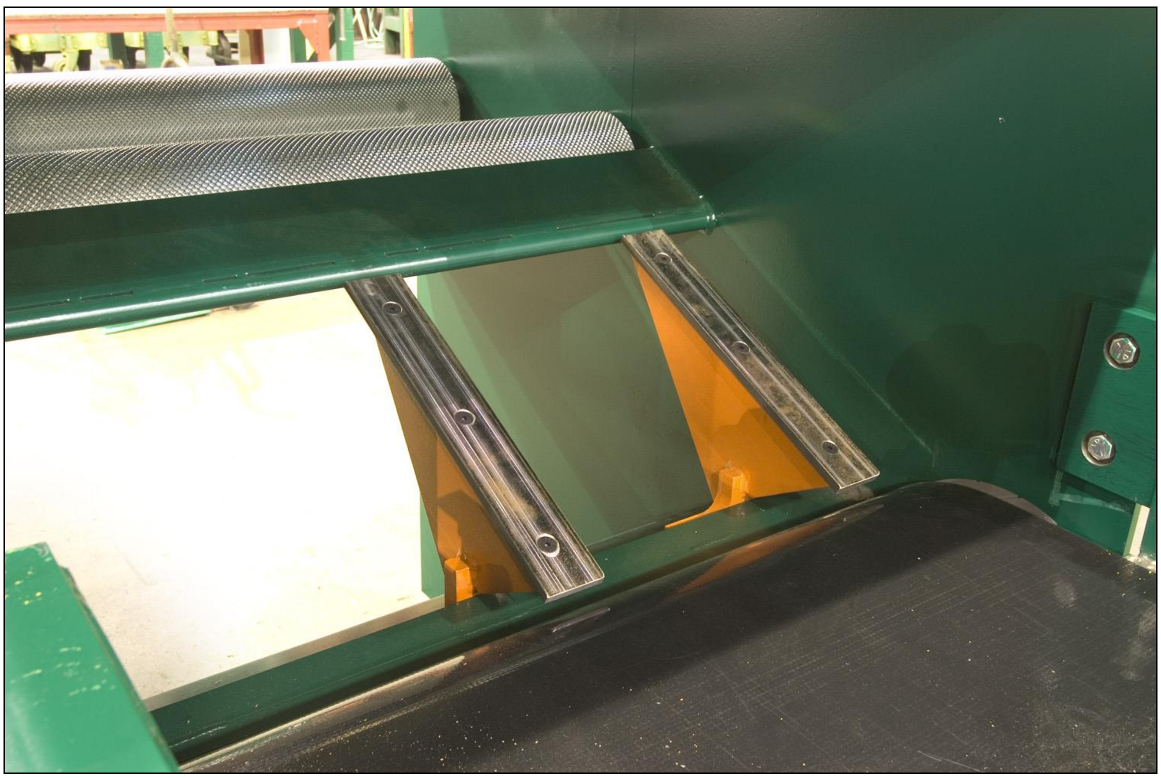

Figure 8: Typical Picker Finger Arrangement

It is also quite common to find picker fingers that have different height settings available so that they might sort products to one of two different outfeed belts downstream. The picker fingers would raise or lower according to the chosen destination of the product coming out of the edger.

Recent developments in picker finger design have allowed the edging separator to be placed very close to the sawbox so that the boards start to ride up onto the picker finger while they are still inside the edger itself. This increases the picker finger accuracy as the variable of piece motion downstream of the sawbox is taken out of the equation. This arrangement is only possible in sawmills that are producing thinner stock that can be easily bent up onto the finger while still being held down on the edger feed rollers at the tail end.

6. Machine Alignment

Machine alignment is a critical part of any linear edger system, enough so that it is worth a few words of description on its own here. Also, the words “machine alignment” refer to the alignment of all the different machinery components of the linear edger system. The infeed, the lumber transport system, the scanning device, the edger and the edging separation device must all be included as part of the edging system in this alignment.

As described above, a linear edger system moves a board along a known reference line where it will be scanned and then later processed through the board edger itself. The critical assumption in this methodology is that the board does in fact move parallel to the established reference line and that all cutting tools are properly calibrated to move relative to that particular reference line. The most common reference line that is used in linear edger systems is the machine centerline itself and is the one that is referred to throughout this document.

When pieces are scanned on their way down the infeed conveyor their image is located on the conveyor relative to the centerline. If, for example, the infeed conveyor belt had stretched and was now tracking badly to one side at the head end then the path of the conveyor would no longer be parallel to the centerline of the edger system. The board would arrive at the edger, without having slipped or moved on the conveyor itself, at a different place relative to the edger system center line than it was in when it was scanned. As the saws are placed and move according to where the scanner saw the piece during the scanning operation they would no longer cut the board in the right location.

It should now be obvious that it is also critical that the edger itself, and all of its feed and hold down rollers, move the board precisely along a path parallel to the centerline as it passes through the machine. While it is over a much shorter length, the non-parallel movement (with the C/L) of a piece over the distance through the edger sawbox can be significant if the edger isn't properly designed and built, carefully installed and exactly aligned, influencing both sawing and picker finger accuracy.

The picker fingers are also placed under each board as it exits the system relative to the machine centerline. It is therefore critical that the outfeed belt continues to track parallel to the machine centerline so that the picker fingers can be placed accurately. This ensures that good lumber is delivered up the picker finger to the outfeed table and edgings are missed, allowing them to fall to the waste conveyor below.

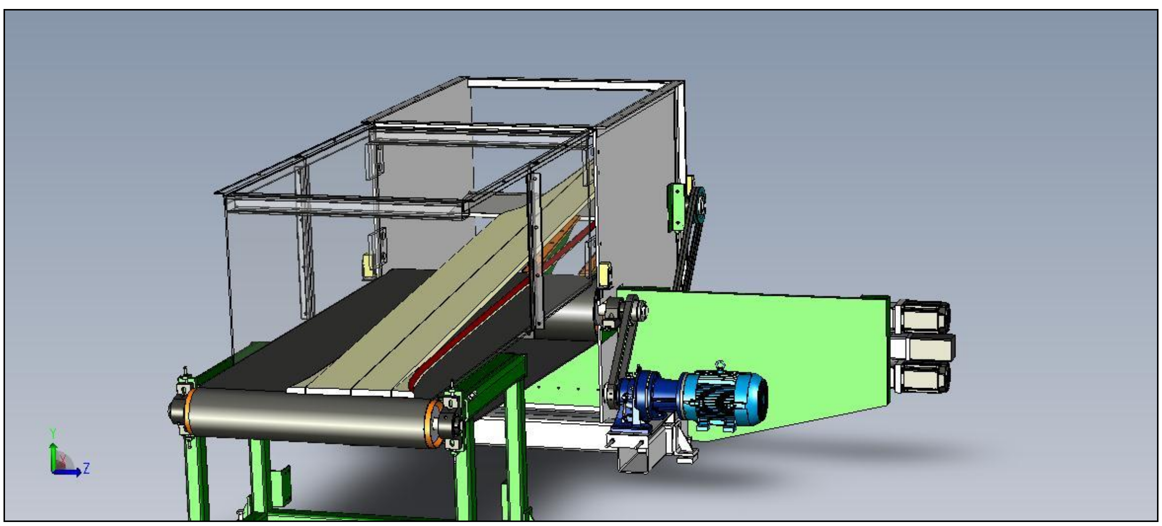

Figure 9: Board passing over picker finger. Alignment assures finger placement accuracy.

Alignment and Calibration

The methods described below might not necessarily be what some people consider to be the best for linear edger alignment but are ones that I have found to be simple and most effective over the years.

Machinery Alignment (sawbox and infeed belts)

As described above machinery alignment is critical to the performance of a linear edger system. As the sawbox itself is where all of the action happens it is the place that linear edger machine alignment must start. It has also been discussed earlier in this paper that the machine centerline is the reference line used for saw placement during edging operations. In order for the saw motion and angle calculations to be correct then it follows that the saw arbor must be perfectly square to that centerline when the sawbox is set at zero degrees of rotation. McDonough linear edgers are shipped with shafts and a machined locking clamp that when in place will ensure that the sawbox is set exactly at zero degrees for this portion of machine alignment. The holes for these shafts are bored into the sawbox simultaneous with the boring operation for the arbor bearings and are therefore located with as little variation as possible, ensuring accurate sawbox angle calibration capabilities later on.

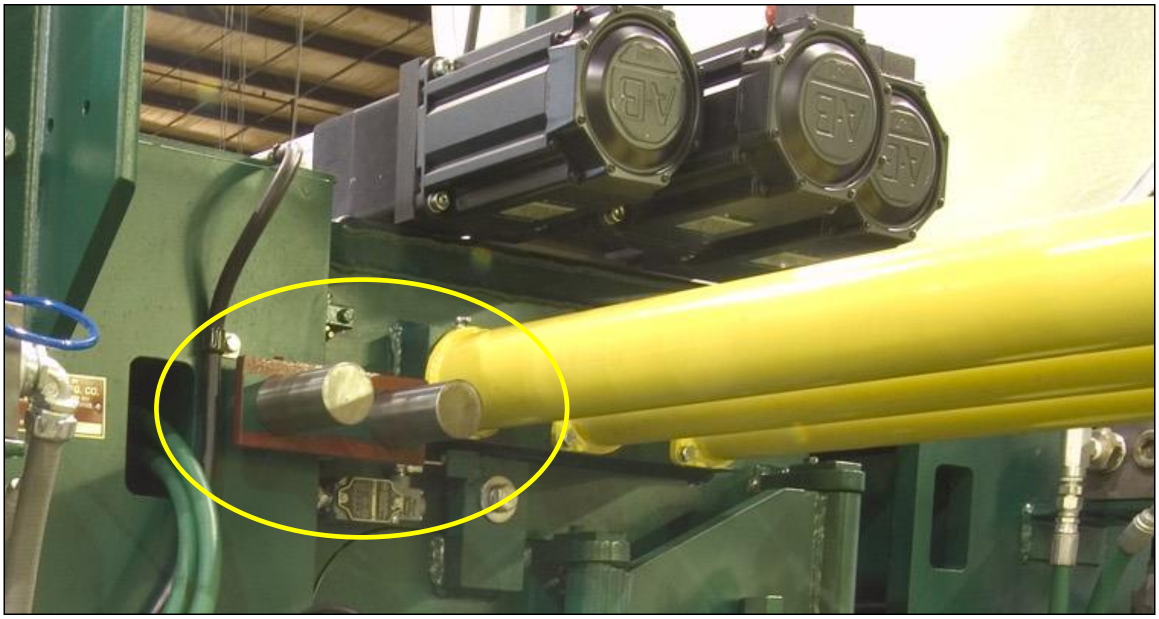

Figure 10: Sawbox Rotation locking shafts and clamp

> ***Maintenance Tip***: McDonough Linear Edgers are also equipped with an angle gauge that is fitted to the top of the rotating sawbox. This gauge is adjustable and should be set to "0" when the locking shafts and clamp are installed on the sawbox. This is typically set at the factory but can get moved during shipment so it should be double checked at startup.

When placing machinery in a linear edger system it is advisable to start with the sawbox itself, physically placing it as close as possible with the desired system centerline. After it has been placed close to what is believed will be its final resting place then always level the edger at the desired elevation for the engineered "top of roll". This will need to be fine tuned once the machine is welded down but needs to be close to avoid compromising the alignment itself. Then use a machinists level along the top of the arbor (making sure the sawbox door is tightly closed) to establish level from side to side. It is advisable to also place the machinists level along the top of each bottom roll to make sure that the machine isn't "twisted" slightly and is in fact level from side to side at both ends. For checking level along the edgers length use an 8' carpenters level or long straight edge and place a machinists level on top of that. In this way you are measuring level over a longer distance and can stretch across the opening between rollers up and downstream of the sawbox itself.

There are different alignment devices that are used for this but a tight piano wire or braided fishing wire (braided is harder to "bend" and stays nice and straight) that is stretched the length of the entire linear edger line is recommended. Stretch the wire between two alignment jigs that are (designed to eliminate accidental movement of the line later on) at a height so that it is between 1" and 2" over the desired "top of roll" height at the sawbox location (remember it will sag slightly and so for longer edger systems set the wire higher at the ends).

Once a wire has been pulled through the machine (or a laser placed) it is important to start at the arbor of the sawbox and work out in both directions from there. At first you may want to adjust the edger itself in order to make sure that the machine is well centered and square on it's substeel to the center line. When centering the machine always measure from the piano wire or laser over to the sidewall adjacent to a cross member. This will eliminate any error in measurement that can show up due to variations in the surface of the plate used to make your machine sidewall.

Once the final position of the edger has been set then finer adjustments should be made by adjusting the ends of the piano wire to bring the centerline to the arbor, rather than the other way around.

Being sure that the arbor is perpendicular to the machine center line with the sawbox locked at zero degrees is critical to the performance of your linear edger system. The edger arbor, feed rolls and press rolls are machined in such a way so that they will be as close to perfectly parallel as possible during manufacturing. In this way the piece will travel straight and true to the machine centerline as it passes through the sawbox.

There are a variety of methods and devices used to establish the squareness of the arbor but one of the simplest and most accurate will be to follow a method known as “swinging the arbor”. In this method a square or similar device is mounted to the arbor and will be swung through and arc so that it just touches the wire both upstream and downstream. A magnetic base and dial indicator works well for this or you might opt to use a commercially available system that has a light indicator that will come on only when the end just touches the wire.

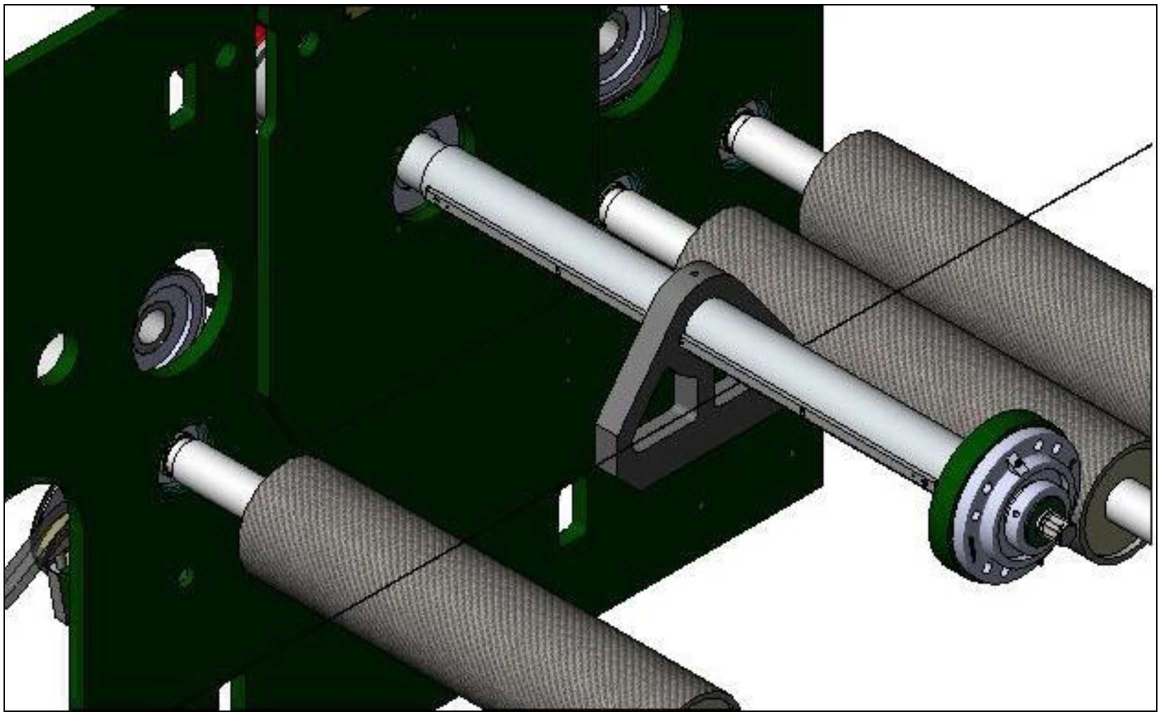

Figure 11: An example of a machined alignment jig installed on arbor with piano wire installed

IT IS VERY IMPORTANT TO ENSURE THAT THE SAWBOX IS LEVEL AT ITS DESIRED ELEVATION BEFORE YOU MOVE IT INTO ITS POSITION OF FINAL ALIGNMENT. FAILURE TO DO SO WILL RESULT IN THE NEED TO REPEAT THIS OPERATION.

Once the edger is set then I will always tack the feet down so that I can be reasonably confident that it will not move during placement of other adjacent machinery.

Following placement of the edger you need to ensure the placement and alignment of the remainder of the machinery that make up the linear edger line. Arguably the next most important piece to be placed is the infeed belt(s). Depending on the scanning configuration of the particular edger system there may be two or more infeed belts and all need to be placed as close as possible to a position that puts their centerline exactly parallel to the now established centerline of the sawbox itself. While we will have the ability to guide infeed belts along their length and to one side of the head and tail pulleys later on it is a huge help if the conveyor is placed so that those pulleys end up exactly perpendicular to the machine centerline. In this way the belt will naturally want to track perfectly parallel with the centerline, making the task of guiding the belts that much easier.

McDonough infeed belts are setup and tracked in our shop before shipment to your mill. The belt should arrive with the centerline marked on it already to ensure it is properly placed and to avoid the need to try and move the belt around after the legs have been welded down. If you have any questions about the method for properly alignment of your McDonough linear edger infeed belt please refer to our Linear Edger Infeed Belt Alignment document shipped along with your machine.

Belt elevations should be established according to the height of the top of roll in the edger sawbox and the most accurate way to do this is through the use of a surveyor's/builder's transit. The top of the belt needs to be perfectly level from side to side and set at an elevation that is exactly the same as the edger feed rolls along it's entire length. The use of a transit will eliminate any errors introduced through the use of even the longest carpenter's level. Starting at the edger, work your way out to the ends of each belt and rollcase until the entire line is completely level to the edger bottom rolls. Use the transit to set the elevation at each individual foot location, always working your way along the length and setting both sides before moving farther out from the edger. Always return and double check all elevations over once complete as large adjustments on the first pass can put previously set elevations slightly out of adjustment.

Once all elevations are completely set it is advisable to use a machinists level to fine tune the belt level from side to side. It is also advisable to use a long carpenter's level to ensure the transition between all belts and rolls is perfectly level across the full width.

In spite of the fact that the infeed belt bed is made of thick plate it will still sag or bend over a high or low leg that is farther back the conveyor. A quick check for correct belt elevation is to slide the 8' carpenters level into the mouth of the edger and it should just touch the top of the bottom feed rolls without "bumping" up onto the roll or having any clearance over it.

Humps or sags along the length of a conveyor belt will cause slight piece movement relative to the machine centerline and it is therefore critical that the belt is set to the correct elevation and is perfectly level over each set of legs along its length.

Once each conveyor has been set level and parallel to the machine centerline you should ensure each leg is welded down so that the conveyor cannot move.

Maintenance Tip: It is recommended that once the elevation of the infeed belt conveyor is established the adjustable feet be welded into a fixed position so that they cannot move up and down, even if the locking nuts were to come loose. Vibrations in the conveyor or sub-steel can loosen the locking nuts over time and cause you to lose level, elevation or both. A small piece of angle, installed beside the adjustable foot can be welded to the substeel and the belt leg to serve this purpose.

Belt Tracking

The conveyor belts themselves still need to be properly tracked on the conveyor to ensure that they run parallel to the machine centerline. An improperly tracked belt will move the piece toward the edger along a path that moves it away from the position that the optimizer thinks it is in. In that way when the piece arrives at the edger the saws will miss their entry point due to the fact that the board has “moved”. The two images below illustrate how this can happen.

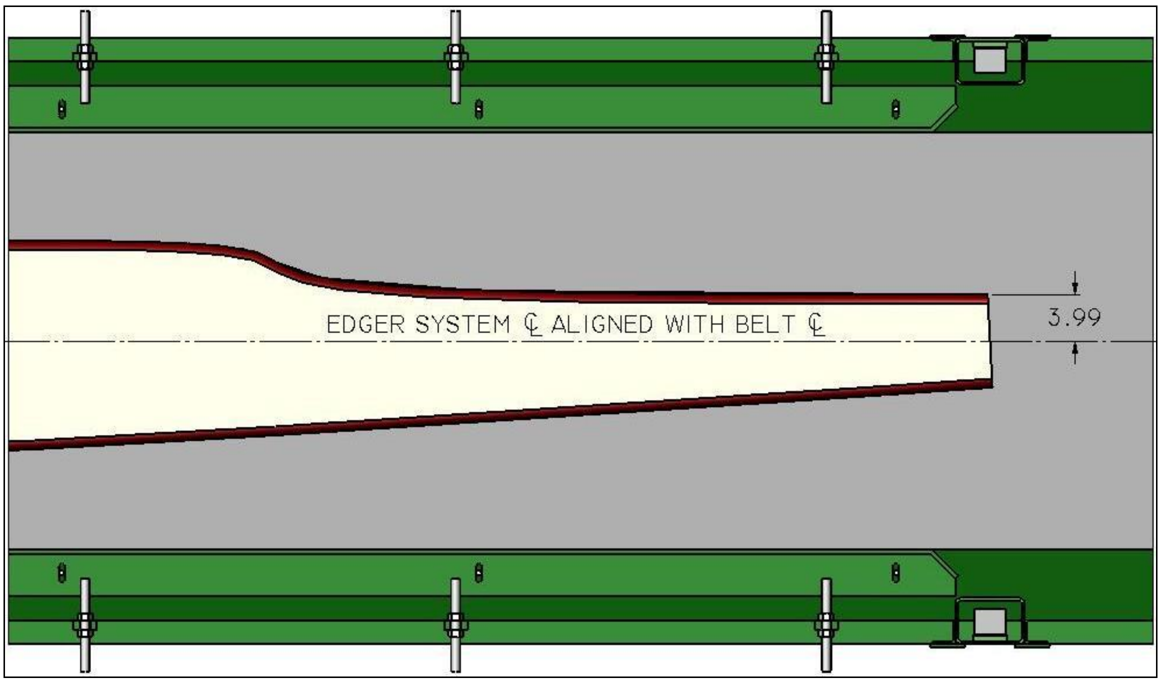

Figure 12: Properly aligned belt runs parallel to the edger C/L

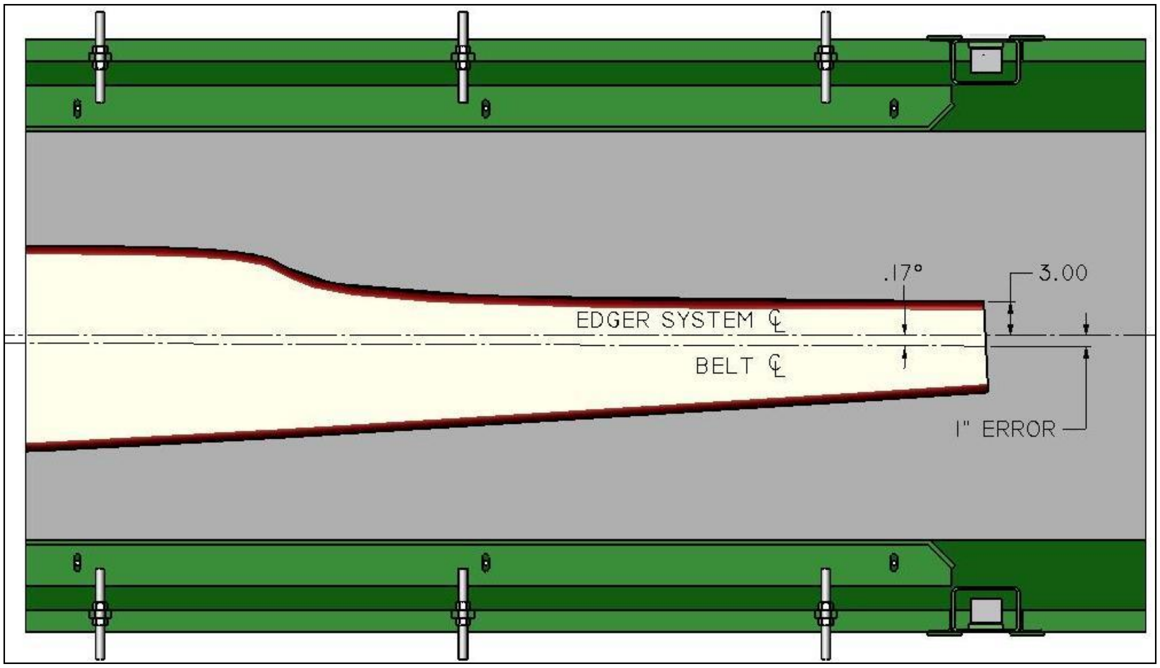

Figure 13: Misaligned belt moves the board relative to the machine C/L

McDonough has produced a detailed belt alignment procedure based on recommendations from our suppliers, the design of our belt systems and our experience from the field. That document is part of your McDonough Linear Edger manual and is also available for download from our website at www.mcdnoughmfg.com.

Maintenance Tip: A good quick check for belt rubbing is to put your hand on the outside of the angle iron that makes up the guide fence of your McDonough linear edger infeed belt. Heat in the fence is a sign that the belt is rubbing and may wear prematurely. It is normal for the belt to occasionally rub the fence as it goes around its length but a guide fence that is hot to the touch is a sign that the entire length of the belt is rubbing at that point and requires adjustment.

> ***Maintenance Tip:*** For belts that are particularly difficult to get tracked near the tail end of the conveyor the belt guides on the underside of the conveyor are helpful to start the conveyor onto the tail pulley in the desired location. It is much easier to guide a belt onto the pulley in the correct location than it is to push it one way or another as it is coming off the other side of the pulley. Difficulty getting a belt to track straight near its tail is a good indicator that the at least one or some of the pulleys or return rolls are not square to the conveyor centerline.

Once the belt is powered and you are able to run it for testing it is advisable to mark the belt center at the tail end of the conveyor on a piece of tape with a sharp marker. Then jog the motor so that your piece of tape and mark will move along the belts length and can be observed relative to the centerline using a speed square. You should be able to observe your mark staying on the machine centerline (aim for +/- 1/32" max) along the conveyors entire length. If you need to make any adjustments then try to make very small adjustments to the fence. It is preferred to establish the "back fence" (the one opposite the side the belt goes on and off) as a fixed fence that is set perfectly parallel to the centerline along its length and preferably half the belt width off the line. This will be important later when we are calibrating saws so please be sure this is done as accurately as possible. Then bring the front side fence in to the belt to remove any small movements in the belt.

The important of roll squareness can not be stressed enough when it comes to belt alignment. Making sure your infeed belt is actually tight enough is also a critical factor. Please refer to the McDonough Belt Alignment Procedure for more details on this.

Saw Position

Like any other sawing machine, saw position and calibration are critical to the performance of an edger system. The saw positions in a linear edger are quite easy to establish but without a good understanding of the machine operation it can be confusing. The saws in all McDonough linear edger systems are given a position during operation that is their position relative to the machine centerline. This position will be to the center of the saw. With the servo axis properly installed and the saws loaded in the machine you should start by measuring and entering a value into the servo "actual" position within the PLC that matches the saws position relative to the machine centerline. It is advisable to take this measurement before removing the centerline from the machine as variations in the sawbox sidewall plates can lead to small discrepancies in this value. This value can be entered directly into the PLC on the servo calibration screen of the HMI. After making sure that the machine is properly locked out and there is no stored energy inside the machine, measure the distance from the center of each saw to the machine centerline. The sign convention for these measurements in a McDonough edger is that if you are looking through the machine in the direction of flow the left side of the centerline is negative and the right side is positive. It is also worth noting that McDonough edger saws are always numbered from left to right, again when looking through the edger in the direction of flow. This measured value is a rough starting point for each saw position and will be fine-tuned later on.

Unlike a transverse edger the saws in a linear edger don't remain in the same place inside the machine during each cutting operation. They "slew" along the arbor according to the angle of the optimized solution relative to the machine centerline and the speed of the piece. Therefore in order for the saw to cut each board along the intended path the saw must not only be in the right location but it must also start its move along the arbor at exactly the right time. In order to properly set the saw position it is desirable to remove one of these two variables (timing and position) while we calibrate the other. By forcing the sawbox to cut a solution with a skew angle of zero degrees we can eliminate the timing variable as the saws will simply preset and then remain still while the board passes through the sawbox.

Follow these steps for saw calibration relative to the machine centerline:

Follow these steps for saw calibration relative to the machine centerline:

1. Using the machine parameters settings within the linear edger optimizer set the maximum skew angle to zero degrees. This will force the optimizer to set the sawing angle to zero for each solution and will mean that the saws will not gear along the arbor while in the cut. In other words, the saw preset position will be equal to the position as it exits the cut.
2. Place a wide flitch on the center of the infeed belt or rollcase, upstream of the scanner. This flitch should have wane on both sides and be free of warp, twist and bow so that you can be certain it will transfer properly through the machine.
3. Pass the flitch through the scanner, stopping it as near as possible to the downstream end of the scan zone.
4. Using a square and fine point marker or pencil, mark the planned saw positions for the saw you are trying to calibrate (I always calibrate saw #2 first and then set the other saws according to that saw). These saw positions can be read off of the optimizer solution screen and are available for each saw. If you set the back fence to a known position in the belt alignment steps above you can now use that as a reference to measure to the target saw position.
5. Add a second mark that is offset from the planned cut path by 1" inside at each end of the board. As we are going to try and cut the board on the first set of marks these marks should remain on the board even after it has been edged.

6. Once the saw path has been marked onto the board run the board through the edger. The belts should accelerate at a rate that the board doesn't slip while coming up to speed.
7. Measure the distance from the actual cut path to the offset marks on the flitch. If you placed these marks 1" from the center of the saw path then they should now be 1.000" less HALF THE SAW KERF (i.e. for saws that have a kerf of 0.200" wide this distance should be 0.900") from the edge of the board at both ends. If the marks are closer at one end than the other then the board is moving either as it passes through the scanner, along the length of the infeed conveyor or as it passes into/through the edger. If this is the case, and be sure to try verify this with several boards, then please go back and verify belt alignment as described in the earlier part of this document or carefully watch the transfer of boards into the edger to ensure that it is smooth. Press rolls that are coming down too early can cause the boards to move on their way into the edger. In addition if the head drum of the infeed belt isn't exactly level to the bottom feed rolls of the edger then that can cause the boards to walk one way or the other.
8. If the actual cut path is too far to the right then you will need to move the saw to the left by adding an offset to that particular axis. If the saw is out of position by 0.050" then you need to add a 0.050" offset to the axis. It is recommended to measure at least 3 boards and determine the average error in the saw placement before making this adjustment.
9. A visual inspection of wane break points is also a very effective way to quickly check and monitor saw placement. For example if according to the optimizer the wane should appear on the side of a board at the 33" mark along the boards length but only appears farther down the board then that saw needs to be moved out to ensure the correct amount of wane shows up in the right places.
10. At this point you can reset the max allowable skew angle to the angle used for normal operation in your mill.

11. Once the middle saw position has been established using this method then the other saws are set very easily by comparing the actual product width to the product width that is being generated by the optimizer. Board widths should be taken in at least three locations along each board and the average of all samples should be used. In multi-saw edgers this process can be sped up by disabling one or more saws in order to force a particular saw pair to be used to cut each piece.
12. If after you turn the sawbox rotation angle back on you immediately notice that the position of the first calibrated saw no longer seems correct then please read “Saw Gearing” below before readjusting anything.

Saw Gearing

The saw gearing calibration is simply the calibration of the timing for saw movement during a cut. When a board enters the edger to be sawn along a cut path that is optimized at an angle to the centerline we have to move the saws along that cut path as the board passes underneath the arbor. We call this “gearing” or “camming” as the saw motion is literally geared to the motion of the sawbox encoder. Based on the angle used for the sawbox set, the PLC will calculate how fast the saw must move along the arbor as a function of the encoder speed. In that way, if the encoder speeds up or slows down (feed drive changes speed) then the saws will still cut the correct path as planned by the optimizer. The steeper the planned sawing angle, obviously the faster the saws must move along the arbor during the cut.

In order for the saws to be able to properly cut a straight path along the length of the board they must already be in motion when the front of the board passes underneath the arbor. We know that they cannot instantly accelerate to speed and so there must be a distance ahead of the board when the saws are accelerating and getting onto the planned path. The motion software actually accounts for this portion of the move and carefully controls the saw motion during this period so that we can be sure they are on their target path and moving at exactly the correct speed when the piece actually arrives. Depending on the speed that we are feeding boards into the machine this distance might be anywhere from 8”-24” in front of the piece to be sawn.

The timing for the start of this saw motion is critical as the saw will end up ahead of the planned cut path if the saw starts moving too early and behind the planned cut path if the saw starts moving too late. If you have saws that are cutting on the correct path when the sawbox angle is set to zero degrees but then always seem to be out of place once you allow angled solutions then your saw gearing timing requires calibration. For a cut angle where the saws will be moving from left to right (a positive skew angle), saws that start to move too early will end up to the right of the planned cut path on the board (heavy wane on the right, square edge on the left of the edge board). For a cut angle where the saws will be moving from right to left (a negative skew angle), saws that start to move too early will end up to the left of the planned cut path on the board (heavy wane on the left and square edge on the right).

Typically this timing is setup during startup by a technician or engineer from McDonough and should not require re-calibration at a later time. The saw gearing is timed off of the last photo-cell prior to the mouth of the machine as it is desirable to trigger the motion as late as possible so that there is less opportunity for false triggers (sawdust in front of the photo-eye etc.) after the saw cams have been loaded and are awaiting the “go” trigger.

If you do need to change this value it is typically setup as a distance in the PLC program that tells the controller how far the trigger photo-eye is from the leading edge of the saw. Tandem arbor sawbox arrangements will have two different numbers in here, one for each sawbox, with the second number being either a distance from the photo-cell to the second sawbox or the distance between the two sawboxes (depending on how the code was written). It is highly recommended that you do not make changes to these timing points without consulting your McDonough engineer or project manager prior to doing so.

Summary:

Following all of the steps above should ensure that your linear edger is functioning properly and cutting good lumber in accordance with your optimizer. As a rule of thumb if you are noticing lumber that doesn't look right coming out of your linear edger then follow these steps to check calibration and alignment.

1. Compare the solution to what the optimizer is asking for. If they look the same then the saw is producing what is being asked to do and we need to analyze the optimizer setup.
2. If the pieces being edged don't match what the optimizer is asking for then we should first check finished board widths against the target widths for each pair of saws. If we find a discrepancy here then generally it is easy to determine which saw has moved. In a two saw edger the saw that is leaving too much wane or producing too much square edge has likely moved and should be calibrated. In a 3 saw edger if only one board width is off then the outer saw on that side has likely moved and needs calibration. If both openings are producing incorrect widths (one wide, one narrow) then adjust the middle saw to split the difference and correct both sides at once.
3. If the board widths are correct but there is too much wane on one side or another then first visually check the infeed belt to ensure that it isn't running off of parallel with the centerline.
4. If the infeed belt appears to be running properly then return to the top of the "Saw Position" section above and follow the steps to calibrate the saws.
5. If the saws are in the right position but too much wane is showing up sometimes on the right or sometimes the left then return to "Saw Gearing" above and go through those steps.

If you are having trouble with any of these steps or would simply like assistance before trying to make a change then please don’t hesitate to call your McDonough representative.