The Book on Optimization

OPTI RIP™

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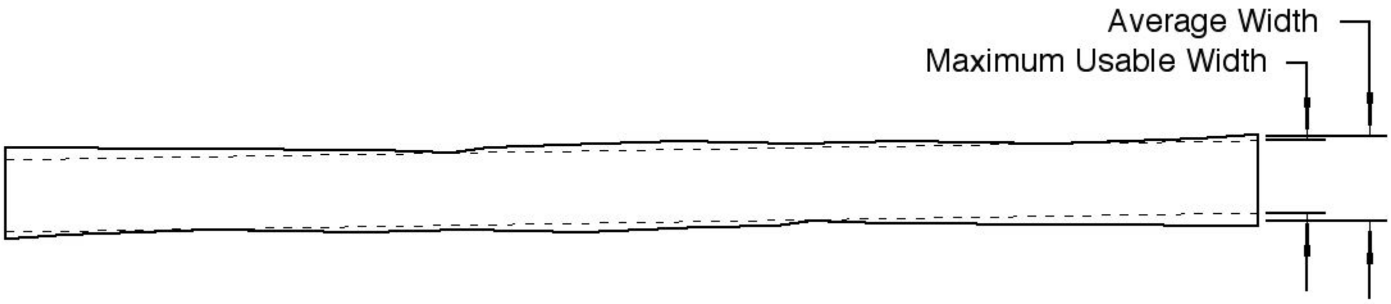
Rip Optimization

When ripping lumber, often the first thought is "How can I get the best yield." It is important, however to ask that question within the context of what kind of products you produce. The highest yield possible is 100%, which means you do nothing to the board. The next highest yield comes from edging one edge of the lumber and then from edging two edges of the lumber. For most products produced, edging alone won't be enough. Further ripping is necessary to produce the products you sell or components you need for production. It will be shown below that this additional ripping results in lower yields.

Edging Only

Assuming we need clean straight edges, the highest yield will be obtained by ripping down the two edges of each board, just far enough in from the edges to clean up both edges (using what we will call the maximum usable width of the board.) Since no board will be perfectly straight and free of wane, this maximum usable width will always be less than the average width of the board. In this case, our yield will be calculated by 100 times the maximum usable width divided by the average width of the board.



The following report shows the results of a simulation of over 40,000 boards being run on a saw where all of the blades can move, cutting the maximum usable width out of each board. The board data being used was gathered from an actual ripping operation.

Opti-Rip Production Report

Setup Number:	1	Report Printed:	02/28/06 01:32 pm
Supplier:		Job Started:	02/28/06 01:32 pm
Material Used:		Job Ended:	02/28/06 01:32 pm
		Rip Widths:	1
Thickness:	1.000	Auto Deduct:	0.000
Lumber Cost $/MBF:	0	Kerf:	0.160
Misc:			
Lineal FtProcessed:	416476	Avg Lumber Length:	8.9
Board Ft Processed:	201312	Avg BdFt/Board:	4.3
Board Ft/Hour:	0		
Process Time:	00:00	Lumber Value:	943
Lumber Piece Count:	46696	Product Value $/MBF:	999
Avg Lumber Width:	5.780	Product Cost $/MBF:	0
Avg Yield:	94.31	Value Increase $/MBF:	999
Lumber Pieces/Hour:	0		

Width	Value/MBF	Lin.Ft.Reqd	PCs.Prod	Lin.Ft.Prod	Bd.Ft.Prod	Rip.Yield
1.000-20.000	1000	0	46696	416476	189873	94.3

Notice the yield of 94.31%. This is the highest possible yield that can be obtained from this lumber while maintaining finished edges. Unfortunately, this solution usually can't be used to meet production requirements.

Ripping for Gluing

When ripping stock to be glued into panels, we can use random width pieces such as were generated in the edging example above, however we generally want to limit the minimum and maximum widths of boards going into the glued panels.

The following report shows a simulation of the same boards run again through a saw with all movable blades. This time we have limited the resulting rips to be within the range of 1 to 3".

```
                    Opti-Rip Production Report

     Setup Number: 1                        Report Printed: 02/28/06 01:34 pm
         Supplier:                             Job Started: 02/28/06 01:34 pm
    Material Used:                               Job Ended: 02/28/06 01:34 pm
                                                Rip Widths: 1
        Thickness: 1.000                      Auto Deduct: 0.000
 Lumber Cost $/MBF: 0                                 Kerf: 0.160
             Misc:

Lineal FtProcessed: 416476                Avg Lumber Length: 8.9
Board Ft Processed: 201312                   Avg BdFt/Board: 4.3
     Board Ft/Hour: 0

     Process Time: 00:00                        Lumber Value: 902
Lumber Piece Count: 46696                Product Value $/MBF: 999
  Avg Lumber Width: 5.780                  Product Cost $/MBF: 0
        Avg Yield: 90.28                 Value Increase $/MBF: 999
Lumber Pieces/Hour: 0

      Width   Value/MBF  Lin.Ft.Reqd  PCs.Prod  Lin.Ft.Prod  Bd.Ft.Prod  Rip.Yield
 1.000-3.000     1000           0     104180      929600      181760       90.2
```

Notice that the yield has dropped to 90.28%. This is due to the fact that we are taking extra saw cuts out of the middle of the wider boards.

Ripping to Specific Widths

While ripping random width rips for glue ups offers the best opportunity for achieving maximum yield, many ripping operations need to generate particular rip widths. The following shows the same lumber being ripped, but this time to five specific widths.

Opti-Rip Production Report

Setup Number: 1
Supplier:
Material Used:

Thickness: 1.000
Lumber Cost $/MBF: 0
Misc:

Lineal FtProcessed: 416476
Board Ft Processed: 201312
Board Ft/Hour: 0

Process Time: 00:00
Lumber Piece Count: 46696
Avg Lumber Width: 5.780
Avg Yield: 87.92
Lumber Pieces/Hour: 0

Report Printed: 02/28/06 01:38 pm
Job Started: 02/28/06 01:38 pm
Job Ended: 02/28/06 01:38 pm
Rip Widths: 5
Auto Deduct: 0.000
Kerf: 0.160

Avg Lumber Length: 8.9
Avg BdFt/Board: 4.3

Lumber Value: 879
Product Value $/MBF: 999
Product Cost $/MBF: 0
Value Increase $/MBF: 999

Width	Value/MBF	Lin.Ft.Reqd	PCs.Prod	Lin.Ft.Prod	Bd.Ft.Prod	Rip.Yield
2.625	1000	0	30825	277893	60789	88.7
3.000	1000	0	26859	237994	59498	86.2
2.500	1000	0	15748	140457	29261	90.0
1.125	1000	0	15764	138451	12979	86.6
1.875	1000	0	10143	92624	14472	88.3

Notice that the yield has dropped again to 87.92%. Because we are ripping only to specific widths, we are no longer using the maximum usable width of the each board. As a result, we are producing larger edgings (waste) and our yield drops.

Ripping for Yield vs. For Value vs. For Required

Ripping for Yield

In the previous example, we ripped into five different widths, but we didn't put any particular priority on any of the rips, so we produced whatever resulted in the highest yield. In many cases, there is a need to produce specific quantities of specific rip widths. A list of these rip widths and quantities is generally called a cut bill.

Our cut bill will generally determine whether we want to rip for yield, value, or required amounts. Ripping for yield is pretty straight forward. We will rip the lumber in such a way that we end up with the highest possible volume of the resulting product, regardless of what quantities of each rip we end up with. When ripping for glue up, ripping for highest yield makes sense because we don't usually care how many of each width we rip. Whenever we rip to specific widths or rip for specific quantities, we are forcing the system away from the highest yield solutions, so yield drops. The harder we have to force the system to get what we want, the lower the resulting yield.

Ripping for Value

The previous example showed five fixed widths being ripped for maximum yield. There are times, however, when the highest yield doesn't make sense. Take for example a moulding operation where we are ripping 3 1/8" and 6" moulding blanks. When a board with a maximum usable width of 6 1/2" is to be ripped, ripping for highest yield would give us two 3 1/8" rips, but one 6" moulding is probably worth more than two 3 1/8" mouldings. In such a case, it is not desirable for the optimizer to calculate the solution with the highest yield. Instead, a value (usually a value per board foot) is put on each desired rip and the optimizer then optimizes for value. Setting all rips to the same value is the same as ripping for yield. The further apart the values are set, the lower the yields that can be expected. Ripping for value can also be used to control the quantities of resulting rips. If the ripping operation is producing too little of a particular rip, increasing the value of that rip will tend to make the system produce more. Alternatively, if it's producing too much of a particular rip, lowering the value for that rip will cause the system to produce less of that rip. Keep in mind that the further the values are changed from all being identical, the more yield will suffer.

```
                     Opti-Rip Production Report

      Setup Number: 1                     Report Printed: 02/28/06 01:50 pm
          Supplier:                          Job Started: 02/28/06 01:50 pm
     Material Used:                            Job Ended: 02/28/06 01:50 pm
                                              Rip Widths: 5
         Thickness: 1.000                    Auto Deduct: 0.000
 Lumber Cost $/MBF: 0                               Kerf: 0.160
              Misc:

Lineal FtProcessed: 416476            Avg Lumber Length: 8.9
Board Ft Processed: 201312               Avg BdFt/Board: 4.3
     Board Ft/Hour: 0

      Process Time: 00:00                   Lumber Value: 908
Lumber Piece Count: 46696             Product Value $/MBF: 1039
  Avg Lumber Width: 5.780              Product Cost $/MBF: 0
         Avg Yield: 87.33             Value Increase $/MBF: 1039
Lumber Pieces/Hour: 0

       Width   Value/MBF  Lin.Ft.Reqd  PCs.Prod  Lin.Ft.Prod  Bd.Ft.Prod  Rip.Yield
       2.625     1000          0        19628      177155       38752       88.9
       3.000     1000          0        16217      144547       36136       87.8
       2.500     1000          0         8066       71284       14850       89.6
       1.125     1000          0        19618      170803       16012       83.9
       1.875     1100          0        49926      448358       70055       86.5
```

Starting with the previous example, let's assume we have a high need for the 1.875" rips. By increasing the value of the 1.875" rip, our simulation gives us different results.

Notice that the increase in the value for the 1.875" rip resulted in a drastic increase in the quantity of 1.875" rips produced. The resulting yield dropped by another 1/2 percent as well. The further the rip values are moved from all being the same, the more the yield will drop.

Ripping for Required

Setting values to control rip quantities can be a difficult task because what works well on one pack of lumber may not work the same on another pack where the board widths are slightly different. Some optimization systems allow the operator to enter desired quantities (by piece count, linear foot, or board foot) for each rip. The optimization system then uses this information to set the values for each rip. As the material is run through the operation, the optimization system monitors the quantities of each rip produced and adjusts each rip's value on the fly, increasing the values for the rips that are being under produced and lowering the values for the values for the rips that are being overproduced. This takes a lot of the guesswork away from the operator. Each optimization system will use it's own particular algorithm for determining how to set the values, so some systems will do a better job than others of optimizing yield while also producing desired rip quantities.

Opti-Rip Production Report

Setup Number:	1	Report Printed:	02/28/06 02:14 pm
Supplier:		Job Started:	02/28/06 02:14 pm
Material Used:		Job Ended:	02/28/06 02:14 pm
		Rip Widths:	5
Thickness:	1.000	Auto Deduct:	0.000
Lumber Cost $/MBF:	0	Kerf:	0.160
Misc:			
Lineal FtProcessed:	25987	Avg Lumber Length:	8.1
Board Ft Processed:	11858	Avg BdFt/Board:	3.7
Board Ft/Hour:	0		
Process Time:	00:00	Lumber Value:	1
Lumber Piece Count:	3173	Product Value $/MBF:	2
Avg Lumber Width:	5.488	Product Cost $/MBF:	0
Avg Yield:	86.86	Value Increase $/MBF:	2
Lumber Pieces/Hour:	0		

Width	Value/MBF	Lin.Ft.Reqd	PCs.Prod	Lin.Ft.Prod	Bd.Ft.Prod	Rip.Yield
2.625		10000	1234	10016	2191	87.7
3.000		15000	1840	15012	3753	86.6
2.500		8000	983	8002	1667	88.4
1.125		12000	1461	12004	1125	84.5
1.875		10000	1224	10016	1565	86.2

The following reports show the previous example, but with desired quantities for each rip being enforced.

The yield again dropped by another half percent as a result of forcing the system to generate the quantities we needed. Again, the more we force the system away from maximizing yield, the lower the yield gets.

Fixed vs. Moving Blades

All Moving Blade Saws

In order to show the effect of product distribution on yield, all of the previous examples simulated a saw where all blades were movable. In reality, one blade is usually fixed (either the innermost blade or one in the middle of the arbor) and all of the other blades (usually three or four other blades) can move, which means that every pocket width can adjust on the fly.

Although saws like these are available on the market, they are generally very expensive. A straight line rip saw would give results identical to that of an all moving blade saw, but since only one cut is being made at a time, such an operation is very labor intensive.

Fixed Arbor Saws

A fixed arbor gang saw has single long arbor with multiple blades on it. The blades are held apart from each other with spacers. The thickness of these spacers determine the sizes of the "pockets" between the blades.

One very important factor in generating the highest yield on a fixed arbor saw while satisfying a cut bill is how the saw arbor is setup. You obviously want to have at least one pocket for each width in your cut bill, but the order in which these pockets are arranged can greatly influence yield.

The trick to maximizing yield is to have the range of maximum usable board widths that the system is likely to see covered as well as possible. In other words, the arbor needs to be able to get high yields from 5" boards, 5 1/4" boards, 5 1/2" boards, etc. This is accomplished by having lots of different combinations of rip widths placed next to each other on the arbor. For this reason, it is usually best to rip as many different widths as possible in one job. Often, a desired rip width will be put in more than one place on an arbor. Ideally, each time it shows up on an arbor, it should be surrounded by different rip widths, increasing the total number of combinations of widths.

Let's take the example above, back to where we were ripping the 5 rips for maximum yield (before changing values or ripping for required quantities). This time, let's do the same job on a 24" fixed arbor saw. The report on the left shows how the arbor was setup (as optimized by computer).

Arbor Setup Report

Setup #: 1
Supplier:
Specie:
Saw Kerf: 0.16
Widths: 11

Pocket #	Width	Value	Lin.Ft.Reqd
1	2.625	1000	0
2	3.000	1000	0
3	1.125	1000	0
4	2.500	1000	0
5	2.625		
6	1.875	1000	0
7	1.875		
8	3.000		
9	1.125		
10	1.125		
11	1.125		

Opti-Rip Production Report

Setup Number: 1
Supplier:
Material Used:

Thickness: 1.000
Lumber Cost $/MBF: 0
Misc:

Lineal FtProcessed: 416476
Board Ft Processed: 201312
Board Ft/Hour: 0

Process Time: 00:00
Lumber Piece Count: 46696
Avg Lumber Width: 5.780
Avg Yield: 87.18
Lumber Pieces/Hour: 0

Report Printed: 02/28/06 03:35 pm
Job Started: 02/28/06 03:35 pm
Job Ended: 02/28/06 03:35 pm
Rip Widths: 11
Auto Deduct: 0.000
Kerf: 0.160

Avg Lumber Length: 8.9
Avg BdFt/Board: 4.3

Lumber Value: 871
Product Value $/MBF: 1000
Product Cost $/MBF: 0
Value Increase $/MBF: 1000

Width	Value/MBF	Lin.Ft.Reqd	PCs.Prod	Lin.Ft.Prod	Bd.Ft.Prod	Rip.Yield
2.625	1000	0	18844	170137	37217	88.3
3.000	1000	0	27756	247016	61754	85.8
1.125	1000	0	26715	234878	22019	86.9
2.500	1000	0	8825	78626	16380	89.1
1.875	1000	0	27088	244126	38144	87.4

On this particular job, we lost 3/4% yield by using a 24" fixed arbor saw instead of the all moving blade saw. This yield is lost because our arbor length is limited and we can't fit every combination of rip widths possible on the arbor.

Since having as many different combinations of sizes on the arbor allows us to get the most out of each width of incoming board, going to a saw with a larger arbor increases yield. If we take our example above and exchange the 24" gang rip saw for a 31" gang rip saw, we get the following results.

Arbor Setup Report

Setup #: 1
Supplier:
Specie:
Saw Kerf: 0.16
Widths: 12

Pocket #	Width	Value	Lin.Ft.Reqd
1	2.625	1000	0
2	3.000	1000	0
3	1.125	1000	0
4	2.500	1000	0
5	2.500		
6	1.875	1000	0
7	1.875		
8	2.625		
9	2.625		
10	3.000		
11	3.000		
12	1.875		

Opti-Rip Production Report

Setup Number: 1
Supplier:
Material Used:

Thickness: 1.000
Lumber Cost $/MBF: 0
Misc:

Report Printed: 02/28/06 03:46 pm
Job Started: 02/28/06 03:46 pm
Job Ended: 02/28/06 03:46 pm
Rip Widths: 12
Auto Deduct: 0.000
Kerf: 0.160

Lineal FtProcessed: 416476
Board Ft Processed: 201312
Board Ft/Hour: 0

Avg Lumber Length: 8.9
Avg BdFt/Board: 4.3

Process Time: 00:00
Lumber Piece Count: 46696
Avg Lumber Width: 5.780
Avg Yield: 87.72
Lumber Pieces/Hour: 0

Lumber Value: 877
Product Value $/MBF: 999
Product Cost $/MBF: 0
Value Increase $/MBF: 999

Width	Value/MBF	Lin.Ft.Reqd	PCs.Prod	Lin.Ft.Prod	Bd.Ft.Prod	Rip.Yield
2.625	1000	0	28119	252160	55160	88.5
3.000	1000	0	23348	206707	51676	85.9
1.125	1000	0	6943	61833	5796	88.2
2.500	1000	0	15973	142934	29778	89.3
1.875	1000	0	24247	218821	34190	87.5

Moving to a wider arbor saw brought us back to within .2% yield of what we would get using an all moving blade saw on this job.

Arbor Setup Report

Setup #: 1
Supplier:
Specie:
Saw Kerf: 0.16
Widths: 9

Pocket #	Width	Value	Lin.Ft.Reqd
1	1.875		10000
2	2.625		10000
3	1.125		12000
4	2.500		8000
5	1.875		
6	3.000		15000
7	3.000		
8	2.500		
9	1.125		

Opti-Rip Production Report

Setup Number: 1
Supplier:
Material Used:

Thickness: 1.000
Lumber Cost $/MBF: 0
Misc:

Report Printed: 02/28/06 04:29 pm
Job Started: 02/28/06 04:29 pm
Job Ended: 02/28/06 04:29 pm
Rip Widths: 9
Auto Deduct: 0.000
Kerf: 0.160

Lineal FtProcessed: 27078
Board Ft Processed: 12369
Board Ft/Hour: 0

Avg Lumber Length: 8.2
Avg BdFt/Board: 3.7

Process Time: 00:00
Lumber Piece Count: 3301
Avg Lumber Width: 5.496
Avg Yield: 84.44
Lumber Pieces/Hour: 0

Lumber Value: 94
Product Value $/MBF: 112
Product Cost $/MBF: 0
Value Increase $/MBF: 112

Width	Value/MBF	Lin.Ft.Reqd	PCs.Prod	Lin.Ft.Prod	Bd.Ft.Prod	Rip.Yield
1.875		10000	1254	10123	1581	86.9
2.625		10000	1252	10318	2257	82.1
1.125		12000	1458	12008	1125	81.7
2.500		8000	999	8153	1698	85.7
3.000		15000	1860	15131	3782	85.0

Finally, let's rip for required quantities using a 24" fixed arbor saw. Using the same required quantities as we did for the all moving blade saw, we get the following.
Again, forcing the output to required quantities lowered our yield. Yield is also about 2% lower than when we did the same job above on the all moving blade saw.

One or Two Moving Blades

People often think when considering fixed blade saws vs. movable blade saws that "the blade moves, therefore it must be better." Although this is true in some cases, it's not a universal truth. Movable blade saws excel at ripping random width material for glue ups. A movable pocket can usually be expanded until the rip solution uses the maximum usable width of a board.

When ripping fixed widths for a particular cut bill, however, a movable blade saw is not always the best solution. People will frequently be choosing between a 24" fixed arbor gang saw and a 12" saw with one movable blade. The nice thing is that the last blade on the arbor can move to make whatever size pocket works best for a particular board. The bad thing is that the movable pocket is always next to a fixed width pocket. This means that unless only one rip is taken from a board, in order for the movable pocket to be used, the neighboring pocket must also be used. This means that you are likely to get a very high quantity of rips from that neighboring pocket. The following example shows the job done above on the all moving blades saw, the 24" gang saw, and the 31" gang saw, but this time done on a 12" saw with one movable blade.

Arbor Setup Report

Setup #: 1
Supplier:
Specie:
Saw Kerf: 0.16
\# Fixed Rips: 5

Needs:

Width	Value	Lin.Ft.Reqd
2.625	1000	0
3.000	1000	0
1.125	1000	0
2.500	1000	0
1.875	1000	0

Fixed Pockets on saw:

Pocket #	Width
1	1.875
2	1.125
3	1.125
4	1.125
5	2.625

Opti-Rip Production Report

Setup Number:	1	Report Printed:	02/28/06 03:59 pm
Supplier:		Job Started:	02/28/06 03:59 pm
Material Used:		Job Ended:	02/28/06 03:59 pm
		Rip Widths:	5
Thickness:	1.000	Auto Deduct:	0.000
Lumber Cost $/MBF:	0	Kerf:	0.160
Misc:			
Lineal FtProcessed:	416476	Avg Lumber Length:	8.9
Board Ft Processed:	201312	Avg BdFt/Board:	4.3
Board Ft/Hour:	0		
Process Time:	00:00	Lumber Value:	861
Lumber Piece Count:	46696	Product Value $/MBF:	1000
Avg Lumber Width:	5.780	Product Cost $/MBF:	0
Avg Yield:	86.18	Value Increase $/MBF:	1000
Lumber Pieces/Hour:	0		

Width	Value/MBF	Lin.Ft.Reqd	PCs.Prod	Lin.Ft.Prod	Bd.Ft.Prod	Rip.Yield
2.625	1000	0	43520	391266	85589	87.2
3.000	1000	0	3716	33423	8355	88.8
1.125	1000	0	50802	448497	42046	84.7
2.500	1000	0	2942	26353	5490	89.9
1.875	1000	0	22952	204976	32027	84.0

With the movable blade saw, we achieved 86.18% yield compared to 87.92% on the all moving blade saw and 87.18% yield on a 24" fixed arbor gang saw. We lost yield because we have fewer combinations of sizes on the shorter arbor and the movable pocket could only be used in combination with the fixed pockets directly next to the movable pocket. Notice that we also got a very large quantity of 1.125" rips because it bordered the movable pocket.

```
                Arbor Setup Report

      Setup #: 1
     Supplier:
       Specie:
     Saw Kerf: 0.16
 # Fixed Rips: 4

Needs:

  Width    Value  Lin.Ft.Reqd
  2.625             10000
  3.000             15000
  1.125             12000
  2.500              8000
  1.875             10000

Fixed Pockets on saw:

Pocket #    Width
1           1.875
2           2.625
3           1.125
4           3.000
```

```
                              Opti-Rip Production Report

      Setup Number: 1                              Report Printed: 02/28/06 04:25 pm
          Supplier:                                   Job Started: 02/28/06 04:25 pm
     Material Used:                                     Job Ended: 02/28/06 04:25 pm
                                                       Rip Widths: 5
         Thickness: 1.000                             Auto Deduct: 0.000
 Lumber Cost $/MBF: 0                                        Kerf: 0.160
              Misc:

Lineal FtProcessed: 27833                      Avg Lumber Length: 8.1
Board Ft Processed: 12766                         Avg BdFt/Board: 3.7
     Board Ft/Hour: 0

      Process Time: 00:00                           Lumber Value: 1
Lumber Piece Count: 3398                     Product Value $/MBF: 2
  Avg Lumber Width: 5.519                     Product Cost $/MBF: 0
         Avg Yield: 82.31                   Value Increase $/MBF: 2
Lumber Pieces/Hour: 0

       Width   Value/MBF  Lin.Ft.Reqd  PCs.Prod  Lin.Ft.Prod  Bd.Ft.Prod  Rip.Yield
       2.625                 10000       1235       10123        2214       82.4
       3.000                 15000       1919       15632        3908       83.7
       1.125                 12000       1461       12014        1126       82.4
       2.500                  8000        978        8005        1667       75.9
       1.875                 10000       1268       10188        1591       86.0
```

If we force the machine to rip the required quantities we need as we did above with the all moving blade saw and the 24" fixed arbor saw, this time with the 12" movable saw, we get the following:

As you can see, we lost 2% yield by using the 12" saw with one movable blade when compared to the result we got on the 24" fixed arbor saw. We also ended up over ripping the 3" rip because a 3" pocket bordered the movable pocket.

The previous examples show the limitations of machines with only one movable blade. A machine with two movable blades will have fewer limitations, so yield will usually increase. When comparing two saws with the same size arbor, the one with a movable blade will usually offer higher yields. On a saw where all of the blades move, the arbor length only needs to be as long as the widest board likely to be ripped and the above limitations all disappear. The all moving blade saws, however, are quite expensive.

One often overlooked factor when considering moving blades is that a system with a moving blade will generally be slower than a system with fixed blades because the blade(s) take time to move. A capable infeed system on a fixed arbor saw will come close to butt feeding boards. On a movable blade saw, this same system will have to pause to wait for one board to clear out of the saw before starting to move the blades, then wait for the blades to move into position before feeding the next board.

When the facts that movable blade saws are usually quite a bit more expensive than fixed arbor saws and require more maintenance are considered as well as the factors listed above, the decision to purchase one or the other is often not easy to make. Software that can simulate various jobs running on various saw configurations can be invaluable in helping to make an informed decision.

Board Skewing

Another important factor to consider when purchasing a rip optimization system is whether the system has the ability to skew boards. Boards are seldom straight as they come into a ripping system. Many optimization systems position each board against a movable fence. The board is held against the fence with canted rollers. Once the fence is in position, a set of pinch rollers feed the board into the saw.

The problem with a fence is that there is no way to control the angle the board will feed into the saw. If the convex side of a bowed board is against the fence, the board will rock and there will be no way to predict the angle that it is actually fed. If the concave side of the board is against the fence, the board won't rock, but the angle the board is fed is strictly determined by the shape of the board. If there is a big knob on one end of the board, for example, the entire board will be fed through the saw on an angle. To compensate for this inaccuracy of feeding, fence systems will often select solutions for boards that use less than the maximum usable width of the boards. The result is larger edgings and lower yield.

A machine that allows the board to be skewed by the operator (or skews the board automatically) generally doesn't use a fence. Instead, once the proper feed angle is established for a board, the system will maintain that angle as the board is fed into the saw. A skewing system allows the ability to use the maximum usable width to be used on all boards. Depending on the lumber, this feature will usually gain 1% to 2% yield.

Infeed Systems

Manual Feed

The simplest way to feed a rip saw is to feed it manually. Usually, a series of lasers project a representation of the saw pattern onto the board as it is held in front of the saw. If the saw contains a movable blade, there will usually be a joystick or foot pedals used to control the position of the movable blade. A small computer may allow the selection of preset rip widths for the movable pocket. The laser line representing that saw blade will move with the blade.

On a simple system, it will be up to the operator to position the board under the lasers where he thinks the board should be ripped and then push the board into the saw. Some systems may incorporate a simple roller table and manually movable fence to aid the operator in feeding the boards straight. On these systems the operator does all of the optimization.

The throughput on such a manual system is potentially quite high. A good operator can have the next board ready to feed before the previous one clears the saw. This is a very physically demanding job, however. It also puts the operator in the saw's kickback zone. Since the operator does all of the optimization, he often doesn't choose the solution that produces the highest value. He is also likely to choose narrow solutions in order to guarantee he doesn't run off the side of the board if it's not fed absolutely straight.

Computer Measuring

The next level of infeed system includes some sort of measuring device connected to a computer. The most common measuring system uses a single ultrasonic sensor to measure the width of the board in one spot. Based on this width, the computer chooses the best rip solution and moves a fence or turns on and off lasers to show the operator where to best feed the board. The operator then manually pushes the board into the saw.

These systems take most of the optimizing burden off of the operator, but since they only measure the board in one location, the computer's solution may not be correct when the boards are tapered or bowed.

Computer Controlled Feeding

The next level of infeed system includes a cross conveyor. This cross conveyor serves to transfer the boards from a measuring area to an evaluation area and finally into the rip saw.

The measuring area may be a single through beam sensor or it may be an array of sensors that generate a more accurate profile of the board to be ripped. The more accurate the profile is, the better job the computer can do at choosing the best solution for the board. Other systems use a camera or series of cameras to gather information about the boards. Data from the camera can be used by the computer to detect defects in the board.

The evaluation area is generally an area where a pattern of laser lines is projected onto a board where an operator can accept the computer's solution or ask the computer to offer a different solution. Some systems automatically skew the board before it is presented to the operator so that the operator sees the best possible solution based on the profile of the board.

The board is then transferred from the evaluation area to the feeding area. The feeding area is frequently comprised of a series of canted rollers and a computer controlled fence. Other systems incorporate a pinch rollers system that allows the board to maintain is skew angle as it transfers from the evaluation area to the feeding area.

Material Handling

Manual Loading

The simplest form of material handling is where the operator manually takes a board from a stack of lumber and places it onto the infeed of the optimization system. He then presses a button to tell the machine to measure the board. Some systems can be placed into an automatic mode where the operator keeps loading boards and the machine processes them without stopping. A scissors lift is commonly used to keep the stack of lumber at a good working height for the operator. With some systems, a single operator is used to both load boards and evaluate the solutions offered by the computer.

The advantage to a manually loaded infeed system is that it is inexpensive, easy to install, and takes up much less floor space than a larger system.

Feeding Directly from a Planer

One material handling arrangement incorporates a planer feeding directly onto a rooftop cross conveyor. This cross conveyor accumulates multiple boards and releases them one at a time to the ripping system.

The advantage to this system is that it eliminates stacking of the boards coming out of the planer and eliminates de-stacking the boards going into the ripsaw. The disadvantage of this system is that it becomes difficult to plane boards that aren't going to be fed through the ripping system. Also, planers can generally handle twice the throughput that ripsaws can, so such a system can slow down the planing operation. As a result, some systems are set up so that boards coming off the planer are split between two independent ripping systems.

Tilt Hoist to Descrambler

Another material handling arrangement involves a tilt hoist and descrambler. The tilt hoist picks up an entire stack of lumber and tilts it, releasing one layer of boards at a time into a descrambler. The descrambler then separates the boards and places them onto the infeed of the ripping system in an orderly fashion. An even ending device is often necessary if the ripping system expects one end of each board to be in a particular position.

The advantage to such as system is that the labor required to de-stack the lumber is removed from the operation. These systems, however, are quite expensive and require a large amount of floor space.

Vacuum Lift

Another method of de-stacking lumber on to a ripping system involves a vacuum lift. The lift uses a vacuum to suck the top layer off of a stack of lumber, lifts it up, transfers the layer sideways, then lowers the layer onto the infeed chains of the ripping system.

These systems take up less floor space than a tilt hoist and descrambler, but they are also quite expensive.

Scanning Systems

The purpose of a scanning system is to gather information about a board to be ripped. This information is fed into a computer that then calculates a rip solution. This solution may be presented to an operator for review, or may be used directly by the machine to rip the board.

Ultrasonic Sensors

Many simple optimization systems use ultrasonic sensors to measure the width of each board. These sensors generally only measure the width of the board at one position on the board. Because of this, they are incapable of detecting taper or bow in boards. Ultrasonic sensors work by bouncing pulses of sound off of the edge of the board. A ripping system may incorporate a single ultrasonic sensor (in which case the other edge of the board has to be placed against a fixed stop) or two ultrasonic sensors, one on either side of the board. If the edge of the board isn't sufficiently smooth and square, an ultrasonic sensor may have trouble reading it. Ultrasonic sensors can be sensitive to temperature and background noise.

Through-Beam/Laser Sensors

Another method of gathering board data that is used incorporates one or more through beam or laser sensors. These sensors are used in conjunction with the lateral conveyor. Systems with single sensors measure the board in only one spot. Systems with multiple lasers measure the board in multiple places, allowing the machine to identify side bend or taper. Sensor based systems can gather quite a bit of data at a reasonable cost. These systems, however, can't detect wane or defects.

Camera Based Scanners

Camera based systems usually use a line scan camera that captures image data as a board is fed past the camera. Since the board needs to move longitudinally past the camera, additional conveyors are required. These systems frequently incorporate two cameras, one above the board and one below it, so that both sides of the board can be scanned.

Some systems also project a laser line onto the board that is also seen by the camera. This additional data can be used to generate a complete cross sectional profile of the board, including the shape of the wane. Smarter systems can be programmed so that they know just how much wane can be tolerated on a finished product that might later be moulded.

Cameras alone frequently can't detect all forms of knots and cracks. For this reason, some systems also incorporate X-ray scanners in addition to the cameras. The X-ray scanners detect variation in density in the wood.

Camera systems use powerful computers to process the image and profile data to determine where defects are located. As a result, these systems can be run without operator intervention. Computer defecting, however, is not perfect. It is often difficult to set these systems so that they find all of the defects, but don't find defects that don't exist.

With smaller trees being harvested and incoming lumber getting narrower, it isn't uncommon for most boards to be ripped into only one or two finished rips. When this is the case, there isn't a lot of choice as to where the board will be ripped, so the extra information gathered about defect location is sometimes of little value.

Camera based systems are generally very expensive. Careful consideration of costs and benefits should be made before purchasing a camera based system.

Reporting

Reports generated by a ripping system can be a valuable tool.

Most systems will tally the incoming lumber. This tally can be compared against tallies sent by lumber suppliers to verify that you are getting what you paid for.

Production reports provide information about jobs that have been run. These will generally include information about how long the job took and what kind of yields were achieved. Tallies of lumber used and rips generated can be used to adjust inventory figures. Some systems show separate costs for each width of rip produced.

Board data is often collected for each board ripped. This data can later be used to evaluate future arbor configurations and generate "what if" scenarios.

Some systems incorporate built in web servers so that reports can be generated from anywhere within a company.

Future Chapters:

Rip first vs chop first
- Yield
- Throughput for each machine
- Manpower necessary.

Chopping
- Algorithms
- Push vs. Roll feed
- Linear Encoder
- Crayon vs. Electronic Marking