Could S-D-R Be the Answer to the Aspen Oversupply Problem?

By **Robert R. Maeglin,** Research Forest Products Technician
Forest Products Laboratory,[1] Forest Service
U.S. Department of Agriculture

If you talk to forest managers and landowners across the Lake States and the adjacent Canadian Provinces, they will tell you there is a surplus of aspen stumpage. They will also tell you that there is a great need for new ways to utilize the aspen crop before it rots on the stump. Pulpwood cannot utilize all that is there.

A few years ago there was great enthusiasm for the prospect of sawing aspen studs. It was hoped that aspen studs would utilize the oversupply of stumpage. However, it was not long before the manufacturers that tried aspen studs found that their operations were not profitable. There were drying problems and the studs warped beyond grading rule limits. Yields of quality studs suitable for making a profit were not possible. Subsequently, the firms turned to softwoods — spruce, fir, and pine.

[1] Maintained at Madison, Wis., in cooperation with the University of Wisconsin.

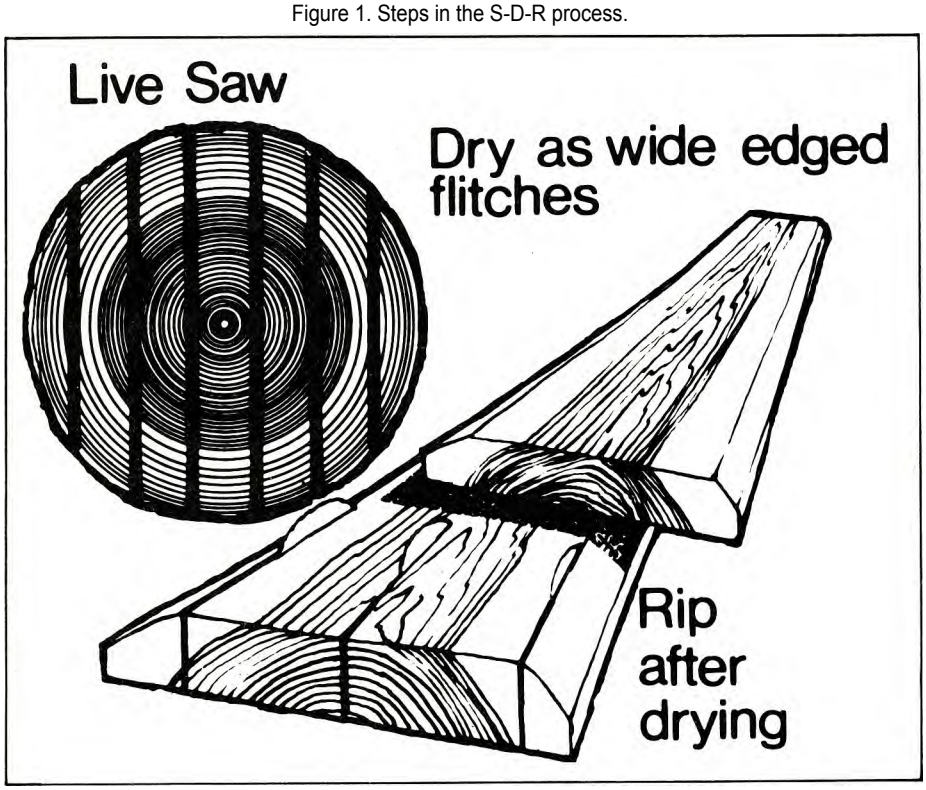
Now there is new hope for balancing the aspen supply and demand. Now there is new hope for sawing and drying aspen studs while getting good yields and making a profit. This hope is in the S-D-R concept. S-D-R is the acronym for Saw, Dry, and Rip, a process developed at the U.S. Forest Products Laboratory (FPL).

Conventionally, studs are sawn green from a log, dried, and planed. Stresses in the log are released in the stud by warping. Additional warp can be induced by conventional drying. This system of stud manufacture has been and is being used around the world. It works well with species having little growth stress, as well as with straight-grained woods. It does not work well with aspen and most small hardwoods.

S-D-R, however, departs from conventional practices, utilizing a new concept of sawing, drying, and ripping. The steps of the process are not new, but the combination of steps is.

Logs are live sawn, through and through on the same plane, into 7/4 (1 3/4 in.) flitches, Figure 1. The flitches are then rough edged before kiln drying to conserve kiln space, and dried at conventional (< 200° F) or high temperature (> 212° F) by an FPL schedule to an average moisture content of 10 percent. After drying, the flitches are ripped into studs, cutting 2 by 4's, 2 by 3's, and 2 by 2's for maximum utilization, but with emphasis on 2 by 4's.

Figure 1. Steps in the S-D-R process.



To date, over 90 5- to 12-inch diameter aspen logs have been sawn, dried, and ripped in aspen drying trials. The studs have been planed and measured for warp, and are now in storage under atmospheric conditions for remeasurement after at least 30 days.

Initial warp measurements on 305 2 by 4's showed a maximum of 11/32 inch of crook, with an average of less than 1/32 inch. Average bow was just over 1/8 inch, and average twist less than 1/32. The National Grading Rule (N.G.R.) for dimension lumber allows for 1/4 inch of crook, 3/4 inch of bow, and 3/8 inch of twist in the 8-foot 2 by 4 STUD grade. Those pieces not meeting the STUD grade are placed in the ECONOMY grade at much lower value. For 2 by 3's, initial average crook was just over 1/32 inch, bow about 1/8 inch, and twist practically nonexistent. Two-by-two's, which have N.G.R. warp limits of 3/4, 3/4, and 3/16 inch respectively for crook, bow, and twist, averaged just under 1/16 inch for crook, 5/32 for bow, and had virtually no twist. There was one piece for all studs that exceeded the grade rule limits initially (Table 1).

While the S-D-R drying trials have just begun on aspen, over 7,000 board feet of yellow-poplar have been cut to study the S-D-R concept. The warp figures for yellow-poplar are similar to those shown previously for aspen. S-D-R 2 by 4 studs showed 87 percent less crook, 30 percent less bow, and 19 percent less twist than conventionally sawn and dried studs (Table 2). S-D-R 2 by 3 studs had 74 percent less crook, 31 percent less bow, and 9 percent less twist. And, the S-D-R 2 by 2 studs had 76 percent less crook, 43 percent less bow, and 77 per-

cent less twist. Of all these S-D-R studs, 99.5 percent met the N.G.R. STUD grade. Only 88.5 percent of conventionally manufactured studs met STUD grade.

Additionally, as shown in Table 2. the yellow-poplar work indicates that each portion of the S-D-R concept (sawing. drying. and the combination) adds to the quality of the studs produced. Because the effect of high-temperature drying on strength has not been evaluated as yet, the use of conventional drying is recommended.

Mill design and economic studies are also being conducted to determine the total feasibility of the S-D-R concept. Final results should be available in mid-1979. Studies of other species, longer lengths, and wider dimensions may be conducted later.

Why Does S-D-R Work?

All trees, as they grow. develop stresses to some degree within the stem due to changes in cell dimensions, wind stress, and other environmental causes. In the tree. the outer portion is in tension and the inner core is in compression. Growth stresses may be very high (thousands of pounds per square inch). If a 2 by 4 is sawn green out of a log these stresses are released, which warps the board. However, if a flitch is sawn from the log it warps very little, because of restraint due to its larger size.

Another important factor is the stress relationships in a tree is the bonding between the stressed fibers within the wood. The bonding agent, lignin, is a natural thermoplastic adhesive that becomes plastic at higher temperatures. As shown in Table 2, there is a 30 percent improvement in crook due to high-temperature drying alone. We hypothesize that the stresses in the wood are released at high temperatures; the lignin becomes plastic and the stressed fibers slip past one another minimizing the stress. On cooling, the lignin again solidifies. holding the fibers in a relatively unstressed condition. When flitcnes are dried at high temperature in the S-D-R system, the effect of the larger piece plus the effect of the high temperature results in an almost complete elimination of stress. Thus, on ripping, the studs are cut straight and stay,straight.

The Future of S-D-R

The S-D-R process, to operate optimally, will require a completely new mill layout. It is envisioned that a BOF[2] (Best Opening Face) type computer-controlled gang headrig will saw flitches for the green edgers to rough edge before stacking and loading into the high-temperature kiln. After drying, the flitches will be fed into a computer-controlled edger that, following width scanning, will maximize the yield of 2 by 4's, 2 by 3's, and 2 by 2's. From the edger the studs will go to a precision end trimmer and then through the planer for final dressing.

The softwood sawlog resource has been under great pressure for many years to produce the millions of studs cut annually for home building and construction. Hardwoods can partially relieve the pressure on the softwood resource. Eastern hardwood studs also represent a transportation-energy advantage to regional markets. Aspen could well play a major role in the stud supply of the northern and eastern markets. S-D-R holds the potential of releasing to timber consumers a high-quality structural product that has not been available before.

[2]Hallock, H. and D. W. Lewis. 1971. Increasing softwood dimension yield from small logs -Best Opening Face USDA For. Serv. Res. Pap. FPL 166. Madison, Wis.

Table 1. Warp data for S-D-R aspen studs from drying trials

Stud size	No.	Initial measure: Average	Initial measure: High	Pieces meeting[1] stud grade
in.		*32nds in.*	*32nds in.*	*Pct*
		CROOK		
2 by 4	305	0.95	11	99.7
2 by 3	67	1.27	6	100
2 by 2	105	1.95	8	100
		BOW		
2 by 4	305	4.59	20	100
2 by 3	67	4.04	12	100
2 by 2	105	4.96	15	100
		TWIST		
2 by 4	305	.88	11	100
2 by 3	67	.21	3	100
2 by 2	105	.12	3	100

[1]The National Grading Rule - STUD grade allows 8/32 crook, 24/32 bow, and 12/32 twist for 2 x 4 and 2 x 3, 8-ft; 24/32 crook, 24/32 bow, and 6/32 twist for 2 x 2, 8-ft.

Table 2. Yellow-poplar warp data from S-D-P and conventionally manufactured 2 by 4 studs

	No. of logs	Average crook	Advantage over control	Average bow	Advantage over control	Average twist	Advantage over control
		32nds in.	*Pct*	*32nds in.*	*Pct*	*32nds in.*	*Pct*
CONTROL							
Conventional sawing Conventional drying	40	4.37		7.22		1.13	
TREATMENT 1							
Conventional sawing High-temperature drying	40	3.06	30	3.73	48	.61	46
TREATMENT 2							
S-D-R sawing Conventional drying	40	.93	79	4.85	33	1.10	3
TREATMENT 3							
S-D-R sawing High-temperature drying	40	.58	87	5.08	30	.91	19