Application Note:

Lumber Stacker

DELTA COMPUTER SYSTEMS, INC.

11719 NE 95th Street, Suite D
Vancouver, WA 98682-2444
Telephone (360) 254-8688
Fax (360) 254-5435
www.deltacompsys.com

Abstract

Sawmills and Planer Mills use lumber stackers to prepare lumber for transport. The stacker arranges the lumber coming out of the mill into uniform rows and places them on top of each other to form the stack. The stack is then bound into a compact and uniform bundle for easy and efficient handling.

The RMC motion controllers provide the high-speed coordinated movement necessary for maximum stacker feed rates. S curves provide smooth operation, and the Event Control Firmware provides 1ms response to events for minimum delay.

Application Requirements

The correct number of boards are placed on forks that will place the boards on a stack. The forks are lifted and extended out over the stack at high speed. They are then lowered onto the top of the stack and retracted, leaving the new layer of boards on top of the stack. This operation is repeated until the desired stack height is achieved.

Since throughput is critical, the forks must execute their move as fast as possible without dropping or skewing the boards. This requires both smooth operation and tight coupling between lift and extend motions of the forks.

Solution Details

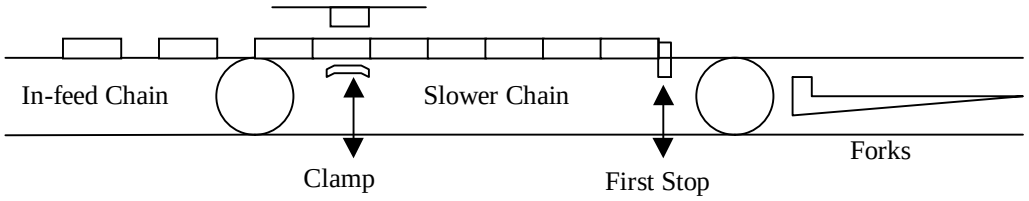
Lumber presented to the stacker has already been sorted for size (and possibly quality).

Step 1- Separate lumber into rows with correct number of boards.

The boards to be stacked are presented to the stacker spread out on a chain with the ends aligned. The in-feed chain carries boards to the stacker. The boards are spread apart on the chains so none are overlapping.

The in-feed chain transfers the boards onto a slower chain where the boards move against a stop so they are pushed together eliminating any space between boards.

When the slow chain is full of boards, a clamp is closed on one board a fixed distance from the stop. When the stop is lowered, the boards between it and the clamp can move along the chain. These boards will form a course (or layer) in the stack. The boards behind the clamp remain in place.

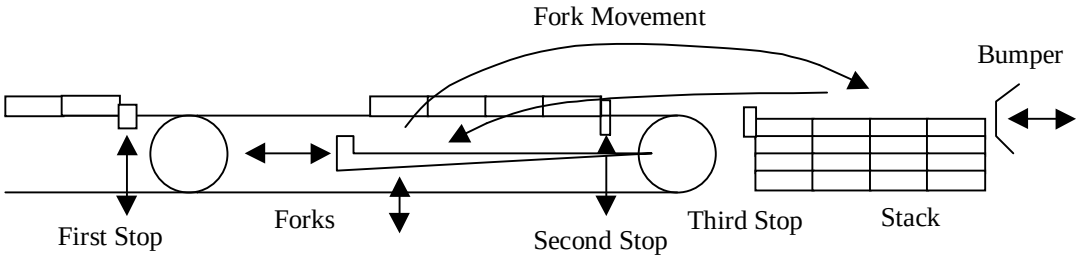


Step 2 - Move row of boards onto forks.

The boards in the course are transferred onto another chain that carries them over the forks.

The first stop is raised and the first stop is raised and the clamp released so the next course of boards can be formed.

The boards that moved over the forks move against another stop. We are now ready to move the course onto the stack.



Step 3 - Place boards on stack.

The forks must first lift the boards off the chain and above the second stop. Then they move out over the stack and beyond a third stop. The forks then drop onto the stack and start retracting. The boards are held in place by the third stop.

A movable bumper on the far side of the stack is brought against the stack to keep boards from tumbling over the edge of the stack as the forks are pulled out from under them.

Step 4- Prepare for new course.

As forks retract to their starting position, the stack is lowered by the thickness of the boards. In some cases spacers are placed across the stack between every 4^{th} or 5^{th} course in the stack.

The forks are mounted on a carriage that is moved back and forth by a hydraulic cylinder. A hydraulic cylinder mounted on the carriage raises and lowers the forks. Hydraulic cylinders are also used for positioning stop 1, moving the back stop, and raising and lowering the stack.

All the hydraulic cylinder positions are controlled by the RMC motion controller.

- Stop 1 position

- Fork Lift
- Fork Extend
- Backstop
- Stack Position

Stop 1 position is only changed when a new dimension of lumber is stacked. It requires only simple point to point moves (Go commands).

Backstop and Stack Position execute moves each time a new course is added to the stack. These moves can be initiated by either a master controller or by internal links to the fork extend axis through Event control firmware. The moves themselves are simple point to point moves (Go commands).

The interesting axes are the fork extend and lift axes. These must be coordinated with each other to achieve a move profile that accomplishes the following:

- Fast extend and retract motion for high throughput.
- Smooth motion to avoid disrupting the stack or dropping lumber.

The sequence necessary to accomplish this is:

1 - Raise the lumber off the chain and over stop 2.

2 - Extend the forks beyond stop 3

3 - Lower forks onto stack.

4 - Retract forks till all lumber is off.

5 - Lower and retract forks to start position.

These moves – in particular the fork extend and retract – are done with S curves to smooth the motion profile. Excessive shaking or jolts to the system can cause the lumber on the forks to be skewed or to fall off.

The following Event Control Table is used to coordinate the fork lift, fork extend and bumper axes. The cycle is started by a rising edge on input 0 (see input-to-event table).

Event Number	**1**	**2**	**3**	**4**	**5**	**6**
Mode	081	081	081	0	081	081
Accel	50	50	200	0	100	100
Decel	50	25	100	0	100	200
Speed	10000	10000	10000	0	60000	60000
Command Value	4000	1000	0	0	60000	0
Command	G	G	G	0	G	G
Link Type	0B1	0A1	0	091	081	0
Link Value	50000	8000	0	2000	1200	0
Link Next	2	3	0	5	6	0

Event Number	**7**	**8**	**9**
Mode	081	0	081

Accel	100	0	100
Decel	100	0	100
Speed	5000	0	5000
Command Value	0	0	6000
Command	G	0	G
Link Type	0B1	0A1	0
Link Value	58000	57000	0
Link Next	8	9	0

Input	**Axis 0**	**Axis 1**	**Axis 2**	**Axis 3**
0 – rising edge	1	4	7	
1 – rising edge				

Event 1:

Lift fork to 4 inches, wait for forks to extend beyond 50 inches.

Event 2:

Lower forks to 1 inch, wait for forks to retract to 8 inches

Event 3:

Lower forks to 0 position.

Event 4:

Wait for forks to lift 2 inches.

Event 5:

Extend forks to 60 inches, wait for forks to lower to 1.2 inches.

Event 6:

Retract forks to 0 position.

Event 7:

Retract bumper to 0 position, wait for forks to extend beyond 58 inches.

Event 8

Wait for forks to retract to 57 inches.

Event 8

Extend bumper to 6 inches.

Product Recommendations

The following products are recommended for use in this and similar applications:

- RMC120-DIO and RMC140-DIO (RMC160-DIO when available) motion controller from Delta Computer Systems, Inc.

Reference

For more information on using features in the RMC product-line, refer to the following topics in the RmcWin software packages on-line help index:

Event Control
Input to Event
Communication Digital I/O