

# PNEUMATIC MOTION CONTROL IN THE SAWMILL INDUSTRY

A CASE STUDY ON A SAWQUIP SAWLINE AT SPRUCE PRODUCTS LTD.

By François Tremblay, Technical Expert at  
PCI Automatisation Industrielle  
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## MOTION CONTROL IN THE SAWMILL INDUSTRY

The sawmill industry is one of the most demanding industries when it comes to motion control. The machinery that manages the handling and sawing of logs is extremely heavy and the forces involved are enormous. For instance, the primary breakdown of a log requires to move one-ton chipping heads at high speed with a precision of under five-thousandths of an inch. Hydraulic cylinders driven by high-performance motion controllers are commonly used. Other less demanding applications, such as bucking saws and stackers, often use electrical motion control. Both hydraulic and electrical motion control systems are very precise and powerful. A great number of manufacturers offers state-of-the-art controllers that can handle them.

While being fast, precise, and powerful, hydraulic and electrical motion control systems have a major drawback for a great number of other applications in the sawmill industry: their unforgiveness characteristic. In other words, these systems are very stiff. Oil is not compressible and electric systems are driven by gears and screws. For instance, if we wanted a hydraulic cylinder mounted on a press roll to hold a log down onto a chain while being fed into a machine, the variation of the log's diameter would quickly cause a jam, since hydraulic movements are not elastic at all. Even if the log managed to get through, damage on the equipment would occur very quickly. For that reason, feed rolls are commonly equipped with pneumatic cylinders.

Pneumatic cylinders are simple, cheap, and very efficient. In a typical sawmill, we find hundreds of them. Unlike hydraulic cylinders that can be easily moved to any position by controlling the flow of oil, air cylinder typically move from one extreme to the other. They are either extended or retracted. Engineering teams in the sawmill industry had long dreamed of pneumatic cylinders that could be positioned anywhere between the two extremes. They never had any success until manufacturers such as ASCO Numatics came up with high-performance pneumatic proportional valves.



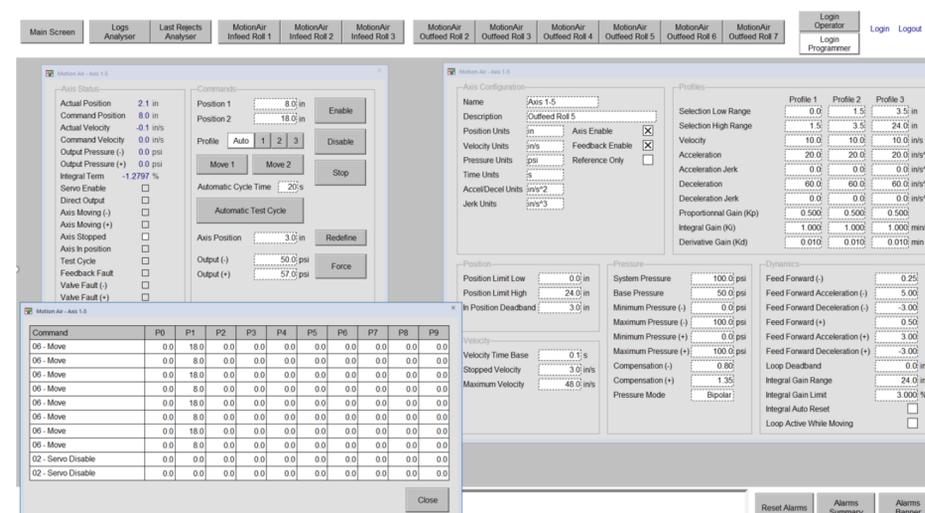
Asco pneumatic  
proportional valve

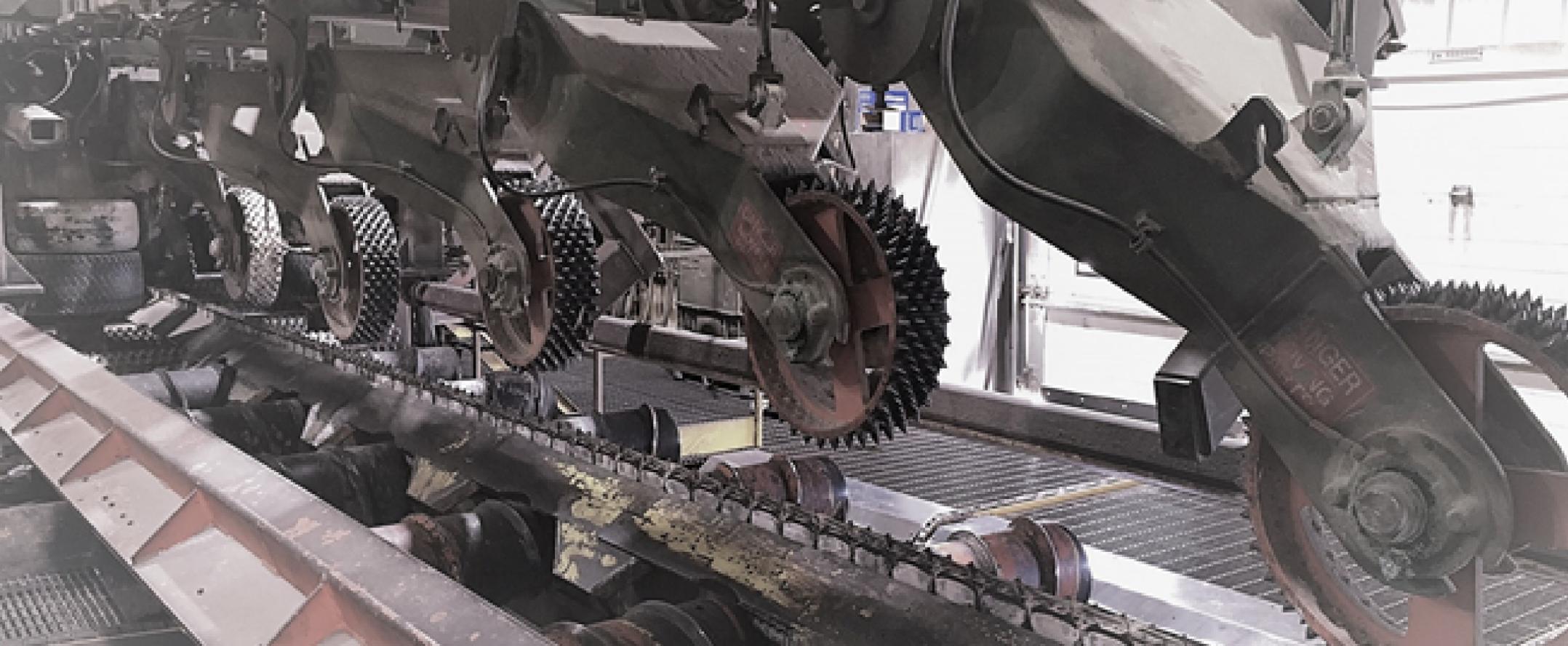
## THE CHALLENGES OF CONTROLLING PNEUMATIC CYLINDERS

With a hydraulic cylinder, controlling the speed of the action is only a matter of controlling the flow of oil. Stopping the flow will stop the movement, with no drift whatsoever. Pneumatic cylinders are a very different thing. Air is highly compressible. Unlike hydraulic cylinders, where positioning is controlled by the flow of an incompressible liquid, positioning pneumatic cylinders is a matter of balancing pressures on the inlet and outlet of the cylinder.

Easier to say than done! At all times, the actual position of a pneumatic cylinder will be affected by several factors such as: air temperature, air pressure and the load on the cylinder. This last factor is one of the most important. In the case of a vertical pressroll mounted on a pivot arm, for instance, the load on the cylinder will change depending on the actual position of the pressroll. The more vertical the arm, the less it is affected by gravity. Therefore, the movement and position of the cylinder follow a non-linear curve that makes it much harder to control.

Fortunately, the challenges of controlling pneumatic air cylinders have been overcome, thanks to the recent development of high performance pneumatic proportional valves and the design of motion control algorithms specific to pneumatic positioning. Indeed, traditional algorithms used in hydraulic and electrical motion controllers are designed for non-elastic mechanisms while pneumatic systems are extremely elastic.





## USING PNEUMATIC MOTION CONTROL ON A SAWLINE

Spruce Products Ltd. is a sawmill located in northern Manitoba, where winters are cold. Frozen logs are slippery. Holding curved or crooked logs steady on a chain is challenging. At the mill, a series of six vertical rolls, designed by the sawmill equipment manufacturer Sawquip, drop on the logs in sequence to hold them on a narrow chain. The rolls are commanded by pneumatic cylinders fed by standard digital valves.

In the winter, dropping the vertical rolls at high speed onto the logs was often a problem. The velocity and inertia of the rolls hitting the log would often kick them off the chain. Also, the pressure applied by each on the six rolls, the pressure of the line at around 100 psi, created an enormous force on the logs, contributing to the problem.

It was an obvious application for pneumatic motion control. We decided to upgrade all six rolls with motion control. We would not only eliminate the high velocity and inertia of the rolls hitting the logs, but we would also be able to apply just the right amount of pressure applied to hold the logs, somewhere around 20 psi. The image above shows the rolls sitting motionless in mid-air, at different positions.

Another great advantage is the fact that the rolls are prepositioned at the right height based on the diameter of the logs. Therefore, the pressing action point is much more accurate, eliminating the frequent jams due to a roll dropping too soon. Moreover, in the event that a roll has dropped too low, it will just gently bounce open when the log hits it, a consequence of the very low pressure applied to the cylinder when holding a position. The roll is basically floating in mid-air, like a feather.



Switching from traditional control to motion control was straightforward and quick. The switchover was executed during coffee breaks and at lunch time, with no downtime nor production loss. On the image on the right, we can see the location where the laser feedback device is mounted, pointing down towards the pivot arm. Both ASCO Numatics valves are mounted on the top right corner, just below the light. Plumbing was simple and only took a few minutes per cylinder.

## LOW COST AND HIGH GAINS

In the past, the problem was sometime solved by combining a hydraulic cylinder and a pneumatic cylinder, mounted back-to-back. The hydraulic one being used for positioning while the pneumatic one for cushioning. The result was good enough, but the price tag for such a system was prohibitive, over ten thousand dollars per axis plus a heavy maintenance.

The price tag to upgrade an existing pneumatic cylinder with motion control is extremely low. The pneumatic cylinder does not need to be replaced. The digital valve is replaced with two low-cost proportional valves. A feedback device, in this case a Keyence laser, is mounted at such a location that it detects the movement of the roll. The control algorithm, the brain of the motion control system, is programmed directly into a ControlLogix Controller.

Another point to consider is the fact that the movements of the cylinders are greatly reduced, since they no longer have to move all the way from one extreme position to the other. The rolls never move needlessly. They stay where they are and only move to match the diameter of the next log. Air consumption is greatly reduced. Furthermore, the cost of maintenance is also reduced significantly since the operation is much smoother.

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