

Issue 8, June 2005

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The World's Largest Paper Making Machine Moog's Advanced Pressure Control Solution

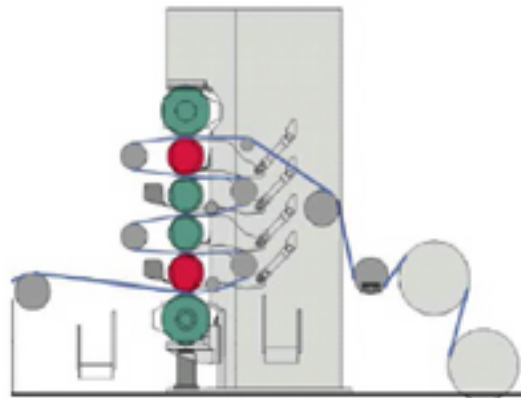
Feature Article

World's Largest Paper Making Machine

by Peter Lillqvist, Area Manager, Moog Finland

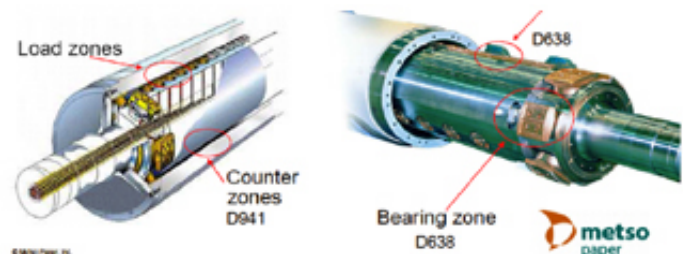
The concept of the printed word on paper might not have changed much since the Gutenberg Bible was produced in 1455 but production techniques have changed fundamentally. The average person frequently encounters the incredible range of magazines available at their local news agent today. This proliferation and the extremely high quality of paper and reproduction are the result of recent developments in digital layouts, printing, and paper making machinery. One of the companies that has contributed notably to this change is the Metso Corporation with its headquarters in Finland. Northern Europeans are in the forefront of both forest production and conservation, so it is no coincidence that one of the foremost paper machine manufacturers is located in this part of the world.

Although paper making techniques have been refined in the last 20 years, the basic concept is still the same. You take paper pulp and pass it through multiple rolls to squeeze out the liquid and then dry it to produce paper. Sounds easy! Well, modern paper making machines such as the PM12 currently being installed at Kvarnsveden in Sweden are 300 meters (985 ft.) long, 70 meters (230 ft.) wide and 30 meters (99 ft.) high. It has a calender width of 11.3 meters (37.1 ft.) and a machine speed of 2,000 m. (6,560 ft.) per minute, which will make it the world's largest paper machine. When in operation at the end of 2005, PM12 will produce 420,000 tons of paper per year, which will increase the capacity at Kvarnsveden to over 1 million tons per year. This is equivalent to 2 kilograms (4.41 lbs.) of paper per European. It utilises 15,000 control elements handling 75,000 control signals and operates six shifts with only 9 operators per shift. This kind of machine is considered to be as technically sophisticated as a modern Jumbo Jet.



(courtesy of Metso Paper)

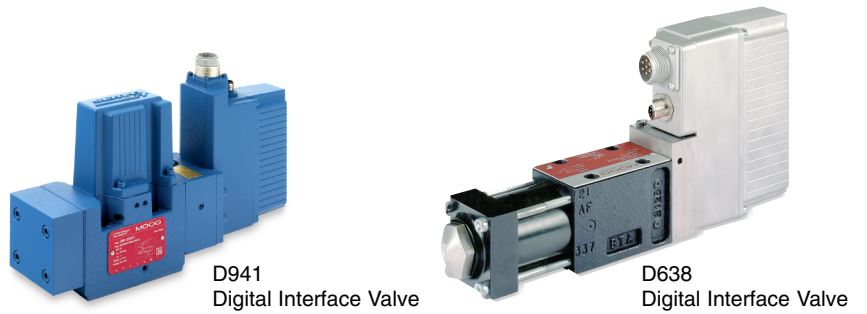
PM 12 utilises 8 high-precision SYM-CD rolls with narrow zone profiling to produce what the industry calls SC (Supercalender) paper with a higher gloss and smoother surface. CD stands for Cross Direction and the CD-roll is a device that corrects the cross directional errors on the paper web. The machine uses up to 76 hydraulic pistons placed inside each roll to exert forces at each load zone to maintain a controlled profile across the complete width of the roll. These forces are hydrostatically counterbalanced on the opposite side of the roll.



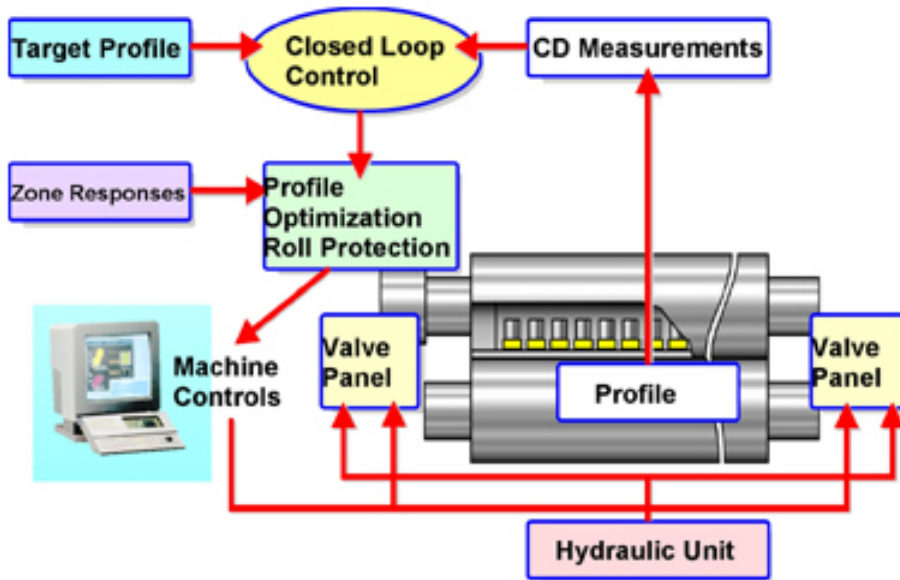
(courtesy of Metso Paper)

The force exerted by each piston is controlled by a Moog D638 pQ Servovalve and the pressure in the counterbalance zones with D941pQ Servo-Proportional Valves. In addition, four Moog D638 pQ Servovalves control the hydrostatic bearings located at either end of each roll.

The term pQ is used to denote electrohydraulic valves that can be accurately controlled in both pressure and flow control modes, which are critical in this application. In normal operation the valves are controlled in pressure or force control mode but there are conditions in which it is necessary to open the rolls fast by selecting the flow control or "fail-safe" mode. One of these situations is the "fast break recovery" when the paper strip rips or breaks.



In order to produce high quality paper, cross directional profile of the paper web is measured and fed back to the machine controller which adjusts the pressure of each valve independently to achieve paper symmetry. An important feature of these valves is the internal pressure control loop. This uses a built-in powerful microprocessor and accurate pressure transducer together with the valve's high dynamics to ensure precise control down to very low pressures. The state of the art controller uses special control algorithms to simplify systems optimisation by reducing the multiple parameters that are the basis for hydraulic pressure control transfer functions, to a single variable.



(courtesy of Metso Paper)

Earlier paper machines used valves controlled by analogue signals but digital control provides many advantages. With 78 valves per roll and up to 600 valves per machine the needs for decentralised control, reduced wiring and improved diagnostics have meant that the valves now need to communicate with the machine controller via a fieldbus. The result of this change is continuous development of real time diagnostics, improved functionality, and unique preventative maintenance solutions. Just one example is the ability of the valve to monitor its own output and react in order to prevent damage to the machine. If the actual pressure is out of a pre-set "window" for more than 30 ms. the valve goes to a pre-defined safe position.

So next time you pick up a glossy magazine at your local newsstand you might reflect on the fact that it is the end result of a highly sophisticated process. It started with a tree and went through multiple phases of production using some of the most advanced motion control products in the world and was eventually distributed to your neighbourhood.

About the Author:

Peter Lillqvist is Area Manager for Moog Finland. He started with Moog in 1999 as an Application Engineer, and has been working the last four years as a System Sales Engineer. He has a Masters degree in Automation Engineering from the University of Tampere.

Did You Know?

Diagnostic Capabilities in Digital Servo-Proportional Valves

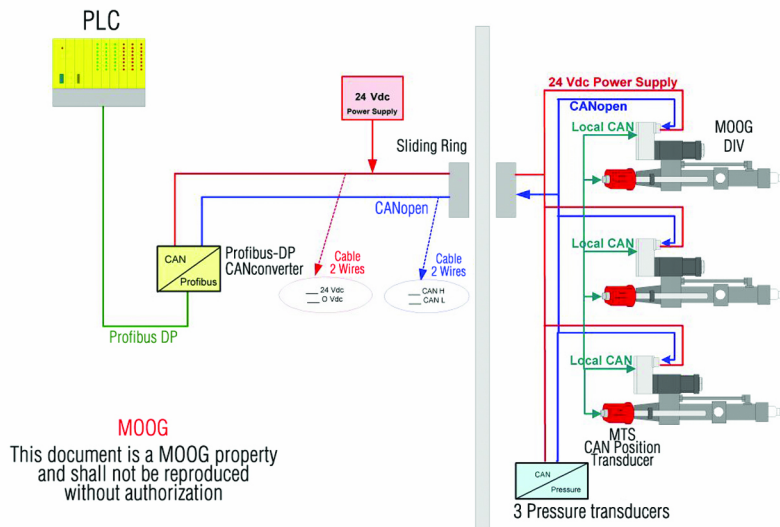
by Bernhard Zervas, System Engineering Manager, Moog Germany

Most engineers know that digital electronics for Servo-Proportional Valves provide some important advantages. Some examples are:

- Sophisticated control algorithms for improved performance.
- Settings and parameters can be copied for series production and replacement, saving time and money because no tuning is required when replacing a valve.
- No drift (minimum variation in tolerance band), which provides very high position accuracy.
- Flow and dynamic characteristics can be set via configuration software, making for easy set-up and adjustment.
- Valves can be used in a fieldbus network for decentralized control of axes, offering greater flexibility for various control architectures.
- Diagnostic capabilities for improved troubleshooting.

To better understand the diagnostic capabilities of digital electronics, we will use the example of a position control application featuring an electro hydraulic actuator with either a digital Axis control or an analog Servo-Proportional Valve. Electro hydraulic actuators are axis that frequently need to have precise position control, and typically receive the position command signal from a host controller. We will compare analog and digital approaches to this typical configuration.

Digital Axis Control Valve Application *Wind Turbine*



BENEFITS:

- Reduced Wiring Effort
- Stable Signal Transport via Field Bus
- Diagnostics of Rotating Components
- Exchange of Valves without New Adjustments

Analog control and valve electronics can only monitor the deviation between the command signal and the actual position signal. When the deviation exceeds a defined level, the fail-safe function is triggered and the actuator has to be stopped or moved into a defined end position for safety reasons. This is interpreted by the host controller of the machine and the hydraulic actuator system as an unknown defect, which has to be analyzed by the maintenance staff after the emergency stop, with resulting troubleshooting downtime.

By contrast, a modern electro-hydraulic actuation system using a digital Axis Control Valve is able to control the valve itself, in addition to the actuator position. When using a proactive maintenance approach, that is being demanded in more and more factories, it is mandatory to obtain significantly more information about the actual status and wear of the electro-hydraulic actuation system and its components. For example it is highly valuable to monitor, relative to defined tolerances, the static and dynamic behavior of the Servo-Proportional Valve, temperature of the integrated valve/axis electronics, sensor signals, leakage (wear of seals) of the actuator, and process data. The Digital Valve's axis control electronics can make all relevant internal control data available for continuous process monitoring. To be able to transmit continuously the large amount of status information available per axis to a host controller, a fieldbus interface is mandatory for the Axis Control Valve.

With the available data, it is now possible to monitor the wear of the electro-hydraulic actuator, allowing for proactive maintenance at the next planned machine service. The available data provides information about the required activities and enables spare parts to be available for the planned machine service, reducing the down time required. If an Axis Control Valve has to be replaced, no new tuning and adjustments are required as all control parameters are simply copied to the new valve, further reducing down time. Contrast this to the emergency stop scenario with the analog valve. Time is money and digital diagnostics saves both.

About the Author:

Bernhard Zervas has been the Manager, Systems Engineering for Moog's Industrial operations in Germany for 3 years. He has over 30 years experience in the international hydraulic industry, with a focus on industrial electro-hydraulic closed-loop, electro mechanical and hybrid applications.

Hot Websites

CANopen and The Manchester School of Engineering



CANopen (www.canopen.org)

This site allows you to search for many topics including applications, conformance, history, protocol, standardization and more. This site also publishes newsletters, seminar listings, and a free product guide as well as many specifications for download.

White Paper on "Diagnostics in Machine Design" (www.eng.man.ac.uk/Aero/wjc/papers/NN_diagnosis.doc)

Learn more about built-in diagnostics as part of system design. Entitled Fault Diagnosis of a Hydraulic Actuator Circuit using Neural Networks - A State Space Classification Approach , it is a 26-page document by W.J.Crowther, K.A.Edge, C.R.Burrows, R.M.Atkinson, D.J.Woollons.

Product Spotlight

Digital Interface Valve: Series D941 Digital Interface Valve with Integrated Microprocessor and Fieldbus Communications



Here is the new digital servovalve that we have been writing about in the stories above. Moog has developed this new Digital Interface Valve hydraulic valve platform, with microprocessor based electronics and a CANopen fieldbus. It is truly a "game-changer" because it brings the capabilities of the electromechanical world to the high-force applications that have traditionally been the province of hydraulics.



This servo-proportional valve can be used in large, complex machines, like the Metso Super Calender paper making machine, that call for large numbers of axes and high volumes of wiring. Series D941 is offered in flow capacities of up to 80lpm (21.1 gpm) at pressures to 5 bar (75 psi).

These new valves can replace analog technology and offer configurable functions that enable customers to define the dynamic behavior of the valve and adapt its characteristics to particular application requirements, while providing high-precision digital flow and pressure control. These valves are central to implementing a distributed control concept in a machine because tasks can be assigned to local devices rather than the main control device, providing our customer's machines with increased flexibility and functionality.

The ability to bring digital control to such high flow capacities is critical, because it enable users, for the first time, to configure these valves through software, rather than through changes in mechanical parts or through passive electronic components. It simply makes life easier for users as you do not have to stock a lot of custom valves and, in many cases, it means that we don't need to send an engineer to tune the valve.

Key benefits of Digital Interface Valve products for customers are:

CANBus Communication

Diagnostic capabilities, integrated monitoring of key environmental and internal characteristics, and valve parameter modifications can be accessed on-site or remotely.

Flexibility

The ability to download parameters via the fieldbus connection or directly from the upper PLC program enables optimum tuning of valve parameters during the machine cycle, even while the machine is operating. The Windows®-based graphical user interface is easy to learn and convenient to use.

Cost Savings

Since the pressure control loop is tunable via software, rather than passive electronic components, it is now possible to stock a single valve for multiple applications reducing the need for several valve models.

Lower Installation Costs

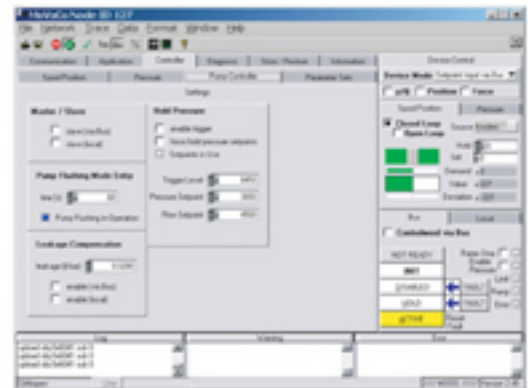
A serial wiring scheme reduces the amount of wiring and improves noise immunity.

Superior Control

The improved frequency response of the design allows high spool position loop gain, providing excellent static and dynamic response for superior control system performance. The improved valve dynamic performance is due to the extremely high natural frequency of the ServoJet® pilot stage (500 Hz) and the implementation of advanced current control algorithms, which are only possible via digital electronics.

Energy Savings

Considerably improved flow recovery (more than 90% of the pilot stage internal leakage flow) contributes to energy savings, especially for machines with multiple valves.



Reliability

The high-pressure recovery of the ServoJet pilot stage (more than 80% delta p at 100% command signal) provides higher spool driving forces and ensures enhanced spool position repeatability.

Safety

Fail-safe versions with defined safe spool position using a spring, a poppet valve or by external supply cut off ensure operator safety.

This product continues Moog's technological leadership by extending the implementation of digital intelligence across our product lines that results in improved performance, cost, and ease of use for our customers.

Ask the Expert

Why use a CAN-bus network and CANopen communication protocol for decentralized axes control?



Some of the most important reasons are transmission security, speed and reliability largely due to the uniqueness of the data transmission of the CAN network. In a CAN network there is no addressing of subscribers or stations in the conventional sense, but instead, prioritized messages are transmitted. A transmitter sends a message to all CAN nodes (broadcasting). Each node decides on the basis of the identifier received whether it should process the message or not. The identifier also determines the priority that the message enjoys in competition for bus access.

Another key reason is international standardization. Open fieldbus systems enable the construction of machines by connecting components from multiple vendors, while minimizing the effort required for interfacing. To achieve an open networking system, it is necessary to standardize the various layers of communication used.

A widely accepted standard for these layers of communication is provided with CANopen. CANopen is a standardized communication profile for simple networking of CANopen-compatible devices from many different manufacturers. The profile family, which is available and maintained by CAN in Automation (CiA), consists of the application layer and communication profile (DS301), various frameworks and recommendations (CiA DS-30x) and various device profiles (CiA DS-40x). The CANopen standard defines various device profiles to enable connection of different types of devices, including for example: electric servovalves, pumps, drives, controllers, position transducers, etc.

For more information, visit www.canopen.org

Upcoming Events

Exhibits and Trade Shows:

- ChinaPlas 2005, Guangzhou International Convention and Exhibition Centre, Guangzhou, PR China (June 21 - 24, 2005)
- IPF 2005, International Plastic Fair, Makuhari Messe, Chiba City, Japan (September 24 - 28, 2005)

For more information, click on [Exhibits and Trade Shows](#).

Moog Training Sessions:

Training sessions for “MACS / IEC 61131 Programming” and “MSC - Moog Servo Controller Hardware and Extension Modules” are held periodically. Sessions are offered both in English and German languages at Moog GmbH in Boeblingen, Germany (near Stuttgart).

For more information, click on [Training Opportunities](#).

Published Articles:

- [Making Waves](#) in April 2005 "Design News" magazine

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