

Hydraulic Solutions Stay Viable (Part 2 of 2)

Far from dead, hydraulics is often the best severe-service solution thanks to software and electronic innovations

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(This is Part 2 of a two-part article about the choices machine builders make among various drive alternatives. Part 1, web-published February 22, took a look at the technologies. This part relates the experiences of machine builders that have made differing choices.)

In addition to the inherent advantages of the electrohydraulic, electromechanical, and electropneumatic drives technologies discussed in Part 1, software is increasingly important in the overall scheme of implementation and operation of drives in severe-duty applications.

"As hydraulic machines are required to perform more complex functions and interface with other devices, software is providing the critical edge in performance," says Tom Driggers, president and CEO, Interlaken Technology Corp. (<http://www.interlaken.com>), a machine builder located in Eden Prairie, Minn. "And open architecture is becoming a major factor in integrating these devices."



Figure 1: Forming Strong Bonds

This hydroforming press provides closed-loop control of forces, motions, and pressures to produce parts. Open architecture is becoming a major factor in connecting the press with other control system devices (Courtesy: Interlaken)

Interlaken is introducing a new hydroforming press for use in production or process development applications. It is a computer-controlled hydraulic press (with data acquisition) that uses a high-pressure liquid to hydroform materials. Interlaken's new press embraces both tube and sheet hydroforming applications.

"The hydroforming press provides closed-loop control of forces, motions, and pressures to produce high-quality parts," says Driggers. "Sophisticated controller software compatible with Windows 98/2000/NT allows users to develop complex force, motion, and pressure profiles that can be both time and event-dependent (Figure 2). Windows-compatible interface software lets users build motion and force profiles designed to fit specific forming needs. And the multichannel closed-loop control system is programmable to handle event as well as time dependencies."

The control system offers dynamic mode switching that lets the user switch between a variety of feedbacks such as force, position, internal pressure, and other system variables. As a result, the hydroformed parts are stronger and lighter due to structural integrity and fewer welds or add-on pieces. In addition, costs are reduced and time is saved by eliminating secondary operations, reducing scrap, slashing material and manufacturing costs, and increasing design flexibility.

A dual-operation Learning/Research mode determines tool and die specifications, measures and optimizes processes, and programs forces and motions. The Production Mode runs the optimized profile while monitoring and recording process variables.

"A typical process might require moving actuators in position control, then switching to force feedback for a portion of the cycle, and then switching back to position again to finish the part," says Driggers. "Interlaken's control system implements these scenarios so the hydroforming press can easily alternate between various time and event commands."

Lathe Power

Electric, hydraulic, pneumatic, and mechanical components from Mannesmann Rexroth (<http://www.us.rexroth.com>) are being used by Industrias Puigjaner (<http://www.denn.es>), Barcelona, Spain, to build the drive and control of a major new machine tool. The machine, with control capable of handling up to 40 axes, is a flow turning system with two independent X-Y slides used to manufacture plates and tubes, and includes a main motor, a live ring, and both hydraulic and pneumatic accessories.

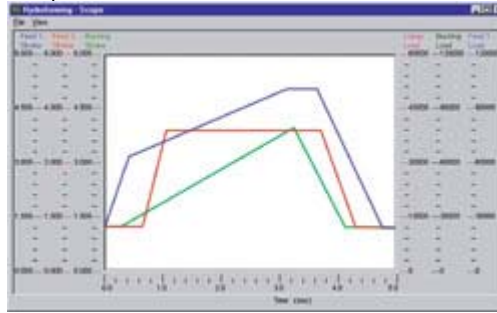


Figure 2: Scoping Out Quality

The press control system has dynamic-mode switching that switches between a variety of process variable feedbacks with real-time visualization. (Courtesy: Interlaken)

The flow turning system features two independent slides that can work simultaneously. One of them is fitted with a live ring with six stations, with capacity for additional facing and bordering tools. The lone machine reduces production times by about 50% and operates without parts clamping.

The parts program is defined using a CAD/CAM program developed specially for this application. Using an open control system with dynamic AC drives and SERCOS interface ensures high process speed and application-specific functions.

This automatic flow turning lathe has the latest drive units, featuring application-specific control as well as customer-oriented services for defining the parts program. The new-generation lathe uses electric servo motors. These motors feature both digital controller and analog interfaces to ensure compatibility with existing controls.

The hardware is integrated with standard components, including a PC terminal that includes the axis control unit and a Windows operating system. The control unit is installed in the bus PC of the terminal, allowing data exchange. The drive units internally manage the closed-loop torque, speed, and position control circuits; the control unit is restricted to generating only the paths, calculations, and sequences of the operating mode.

This intelligent architecture allows the control unit to control up to 40 axes without performance restrictions. Communication between the control unit and the intelligent driver is achieved via SERCOS, an internationally standardized communication interface with optical fiber technology that allows synchronous operation of the drive units with microsecond accuracy.

The PC software was developed in Borland C++ and comprises the CAD editor as well as the HMI, operating modes, and machine diagnostics. The complete operating sequence with the machine accessories is graphically defined using cards in the tree structure. Thanks to the Windows editor, no special programming knowledge is required for definition of the parts.

VSDs Aid Flexibility, Productivity

Standard hydraulic injection presses cannot overlap process steps such as screw recovery and mold clamping/unclamping. All-electric and hybrid-electric machines, in contrast, can overlap machine functions to shorten cycle times. Users of hydraulic presses may add a special pump package to provide the capability to overlap process steps, but it is an expensive solution.

Magnum LLC (<http://www.magnumllc.com>) offers a more economical approach than either all-electric servo drives or special hydraulic pump packages. It retrofits AC induction pump motors with variable-speed drive systems in place of the usual fixed-speed pump motor. Using off-the-shelf drives, Magnum has provided this service mainly to save energy costs.

Savings accrue because the variable-speed pump motor slows during parts of the molding cycle when the process requires little or no fluid flow. A normal fixed-speed drive simply keeps pumping oil over a relief valve and back to its reservoir during idle periods.

"Firms buying our system have benefited from energy savings for years, but they are just now finding out about the ability of the drives to increase productivity by shortening cycle times," says Magnum's Pat Mulligan. "Energy savings can be from 50-80% and productivity can be enhanced 15-20%."

Custom molders and automotive parts suppliers say productivity improvements allow them to take on molding jobs they could not have performed cost-competitively with a standard machine. Steve Dowling, vice president of operations at custom molder Universal Plastic Molding (<http://www.upminc.com>), Baldwin Park, Calif., says the ability to overlap screw return with clamp movements benefits jobs with short cycle times the most. It's just the opposite with energy savings: "The longer the initial cycle time, the greater the time savings," says Dowling.

Mulligan says variable-speed drives can improve processes with cycle times as short as 10 sec. The variable-speed drive can raise the motor rpm above its rated capacity for short periods when maximum oil flow is required. "The brief burst of higher speed doesn't put any stress on the motor, but delivers a higher volume of oil at a higher velocity," says Mulligan.

A hydraulic press uses several pump motors and drives to deliver oil for specific process functions. A particular motor and pump unit is activated at certain points in the process. Magnum evaluates an existing machine to determine whether and how a variable-speed drive could provide benefits. "We let the operator set up the machine, then take power readings to determine what each motor in the hydraulic system does during the molding cycle," Mulligan says. "Our program calculates what the optimum motor speed should be for a particular operation and what size is needed." The variable-speed drive controls are then piggybacked on the existing machine control system, and operate automatically when the machine is in use.

Machine maintenance may also be less with the variable-speed drive. "The valves within the hydraulic system are always left completely open because the drive is controlling the motor and the flow of oil through the system," says Magnum co-owner Dave Sandy. "This open position of the valves eliminates the stress on seals, valves, and hoses when valves open and close during standard molding." Keeping the valves wide open allows the oil to move more quickly and keeps it 10-12° F cooler, since the oil is not sheared by being forced through small valve apertures.

Sidebar:

IMMs Turn Deaf Ear To Electrical Noise

Nobody likes a noisy neighbor. That's what robot unloaders are to hydraulic injection molding machines (IMMs) using analog feedback position devices to monitor clamp, inject, and eject locations. Robot drives generate electrical noise that can interfere with analog signals, causing the control to receive erroneous positioning feedback on those critical machine components.

"The results can be disastrous," explains Derek Beeker, manager, quality and reliability, Milacron Inc. (<http://www.milacron.com>). "If an analog feedback signal jumps a couple of volts due to electrical interference from a robot unloader, an IMM's clamp could stop short of fully opening, causing the robot to crash into the partially closed mold."

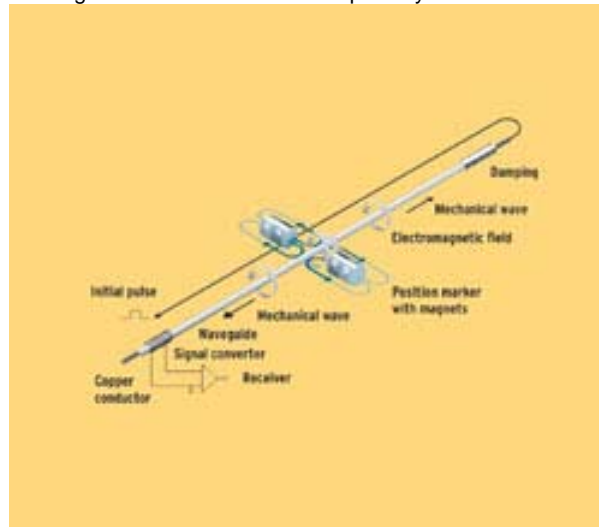


Figure 3: Magnetostrictive Forces at Work
The Magnetostriction process as applied to the non-contact positioning sensor.

To eliminate that possibility on its hydraulic IMMs, as well as increase positioning resolution tenfold, Milacron replaced the analog feedback devices normally used on its machines with digital versions of a magnetostrictive linear position transducer from Balluff (<http://www.balluff.com>). The digital feedback integrates with Milacron's new digital control, provides drive noise immunity, and improves positioning resolution from 0.01 to 0.001 in. Magnetostriction non-contact positioning technology tracks the location of a magnet attached to a machine component (Figure 3).

"Digital feedback certainly made the difference for those analog-controlled IMMs, just as it does now for our hydraulics with new digital machine control," says Beeker. Milacron uses the

magnetostrictive units to monitor up to five axes on its new hydraulic IMM models.

Milacron also improved positioning resolution by switching to digital-output feedback. Unlike analog signals, digital output resolution is constant regardless of stroke length. In theory, analog devices have nearly infinite resolution, but true resolution depends on control processing capabilities. Previous generation 486 control used a 14-bit A/D converter, which effectively spread 14 bits over the entire stroke length—whether long or short. Thus, as stroke length increased, resolution worsened due to greater length per bit.

Conversely, a digital transducer generates a pulse-width-modulated (PWM) signal using start/stop pulses. Magnet position is directly proportional to the time interval between pulses. Clocks within digital controls have a specific frequency used to measure the time interval of such pulses. A higher frequency of time interval checks means better position resolution. "Resolution is all about distance per bit with analog signals, but this digital device provides 0.001 in. resolution regardless of length," says Beeker.

Since stroke lengths are relatively small on low-tonnage machines, resolution may not be drastically affected. But for larger machines with long component stroke lengths, consistent digital-feedback resolution makes a big difference.

"We used to shoot for 0.01 in. open-position repeatability on small IMMs (200 tons and lower) and 0.015 in. on larger machines," says Beeker. "We're now getting under 0.01 in. on machines through 800 tons, which is something we could never attain with analog feedback devices."