Upgrading Your Motion System: Converting Old to New

In this stamping press application the old method used a conventional servomotor and gearbox coupled to the feed roll with a belt. The Cartridge DDR mounts directly on the feed roll and eliminates the gearbox, belts, pulleys, and mounting structure to hold it all together, and installed in less than 10 minutes. The OEM realized an immediate cost savings, a reduction in parts that improves reliability, and improved accuracy from 0.002 inch with the geared servo to 0.0005 inch.

By Lee Stephens

Competition drives us all to look for ways to produce machines that are faster, smaller, more accurate, quieter and cost less than their predecessors or than the competition. Upgrades to motion systems can be required due to obsolescence, cost, or technology advancement. Whatever the reason, technology changes imply advancement which in turn drives that competitive enhancement. Advancement is often accompanied by design and implementation challenges. The ability to handle these challenges will determine the success or failure of the change.

Some of the more typical technology advancements include replacing hydraulic/pneumatic actuation with motor driven actuators, changing stepper motor technology to servo, or replacing brush servomotors with brushless servos. When one is transitioning from a stepper control to a servo control there is typically less stringency than replacing a hydraulic or mechanical system with servo control. Electrical expertise may be available within a company that has stepper motors and stepper drives. These experts may not be available in a company using hydraulic/pneumatic controls. With training and experience though, changing technology does not have to be daunting.

Increase Repeatability, Decreasing Variance

Assume for a moment that you need to flow a liquid, semi-liquid or molten material at a specific rate. Should the material viscosity change between batches, achieving consistency with a hydraulic or pneumatic ram could be challenging. One solution is to connect a PLC to a force cell to control the force in an on and off format. This is often referred to as Bang-Bang control and works great with the thermostat in a house, but is not really intended for the control of precision mechanics.

Users may supplement this type of control with an exotic fuzzy logic scheme to round out the instantaneous changes, but this is not much more than 'chattering' an input or valve to obtain a reduced rate of change. Replacing the air cylinder with a servo actuator allows both force and speed to be controlled with the aid of a servo amplifier and without any special or exotic components. The position, velocity and current of a motor are constantly controlled to the specific tuning parameters required for the application.

Understand Your Requirements

A detailed understanding of the application's motion requirements is job one of the motion control engineer. This implies a detailed understanding of mechanics, electronics, software, and dynamics (kinematics). Should one's system require a point-to-point move for the pick and place of an electrical component, it may be an unnecessary constraint on the control system to reduce following-error to the minimum. Such misapplication may result in an undue amount of effort in the control system causing other issues such as resonance or heat in the unit under control. In the case of a contouring or printing application, such an error is a direct measure of the output quality and must be accounted for.

A full understanding of application requirements and limitations can be increased with the use of simulation and breadboards. With accurate simulation, one can reduce the number of false starts and re-design issues, both of which are a waste of capital and taxing on the creativity of the group.

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A number of very good simulation tools exist that can help to significantly reduce design time. Physical systems can be designed to aid the simulation process but take a significant amount of time, space and experimentation. Implementing a physical breadboard is also subject to materials delays, internal staffing issues as well as capital expenditure limitations. This is not to suggest that a breadboard should necessarily be avoided, as it can serve as the basis for determining whether a system is worthy of investment beyond the brainstorming stage, without too much difficulty.

Using a simulation tool, such as VisSim from Visual Solutions or Motioneering and Model Q modeling software from Danaher Motion, allows users to vary the design within the specifications required to determine it's viability and usability. Approximate force, torque, accelerations and frequencies can be analyzed prior to investing in material.

Replacement due to Obsolescence

When an upgrade is required due to obsolescence, there are some often overlooked performance issues that can make or break the project. A brush-style moving coil rotary motor, for instance, may suffer from longevity and power handling shortcomings, but its replacement can be wrought with performance obstacles too. It is not unheard of for applications to require velocity loop bandwidths in excess of 3 or 4 times the capability of standard digital servo amplifiers, but replacing one of these brush-style motors in a high performance application can still be successfully accomplished.

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Recent advancements in FPGA technology have allowed digital servo amplifiers like the Danaher Motion S200 family to achieve current loop bandwidths of 3 – 5 KHz. With this high bandwidth, the possibility of a 1 KHz velocity loop or greater can be accomplished. The performance of a high bandwidth system coupled with the right motors can achieve and even exceed that of the earlier technology, while offering the wear and power handling advantages of the brushless technology.

Upgrade Example

One example of a technology upgrade proved to be as cost effective as it was an advancement in control. In an electronic assembly machine at Universal Instruments, there was a component placement head that needed to operate faster. This placement head is on the Radial Lead Inserter. The previous method of control was pneumatic, which proved to limit the machine's performance for a number of reasons including, but not limited to:

- environmental factors
- compression time variances
- valve actuation variation
- exhaust limitations

To compensate for these variances, the old system employed deceleration hydraulic shock absorbers, proportional cushioned air cylinders, intensifiers, and special exhaust reclassifying mufflers to remove atomized oil that could not be exhausted to the air.

Transitioning to a servo environment was not without challenge, but the implementation of a Danaher Motion special R-series motor met the application requirements without the need for shock absorbers, special valves, or other pneumatic parts. Since this machine function was part of a sequence of operations, the consistency of move time and acceleration allowed for the pre-initiation of other functions that produced an increase in cycle rate as well.

This simple electric actuator system ensures consistent bi-directional operation, while providing significant additional OEM and end-user benefits.

Life tests revealed other revelations. An unanticipated benefit was that the lack of shock decreased the wear on some components, significantly increasing the reliability and uptime of the machine. Set-up times for the machine build were reduced as well. When evaluated in combination, the brushless motor and amplifier were more cost effective than the previous scheme.

This system was first modeled in VisSim which yielded great rewards in reduced evaluation time. Prior to the simulation, no motor appeared to fit the application due to envelope constraints and required performance. Using the model with a custom motor and standard amplifier from Danaher Motion, the application was deemed worthy of continuation. The result is the patented Radial Lead 8XT from Universal Instruments. This patent (USPTO #6,161,443) was the result of physical breadboards as well as models in which the author was personally involved.

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