

Technologies That Make a Difference

Leading system integrators provide a glimpse of successful motion control solutions

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If you're looking for engineers who have mastered the art of building effective motion control systems, chances are you'll find many of them at integrator companies.

These are the firms that many busy OEMs look to when it is time to upgrade a packaging machine, design an inspection station, or tackle another challenge that demands an expert blend of controls, drives, motors, and actuators.

Since it's their job to stay on top of the fast-moving field of motion control, integrators are constantly surveying the vendor waterfront for new ideas in hardware and software to enhance their motion control designs.

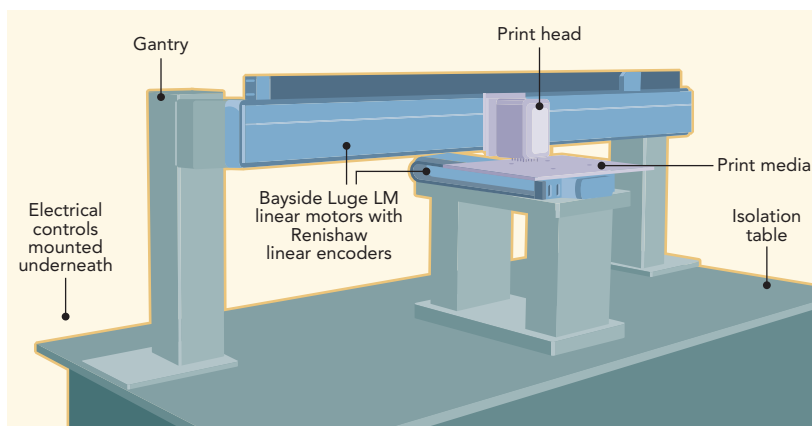
Recently, *Design News* asked engineers from three well-known integrators to walk us through a successful project where wise use of motion control components made the difference.

Test Stand Helps Measure Print Quality

Spectra Inc., a leading manufacturer of large ink-jet print heads for billboards and other commercial applications, wanted a better understanding of the effects of print head motion on print head operation.

To meet that need, the Lebanon, NH company called on Axis New England, a value-added reseller of motion control products and systems for high-tech applications, to design a special test stand. Spectra wanted to look at how lateral acceleration of the print head at high speeds affected ink flow and ink output from the print head. In addition, the test system would help verify the quality of scan printing at high speed and would support print design verification testing and design manufacturing testing in a scan printing environment.

Axis New England (Woburn, MA) provided Spectra with a two-axis, gantry-style motion system consisting of components from four vendors. The solution includes: a high-speed, 1,400-mm, travel X-axis for shuttling the print head, and a 300-mm, travel Y-axis for incrementing the print media. The system had to induce acceleration on a 4 kg print head up to 2G, reaching a velocity of 2 m/sec in 200 mm. In addition, to meet the positional demands of



Axis New England designed a special test stand for assessing print quality of large commercial ink-jet printers. The servo system features linear motors and 0.5-micron encoders for position feedback.

ink-jet printing, it needed a repeatability of 1 micron, an absolute accuracy of 10 micron, and absolutely no backlash.

To answer these stringent requirements, Axis specified Bayside Motion Group's Luge LM series linear motor on both the X and Y axes, with Renishaw 0.5-micron linear encoders for position feedback. The stages were mounted and laser aligned on a custom-

machined steel gantry to provide adequate stiffness. The designers then mounted this assembly to a Newport RS series optical-grade, isolation-damping table. The structure had a natural frequency greater than 100 Hz to eliminate any vibration disturbances that could interfere with the system's positioning and velocity smoothness and cause poor print media output.

For the central controller, Axis engineers specified a Delta Tau PMAC2A/PC104. It incorporates an 80 MHz 56300 series Motorola DSP to provide up to eight axes of motion. Communication capabilities include 10/100 Ethernet, as well as USB2.0 for exchanging data with the host PC software interface in the system. Dual-ported RAM for communications of the PC/104 bus is also an option.

The designers selected this control system for its outstanding servo loop closure and its ability to output a direct PWM (pulse width modulation) signal to Copley Controls' new Xenus series brushless servo amplifiers. These amplifiers can accept the controller's direct single-phase PWM reference signal, which represents the output current required by the motor. This pure digital solution eliminates any control system latency found in traditional analog output servo controls and analog input servo amplifiers.

In short, this control scheme, coupled with a high-resolution linear feedback encoder, results in an extremely responsive servo system that is capable of the demanding move profiles required in this application. —Gregory Ellrodt, senior systems engineer, Axis New England, (781) 937-0411

Customer Goal: Meet Tight Tolerances

INVOTEC, a design and manufacturing firm in Dayton, OH, is used to meeting tough demands from OEM customers, many of them in the auto and medical fields. This time, a manufacturer needed help with production of a stamped leaf spring component.

The part measures about 2.5 inches in length with two "legs" and critical dimensional tolerances on the location of each leg relative to the centerline of the part, both in the X- and Y- plane. However, the supplier's manufacturing process required a combination of stamping, coining, and tumbling operations that was not statistically capable of meeting the required tolerances. The challenge for INVOTEC: Develop a machine that could be integrated into the existing manufacturing line to create the final bend in the spring "legs" in order to meet the dimensional tolerances.

INVOTEC solved the problem by designing a closed-loop forming system that first automatically measures the locations (both the X and Y axes) of each spring leg relative to the part centerline. It then uses the measurement results to iteratively bend each leg in the proper direction and through the proper distance to achieve the required dimensions.

The spring-forming system consists of a single staging fixture, which locates and clamps the spring and shuttles between two bending stations, one for each bending plane. Each bending station incorporates a high-resolution camera and vision processor to provide the dimensional measurements of leg location, along with two servo motor-driven linear actuators to bend each leg of the spring.

The first station bends each leg toward the part centerline established perpendicular to a line running through both legs. The "push"

sequences of the servos are conducted simultaneously—but independently. Each side performs the push sequence until the leg dimension is measured within preset limits. The servo system performs an initial "push" on each leg, followed by an inspection that measures the resultant position of each leg. If the dimension is not within the specified tolerance, an adjustable "push gain" value is added to the push distance, and the sequence takes place again. If the desired dimensions cannot be achieved within five iterations, the component is considered a reject.

Upon initial startup, the servo system performs a teaching operation using the first part run. We purposely set the push position to start wide. The final push position that achieves an acceptable dimension is recorded to establish the starting push position for the next part. This shortens the cycle time for subsequent parts. The design can also adjust "on the fly" for material changes.

When the adjustment procedure for the first axis is complete, the part is pneumatically shuttled to the second station. INVOTES adjusts the forks to a tolerance setting relative to a centerline established during the calibration procedure. The bend tooling at this station pushes the fork in either direction, depending on the initial position of the fork. Similar to station one, upon initial startup, the optimum push parameters are recorded for both axes.

With the second station sequence complete, the system moves the part back to station one to be rechecked for dimensional accuracy and adjusted if necessary. Cycle times average approximately 11 sec per part.

Among the key components in this design is a servo system consisting of Parker thrust cylinders, fitted with Parker NEMA 23 servo motors. A Cognex Checkpoint III machine vision system determines the measurement results and push positions and links via RS232 to a Compumotor 6K4 four-axis controller. An Allen-Bradley MicroLogix 1500 PLC controls the power up, safety control, and pneumatic sequencing, while an Allen-Bradley Panelview 600 performs startup control and e-stop recovery. There's also a separate vision system monitor.

This combination of motion control and machine vision has given the customer a nearly 100 percent yield in the manufacture of this difficult leaf spring component.

Deploying servo controls on the adjustment axes provided the positional accuracy and feedback necessary to adjust the component to meet the required dimensional tolerances. The servos also enabled the system to "learn" from the components processed to minimize the required cycle time and adjust for minor material changes over time. The customer was pleased with the results of the machine development process and is considering development of an additional system with INVOTEC. —John C. Hanna, president, and Timothy S. Osborne, senior controls designer, INVOTEC, (937-886-3232).

Fly High with Flying Carriages

Some motion control designs prove so versatile that they can adapt to a wide range of customer applications.

That's the case with a reciprocating flying carriage, developed by RCS Automation (Rochester, NY), an integrator that designs and builds custom servo-controlled equipment for automated machinery. Typical operations for the carriage include: cutting, sealing, punching, and spraying. The carriage is servo-driven, using ball screw, rack and