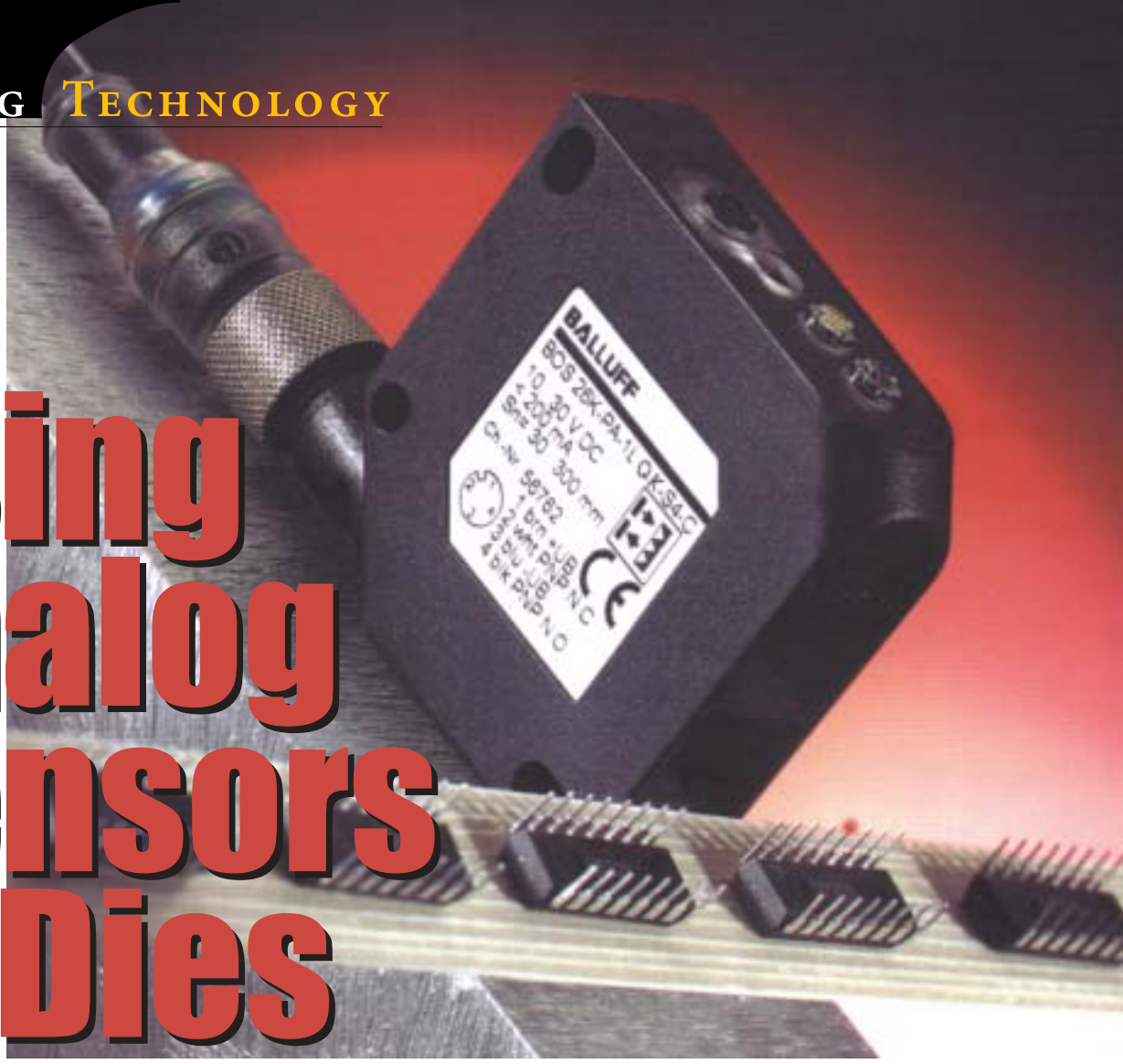
Using Analog Sensors in Dies



Analog sensors such as this Balluff laser unit can be used to measure bend angles. Here the sensor measures the distance to the legs of the chip being formed. The distance then is converted into the bend angle to enable the rejection of bad parts before they ship to the customer.

Analog sensors provide a wealth of measurement data that stampers use to prevent die crashes, prevent bad parts from being shipped to the customer and adjust dies in real time to avoid production of bad parts.

BY TODD WENZEL

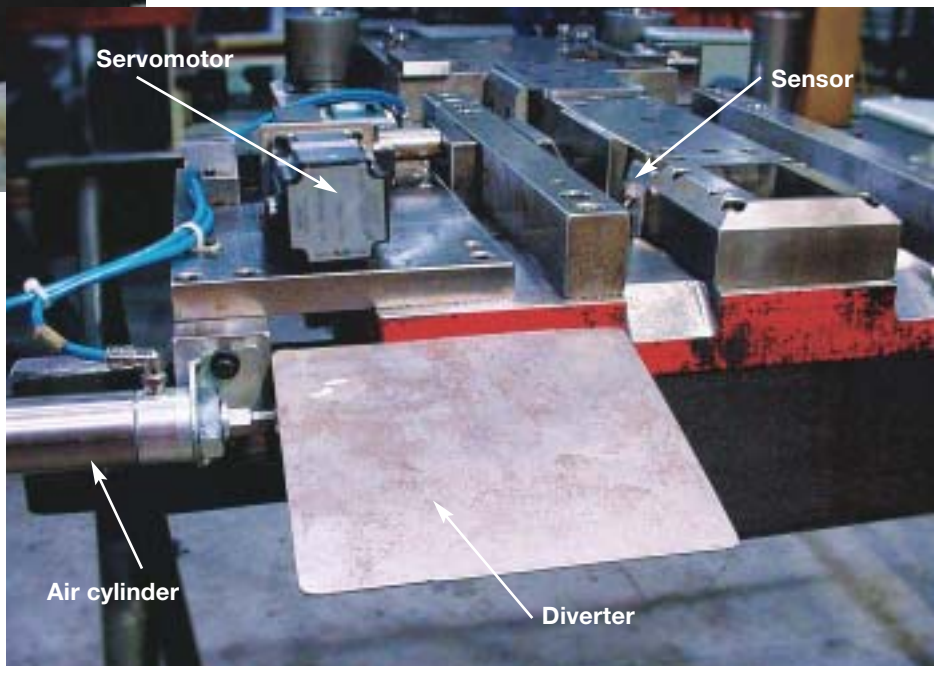
Stampers in today's competitive environment must find ways to improve part quality and make manufacturing practices more efficient. Information technology, growing more affordable and powerful each year, has been implemented to automate many stamping shops and help reduce waste. Stampers harness the power of information technology by using digital sensors in modern dies to gather the data needed to improve profitability, by preventing die crashes and running presses unattended. In fact, some companies move beyond the use of digital sensors and investigate analog-sensor applications.

Before discussing the advantages of analog sensors and outlining basic usage parameters, it's important to understand the difference between digital and analog sensors. Digital output sensors can report one of only two possible states—on or off, indicating the presence or absence of the target. In this discussion, "target" is defined as the attribute or feature the sensor is observing. The sensor's response or "state" is represented as an electrical output. For example, with a digital sensor, 24 volts DC may represent "on" and 0 volts DC represent "off."

Analog-output sensors, however, are not limited to just two responses, but instead provide a range of signal. For distance measurements with an analog

Todd Wenzel is vice president, TCR Integrated Stamping Systems, Wisconsin Rapids, WI; 715-424-3887*; e-mail info@tcr-inc.com; www.tcr-inc.com.*

This Ultra Tool and Manufacturing progressive die (below) incorporates an analog sensor (at station six) to measure inside bend angle and a servomotor (station five) to adjust the form if required to bring the part back to nominal. The air cylinder controls the bad-part diverter to avoid shipping defective parts to the customer. The photo to the left shows the die with the strip in place.



sensor, the voltage increases as the target closes in and decreases as the target moves away. These sensors are called analog because the electrical output directly relates to the target. The control monitoring the sensor then coverts the output into a measurement. Rather than simply indicating whether or not a target is within the sensor's range, an analog sensor can indicate the distance from the sensor to the target. For stampers, this capability opens up a wealth of data to be mined.

In addition to distance, analog sensors can report on force, temperature, sound waves, electrical current, torque and more. Distance and force typically represent the most common applications in stamping dies. When operations such as welding and assembly are performed in the press, other types of measurements become more relevant.

The Goals: Die Protection and Part Quality

The benefits of using sensors in general and analog sensors in particular, to increase profitability, fall into three categories:

- Prevention of die crashes;
- Prevention of bad parts being shipped to a customer;
- Ability to adjust the stamping die in a real-time closed loop to prevent production of bad parts.

Many companies employ sensors to prevent die crashes. The advantages of preventing dies crashes seem clear, but consider the hidden costs associated with crashes. These costs include lost production time as stampers make rapid schedule changes to accommodate interrupted production runs; overtime in the toolroom to perform repairs; overhead for additional toolmakers dedicated to repairs; overtime in the pressroom to ship rush orders on time; and premium shipping costs to expedite late orders.

Fewer stampers use sensors to prevent shipment of bad parts or to adjust tooling on the fly. The impact on manufacturers when bad parts ship to customers needs little explanation. Most stampers supplying large markets such as the automotive industry have heard of or experienced the nightmare of hand-sorting truckloads of parts, sometimes at the customer's site with part-time employees. Such events, if repeated more than once or twice, can result in the loss of an entire contract.

The ability to measure certain key features using sensors is a necessary step in order to eject bad parts or stop a press when a bad part is produced. This data can be used to eliminate shipment of bad parts and create statistical-process-control reports of part quality and variation.

Finally, by investing in the technology to build self-adjusting tooling that responds in real time to part or material variation, a stamper often can use less-expensive material and greatly increase the margins of the job. Due to skyrocketing raw-material costs, the ability to prevent the production of bad parts in the first place is perhaps having the most impact on the metalforming industry. Stampers must strive to minimize the loss of steel or other costly material that must be reworked or scrapped. In the past, if a part had a particularly tight tolerance sensitive to changes in material thickness or yield strength, stampers often would opt to purchase very tight tolerance material, at a significant premium. Today, even the poorest material is expensive and hard to get, and the very tight tolerance material may not be available at all, at any premium.

Measuring Force

Analog sensors that measure force find use in applications where force variation reveals potential problems or

part-quality variation. For example, consider a job that requires the workpiece to be pierced with a relatively small hole. If hole diameter approaches material thickness, the likelihood increases that the punch will be snapped off during production. Traditionally, the operator must check part quality by periodically visually inspecting the work and stopping the process if parts fail to meet specification.

But, by installing a force-measuring analog sensor behind the punch, the sensor then can measure force in every stroke. If the punch snaps off, the sensor will measure a large drop in force on the next stroke. The control that monitors the analog sensor's signal reacts to the change and stops the press before producing any more bad parts.

Using Analog Sensors to Control Bend Angles

Ultra Tool and Manufacturing, Menomonee Falls, WI, implemented a sensor program in 2001. It has invested in analog sensors in progressive tooling to help maintain a competitive edge. "Incorporating analog sensors enhances our capabilities and allows us to provide our customers with parts that might be difficult to produce in standard progressive tools," says Randy Bertram, plant manager for Ultra Tool. The firm offers prototype stamping, die build and production stamping for industries including automotive, recreational, electronic and consumer products.

The use of digital and analog technology allows Ultra Tool to adjust tooling on the fly, automatically adjusting parts to meet specifications or sorting out-of-spec parts into a separate container. Bertram describes the use of analog sensors to produce a particularly difficult component for a key customer.

"The customer required extremely tight tolerances," he says. "By incorporating analog sensors in the tool, we can measure critical dimensions on the fly, and automatically adjust the tool to bring that dimension back into specification if required. It allows us to work more closely with our customers."

According to Bertram, the decision to invest in a sensor program requires an upfront investment and a cultural shift in the mindset of the company. "You have to know going in that you will need to dedicate a toolmaker on a full-time basis to the effort, and retrain your entire workforce," he says. "The long-term benefits are essential to remaining competitive in today's market."

Ultra Tool has two toolmakers dedicated to its sensor program. Once it expanded its program beyond simple sensors, it experienced a significant decrease in die crashes and die maintenance. The company also has experienced dramatic gains in press speed.

"The sensors have helped us maximize our run time, giving us a 30- to 40-percent gain overall and in some cases a 100-percent gain," Bertram adds. **MF**