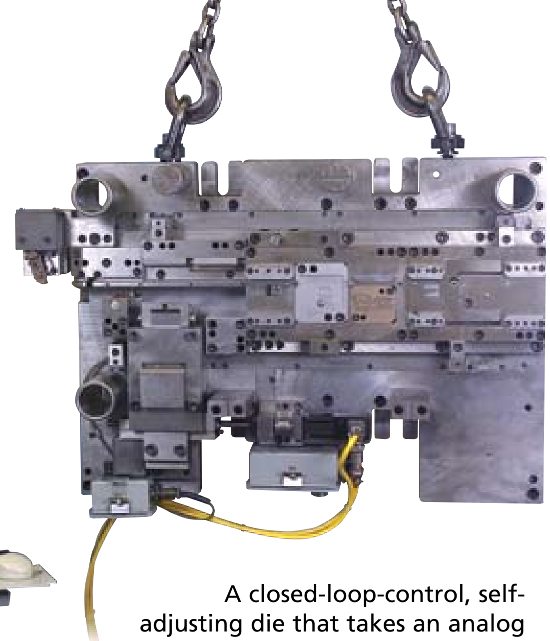
cygnus Business Media

F&M FABRICATING & METALWORKING ©



A closed-loop-control, self-adjusting die that takes an analog measurement and adjusts the servo-motor automatically, if necessary, while the die is running. (Courtesy of Bachman Machine)

THE QUEST FOR ZERO SCRAP

IN-DIE-SENSING STEPS UP IN AN INDUSTRY WHERE MORE PARTS ARE CONSIDERED CRITICAL, AND A BAD BATCH SENT TO A CUSTOMER COULD COST A STAMPER THOUSANDS, IF NOT MILLIONS, OF DOLLARS.

By Tim Heston

In a high-volume automotive stamping operation, what happens if a punch breaks in the middle of a critical job and the company ships a load of parts, some good and some bad? Most likely, the customer sends the shipment back for workers to sort and, on top of this, charges thousands of dollars an hour for the downtime.

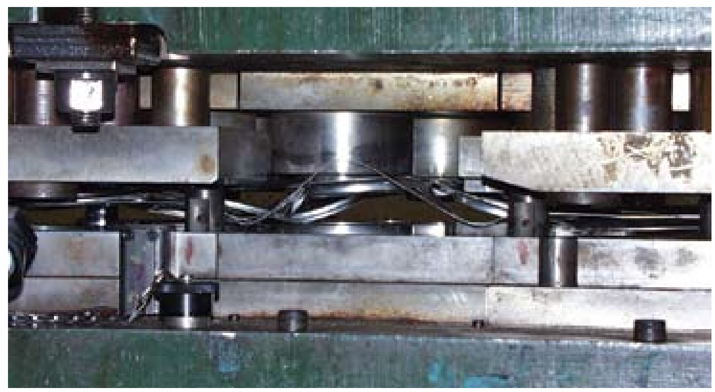
"These situations are really driving sensor use in dies," says James Barrett, applications engineer with Link Systems (www.linkelectric.com), Nashville, Tenn.

Recent demand has pushed greater sophistication within in-die sensing, with more companies making the commitment to invest for critical, high-volume parts. Major stamping players have ventured beyond digital go-no-go sensors into analog technology. Unlike digital's binary output, analog sensors give a sensing range and, as a result, can perform real-time part measurement. Connect these devices to a closed-loop control, and a press can make adjustments in real-time to reduce or even eliminate bad parts.

In the face of global competition and rising material costs, such sensors—now less expensive and with more features than ever—have caught the spotlight in an industry hunting to cut costs.

EVOLUTION OF IN-DIE SENSING AT BACHMAN MACHINE

Saint Louis-based Bachman Machine (www.bachmanmachine.com) could be called an in-die-sensing pioneer. The metal manufacturer offers diverse capabilities, from precision machining and tool-and-die services to stamping and plastic molding. Six years ago, the company became an early adopter of the technology. CEO Bill Bachman and his management team bought into the idea, made the capital investment and turned to Steve Helton to spearhead the program. Digging into his new role as sensor application specialist, Helton communicated with press operators, designers and management to move the initiative forward.



A press-save at Bachman Machine showing a short-feed condition. The die-protection control on the press stopped motion before a die crash occurred. (Courtesy of Bachman Machine)

"Management buy-in is critical for any die-protection program," Helton says, due to the up-front investment. But with sensors integrated into the proper applications, he says, "the payback is just incredible."

As a first foray, Bachman monitored whether material feeds were too short or long for critical applications. Depending on the part thickness and complexity, Bachman keeps material progression within +/-0.010 to 0.025 inch. If the material has camber, or a broken punch or slipped feed roller prevents proper material progression, the sensors catch it. If the die-protection control sees material hasn't reached proper feed length by a pre-programmed amount at a certain point in the stroke, the press will shut down before a crash.

Soon, the company realized a 10 to 20 percent drop in die-maintenance costs. As an example, the sensors eliminated the need to replace the pilots in the dies.

Helton explains: "Instead of allowing the operator to get the feeds set up to where it's semi-close, then working the pilots very hard to pull the strip into proper position before the die completely closes, now the material has got to be [in the proper position] or the press will not run."

Bachman Machine uses sensors on all critical press operations, including the progressive-transfer operation above. (Courtesy of Bachman Machine)

Admittedly, eliminating pilot replacements represents a relatively small savings individually, he says, but over time it adds up significantly.

Soon after its short/long feed sensors, Bachman began monitoring stripper shut height, stopping after the first hit, eliminating the second, third or fourth mis-hit and thus minimizing scrap or damage to the die (the company's presses typically run between 110 and 120 strokes per minute).

Today, Bachman uses anywhere from one to 26 or more sensors on its dies for a variety of critical elements: wipe angles, ensuring cams return before the dies close, checking the form radius in a critical part for an automotive safety system, and so on. Sensors allow on-the-fly compensation for inconsistencies in material thickness and hardness (via sensing variations in springback) throughout the coil and between different coils. Without sensors, material inconsistency could require operators to stop the press and perhaps mechanically shim the punch or die—something that obviously adds to downtime.

Within some applications that integrate progressive and transfer operations, the company may use a sensor on a turntable to check part position. For instance, a part may be blanked out, then a turntable rotates it before it is picked up with fingers and moved with the transfer mechanism. "We'll check to see if that turntable is in proper position, open and closed, and both rotations, clockwise and counterclockwise, and we look to see if the fingers are properly located in the transfer bar," Helton says.

The company builds its own dies in its precision machining department, where sensors are seamlessly integrated. Channels are machined into the die sets, wires are dropped in and caps are placed over the channels to protect wires from damage. To simplify the electronics maintenance, Helton uses a junction box with a one-point connection, no matter if the die has one sensor or 26. "We hook [the junction box] up to our die-protection channel through a quick-disconnect umbilical cord," he says. "If the umbilical cord becomes damaged, we can put another one on there, and we're back up and running right away."

Most sensors at Bachman are inductive proximity devices. Unlike lasers and photo-eyes, these sensors aren't affected by oils or other debris. And they're durable: "Almost all of the inductive proximity sensors I have changed have been physically damaged; they typically don't wear out," he explains.

THE ANALOG ADVANTAGE

Recently, say sources, sensor manufacturers have introduced analog sensors that fit metal forming like a glove. Unlike digital go-no-go units, these give a range of outputs (say, between 0 and 10 volts) that in turn can be converted into specific engineering units (e.g., distance measurements).

"Instead of just knowing whether a particular feature is within my sensing range," says Link System's Barrett, "I can say that the part feature I'm looking for is a specific distance away from the face of my sensor."

The same voltage-to-engineering-units conversion can be made for a bend angle, a part flange or myriad other characteristics. Bachman and others are now use analog-sensor feedback systems that adjust dies with stepper or servo motors in real time to, for instance, accommodate springback.

When choosing analog sensors, Helton looks for the linearity of the analog curve. During testing, he analyzes the output proportional to the displacement of the sensor's target. "And you want that output [analog curve] as straight as you can per X amount of displacement," he says.

Put simply, the straighter the analog curve during displacements of its target, the more repeatable the sensor. "Today, industry is making more economical, durable sensors that have a good, straight linearity to it," Helton says.

Integrating these analog sensors, Bachman crawled before walking. Using third-party software, programming is icon-driven and straightforward, yet the learning curve was steep. Early on, the company hit some obstacles during offline tests, with timing issues that caused programming loops, locking the software.

"Each element of the program had to start and process at the right time, as we manually patched these programs together," Helton explains.

SIMPLIFYING MATTERS

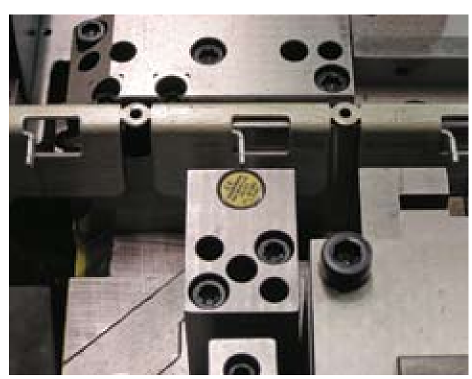
Programming sensors with third-party software can, when mastered, produce some extremely powerful results, Barrett says, but paying attention to detail is extremely important. Consider measuring a bend angle. For reliability, measurement should happen after the bend but before the strippers release the material. Manually programming the sensors, "you have got to set an angular window where the reading is valid," he says. "Then you have to write the translation between voltage and engineering units. Next, you must decide what to do based on the information—move the servos in the die a certain amount, etc., if you want a closed-loop control; or provide a mechanism that will determine whether a certain part is bad at a specific station, usually three or four stations before the actual kick-out station, where the part is ejected. A lot gets tied in. Conceptually, it's not too bad, until you get into the nitty-gritty details—then you have to make it all work at high speed."

Link Systems, together with Bachman Machine, will be demonstrating an intricate analog sensing application at the Metalform show (www.metalform.com) in Chicago next month that attempts to simplify this. In-die-sensing programming is integrated directly into the control package, eliminating much of the manual programming previously required, according to Link.

Within this new system, the sensors must be taught upper and lower limits (a shortest and longest allowable part, for instance). It also uses a so-called "bad-parts-in-a-row" limit, and a limit that only allows a certain number of bad parts in a selected number of strokes—six or seven parts within a group of 100, for example. This helps eliminate the obvious danger of such sensors: "You don't want to set up, walk away, then come back and find 1,000 parts in the reject bin," Barrett says.

Consider a part with a feature that should be 1.000 inch +/-0.005 inch as the allowable dimension. Using this control, a setup person would tell the system how many strips run through the die (two part-out, three part-out, etc.) and how many stations the die has. Each part-out and each station now becomes a "tracking point." He then tells the system what input the sensors need; certain sensors may read, say, 4 to 20 milliamps, some 0 to 10 volts. (The control, says Barrett, can accommodate a variety of different sensors, from photo-eyes and inductive-proximity sensors to thermocouple and strain-gauge devices.)

Next comes the translation of these electrical units into engineering units. The program allows a setup person to establish only two



An analog sensor in a self-adjusting die. (Courtesy of Bachman Machine)

A control from Link Systems integrates in-die-measurement setup and programming. (Courtesy of Link Systems)

high/low limit sets: one that warns that a part is starting to vary, then another that, depending on the operation, can either stop the press or mark the part as bad. The warning limit for the 1.000-inch example might be 0.997 inch on the low end and 1.003 inch on the high end; the stopping limit would be 0.995 and 1.005 inch. "These limits can often be taken right off the customer print," says Barrett.

Then the setup person would choose the action to take at those limits—be it real-time adjustments, bad-part ejections or press stoppages—and at which stations the actions should occur. Under a closed-loop system, for instance, the warning limit could signal the servo or stepper motors to make adjustments to account for part variation. If a part has a bend at least 0.1 degree larger than it should be, the servo-motor will bump, say, six counts to accommodate for the error and, some number of hits later (depending on where the adjustment station is in relation to the measurement station), the system will again check the part and possibly make a further adjustment. If a part is marked "bad," the sensor may be at, say, station "five"; a programmable limit switch at station "eight" can then eject the bad part.

The system also tracks parts going through, and also allows automatic toggling between separate bins. "Say we have two bins on the press output," Barrett says. "I can set the programmable limit switch to toggle every 100 parts and switch to a diverter ... which shifts over to another bin automatically without stopping the press."

Sources emphasize that all of this has been done for years with third-party software, which some concede gives users more power and flexibility. But the learning curve can, depending on the application, be steep. The new control to be introduced at Metalform attempts to integrate in-die sensing so that a setup person does not have to be an experienced programmer to initiate an in-die-sensing operation.

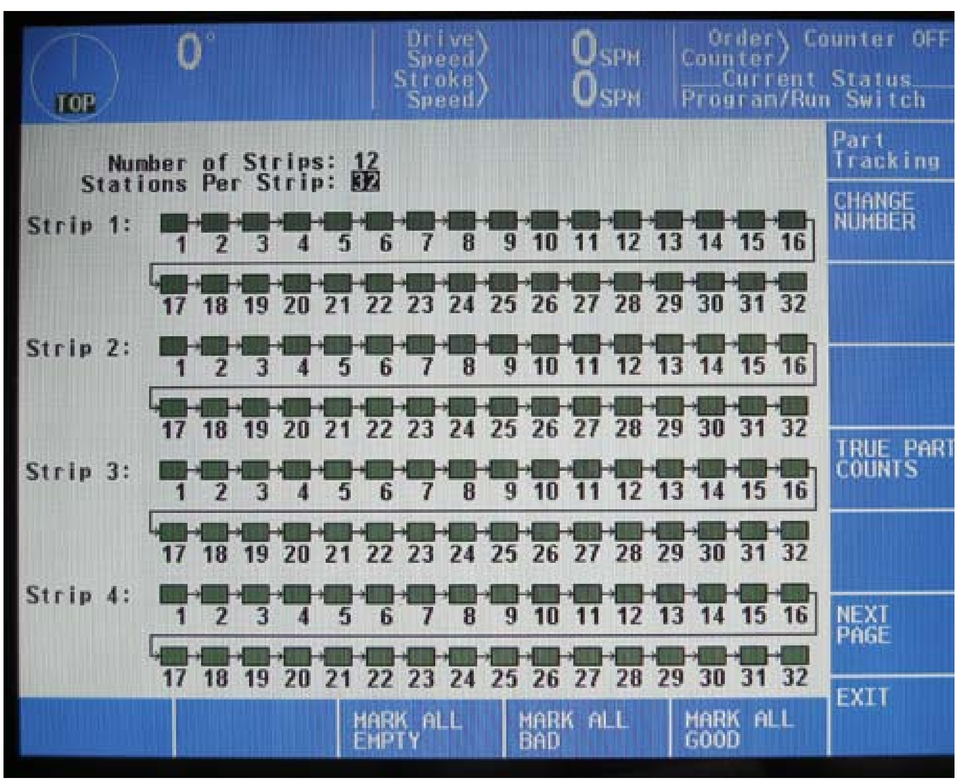
THE ULTIMATE GOAL: ZERO SCRAP, ZERO BREAKDOWNS

The industry has seen a relatively slow progression toward in-die sensing, though there has been a significant up-tick in demand for the technology as scrap becomes more and more expensive. "The technology is following a similar path as traditional die protection and tonnage monitoring," says Thomas Mascari, vice president of engineering at Link Systems. "Those technologies did not immediately catch fire. Nobody likes to pay for equipment, but we do like to save money."

Another driver, says Mascari, has been upgrades in microprocessor and signal-processor technology, making real-time adjustment more "real time" than ever. If a bad part is detected, within milliseconds the system either shuts down or corrects the problem.

I SEE US USING MORE SENSORS EVERY PLACE WE CAN, WHERE IT MAKES ECONOMIC SENSE. IF THERE'S A MOVING MECHANICAL PART THAT CAN FAIL, WE'LL CHECK IT.
—STEVE HELTON, SENSOR APPLICATION SPECIALIST, BACHMAN MACHINE

For high-volume, critical work at Bachman Machine, such technology can make the difference between keeping and losing the contract, particularly in the competitive automotive market. "In three to five years, I see us using more sensors every place we can, where it makes economic sense," concludes Helton. For those applications, "if there's a moving mechanical part that can fail, we'll check it."



A control tracking parts, here in an operation with 12 strips and 32 stations. (Courtesy of Link Systems)

LINK Systems®

IT ALL ADDS UP...

Q^{P} + $engr^{exp}$ + sales/service + $(soa)_{tech}$ = LINK

Quality Products
Engineering Expertise
Service after the Sale
\+ State-of-the-Art Technology

= One Clear Choice

LINK IS THE ANSWER

The **OmniLink 5000 and OmniLink II Press Automation Controls from LINK Systems** can enhance the productivity, competitiveness, and profitability of your stamping operations with a tailored array of Process Control, Die Protection, Monitoring, Programmable Limit Switch, Job Storage and Recall, Communications, and other capabilities to supplement or replace your existing press controls. These integrated systems use distributed intelligence in a flexible modular design whose functions are programmed and displayed by the large OmniLink II Color Operator Terminal.

At **LINK**, we work with YOU to find the optimal solution to all of your stamping applications. We would like for YOU to become one of our latest success stories.

LINK SYSTEMS 32 YEARS NASHVILLE, TN 1972 2004

LINK SYSTEMS

444 McNally Drive, Nashville TN 37211 Tel: 615-833-4168 Fax: 615-834-1984

www.linkelectric.com