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Setting up a die sensor program

Starting up a die protection program

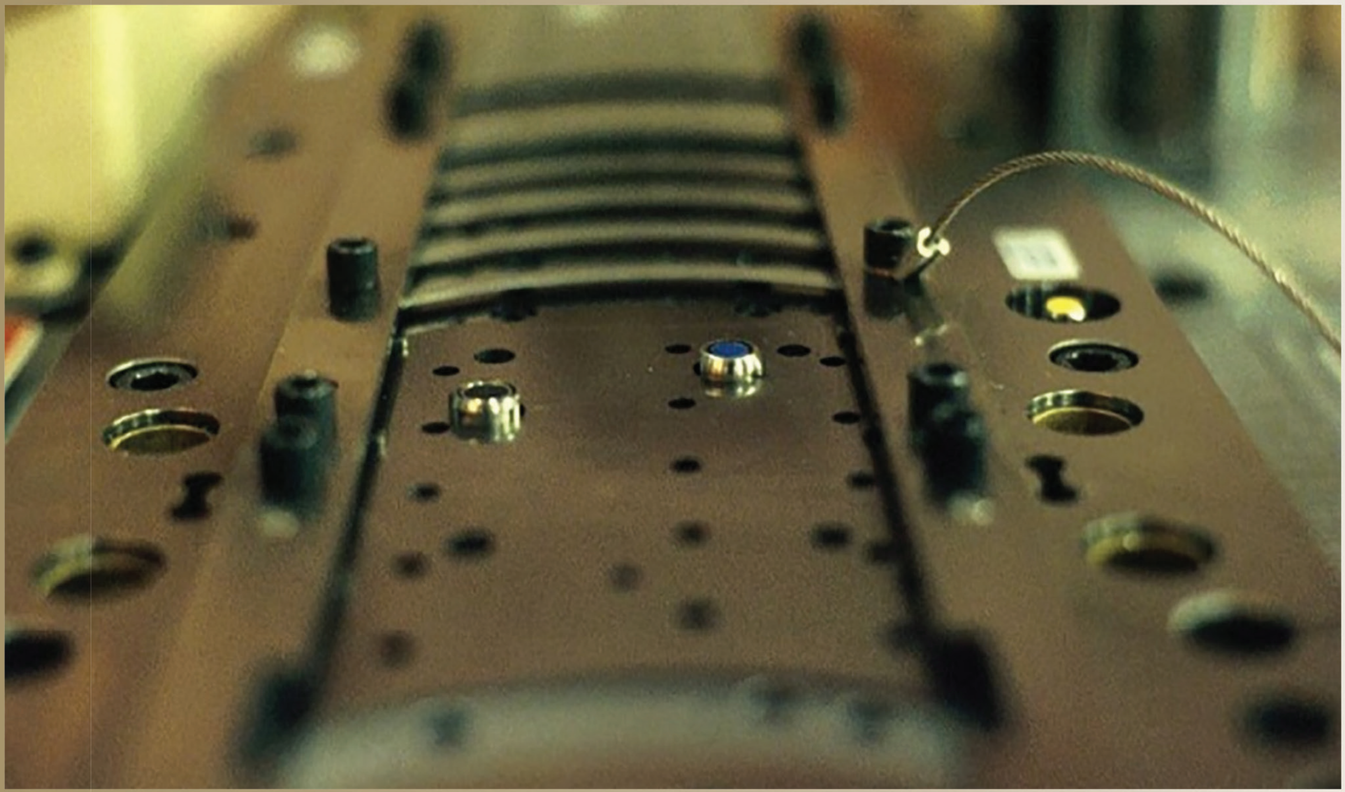
5 steps to prevent damage to tooling, press

By Jim Finnerty

The term die protection describes an electronic system that uses simple switches or sensors installed in and around the press and tooling to monitor critical events in the stamping process. The sensors are placed so that they detect problems with enough time to stop the press before the die closes, thus preventing damage to the tooling and the press.

The primary goal for die protection is to detect problems and stop the machine before damage can occur. When you compare different types of press monitoring equipment, you will find that there is no quicker ROI than having a properly implemented die protection system. The very first time that a die protection controller stops the press in time to prevent a die crash, it has probably paid for itself.

Implementing a successful die protection program is a multistep process, and proper implementation requires a plan.



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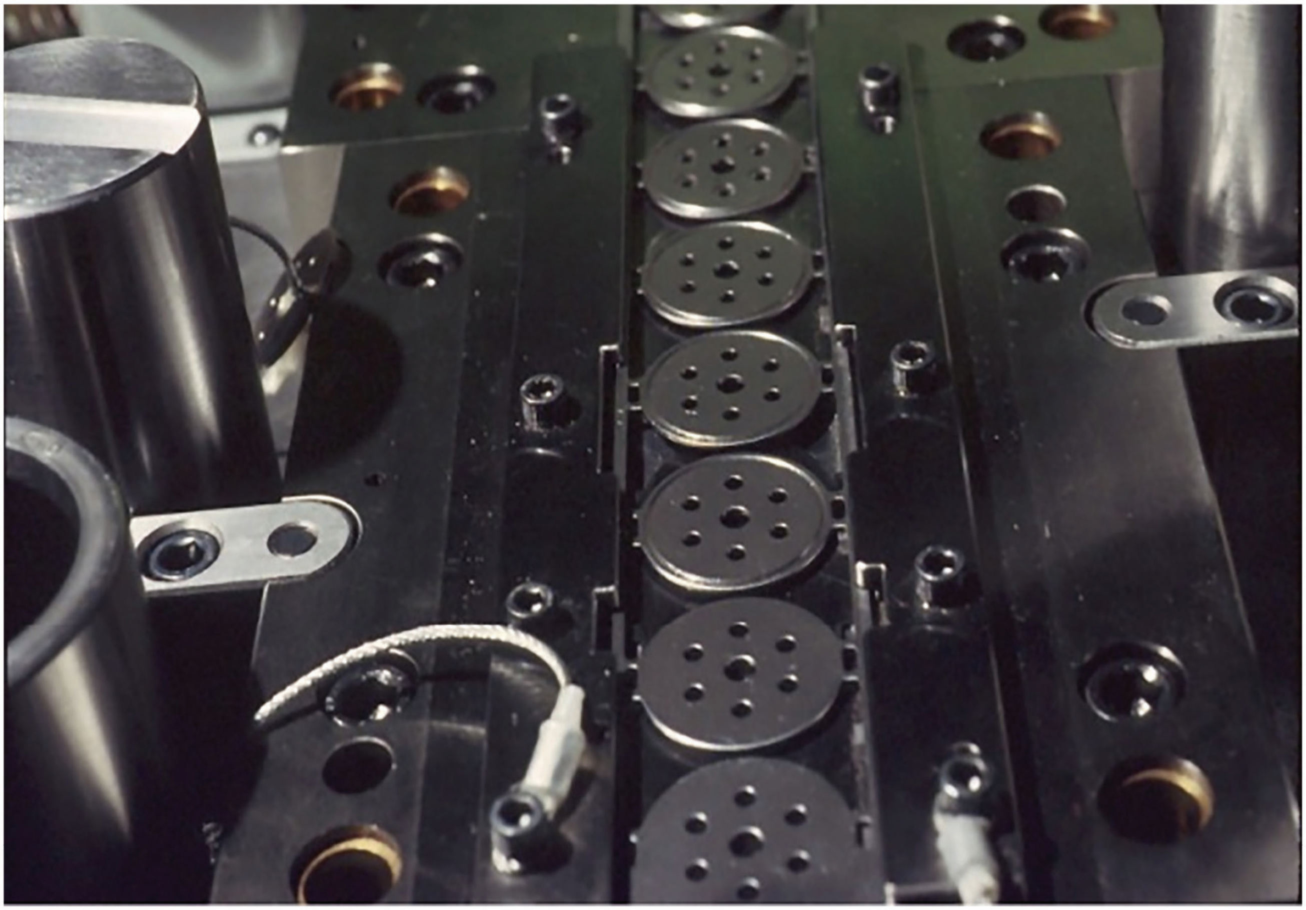


The best-practice connection method is to use an intermediate die-mounted junction box to which all the sensors are permanently wired.

1. Select a Control System

The most important factors to consider when selecting a die protection controller are capacity (for both sensor inputs and setup memory), accuracy, speed, available monitoring logic, and ease of use.

A typical progressive die needs a minimum of four or five sensors to detect common predictable malfunctions: end of material, material buckle, short feed (and possibly overfeed), and failed part ejection.

Review your die maintenance and quality control (QC) records to identify other problem areas. If you find recurring die malfunctions or quality problems, plan to install sensors to detect them also.

Keep in mind that some problems require multiple sensors for detection. For example, you can detect pulled slugs by installing sensors in the bottom die under each corner of every spring stripper. Transfer operations are also sensor-intensive, typically requiring two sensors per station. Select a die protection controller with enough inputs to monitor what you anticipate being your most heavily sensored die, plus a few spares.

Ensure that the controller has sufficient setup memory to store setup information for all the dies that can be run in each press. The controller should also provide a way to conveniently back up your settings, as it can take years to create settings for all your dies.

Modern resolver-based controls are precise and fast. Resolver timing signals are typically accurate to one-third of a degree of crankshaft rotation. It is important to choose a high-speed die protection controller even if you run at low to moderate speeds. This is because some sensor actuations are short, regardless of how fast the press is running. Picture an air-ejected part flying past a photoelectric sensor. Such a sensor signal may be less than 10 ms in duration.

Ensure that the control system has the monitoring logic needed for your applications. Some sensors need to be monitored continuously to make sure they are always off, such as for material buckle; or on, such as to detect the end of material. Some sensors should have brief, momentary actuations during a specific timing window such as for part ejection, while others should stay actuated for a specified portion of the cycle. This would apply to detect material feed until the pilots have captured the strip. Still others should be monitored so that they are actuated only during certain portions of the cycle—especially sensors that monitor things such as side-action cams, transfer mechanisms, and air cylinders.

Finally, in addition to the expected failures, your control system should be able to detect malfunctioning sensors, such as when a cyclic sensor is shorted or otherwise stays actuated for an entire stroke. For example, if a part fails to fully eject, but instead "sticks" in front of the sensor, the controller needs to have the ability to determine when a cyclic sensor fails to cycle. This is often called "fail-safe detection."

2. Develop a Sensor Connection Scheme

Sensors must be connected to the controller.

Press-mounted sensors that are used on every job, such as material buckle and end-of-stock sensors, can be hard-wired to the controller permanently. These sensors do not change from job to job, so there is no need to provide a means to connect them at run time.

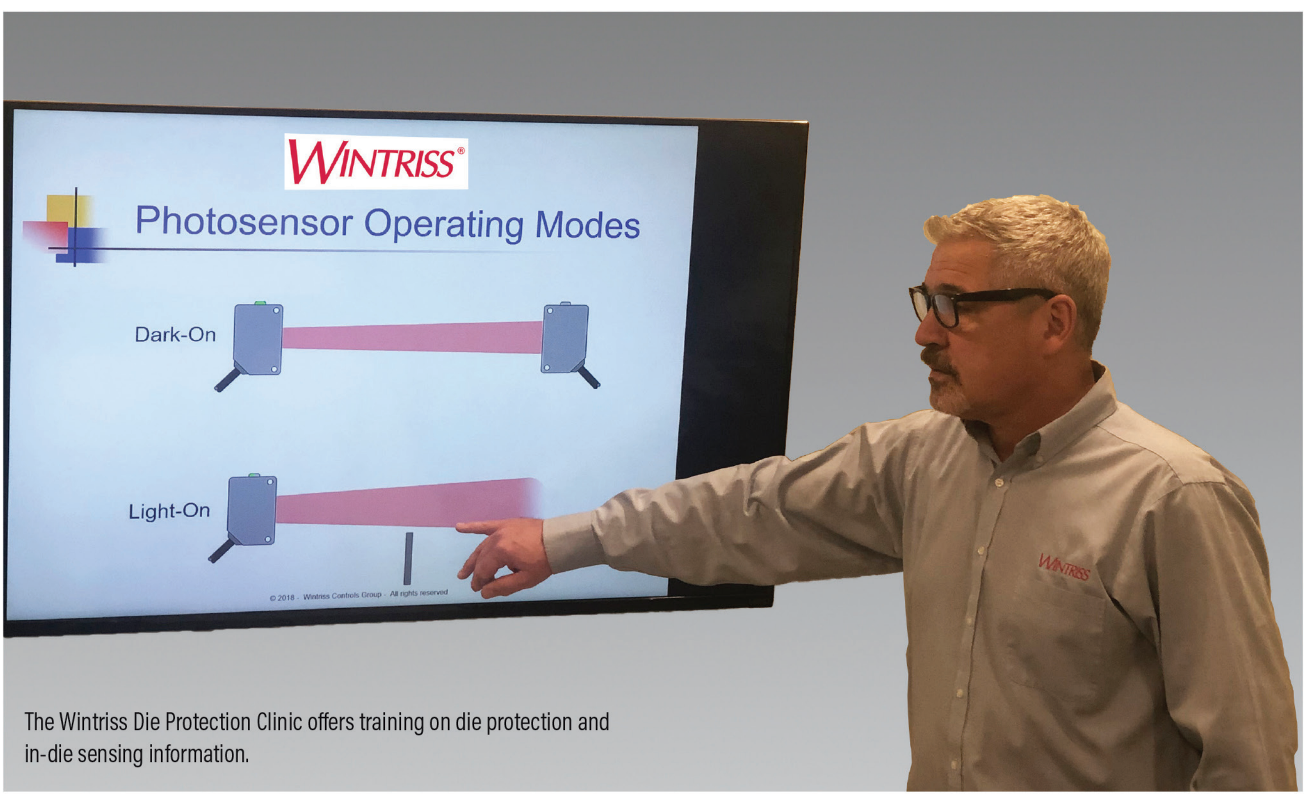
Die-mounted sensors are a different story. When a die is changed, sensors such as those detecting part ejection, misfeed, stripper position, cam return, and so forth need to be connected to the controller during setup. It is impractical to wire die-mounted sensors directly to the controller. Instead, a press-mounted sensor interface device is wired to the controller and placed close to the die area.

Typically, these devices feature connectors to accept individual sensors, as well as a master connector that enables power and sensor signals from an array of sensors to connect through a single cable. This is usually done from a die-mounted junction box. In addition to being a convenient connection point for the sensors, the interface device provides 24-VDC power for electronic sensors. It may feature pulse-stretching for short sensor signals. Also, the interface device may offer impedance-matching circuitry to enable the use of simple electromechanical sensors such as spring probes with water-based lubricants.

Importantly, something as seemingly trivial as die wiring can make or break the entire implementation process. Poor wiring practices can ruin an otherwise well-planned die protection program. There are two ways to connect die-mounted sensors to the interface device.

The first, called the traditional sensor connection method, which uses individual sensor connectors on the interface device, is troublesome. This inefficient wiring scheme requires each sensor to have a length of cable attached to it that is long enough to reach the press-mounted interface. When the die is not in use, these permanently attached sensor cables are hastily coiled up and stored with it. At run time, they are uncoiled and plugged into the press-mounted interface.

Sensors more often need to be replaced because of damage to the cables than all other sensor failure reasons combined. In addition to the possibility of catastrophic physical damage to a loose cable, it is critical to consider cable "wear." In this context, this does not refer to abrasion, but rather, to work hardening. Most sensor wires are made from copper, which work-hardens quickly. Work hardening occurs when a metal is cold-bent repeatedly. Each time a cable is flexed, the copper wires inside become harder, more brittle, and will break inevitably. It is the repeated



The Wintriss Die Protection Clinic offers training on die protection and in-die sensing information.

coiling and uncoiling of the sensor cables that will cause failure.

The traditional method of connecting one sensor at a time also is inefficient. The setup operator needs to ensure that each sensor is plugged into the correct input. Mistakes can lead to nuisance stops and die crashes.

The second best-practice connection method is to use an intermediate die-mounted junction box to which all the sensors are permanently wired. The die-mounted box is plugged into the master connector on the press-mounted interface through a single, easily replaceable cable. This eliminates wiring errors and sensor cable wear. Standardization is important here. You should use the same setup on every die and every press.

You can purchase a die-mountable junction box, or you can make your own with an enclosure, terminal strip, and connector. Either way, be sure to select components and devices that can withstand the rigors of in-die use. If the sensors are installed in the die in such a way that they must be removed when the die is serviced, consider using a die-mounted junction box with connectors for the individual sensors. That way, you will not have to disconnect and reconnect wires on a terminal strip each time the die undergoes maintenance.

Junction boxes should be located on the die in such a way to protect them from accidental physical damage while the die is being handled. Placing the junction box on top of the lower die shoe is better than installing it on the side of the die or underneath it.

With sensors installed in and around the tool, Wintriss DiPro 1500 signals the press to stop if malfunctions such as improper part ejection and misfeeds are detected.

Press-mounted sensors that are used on every job, such as material buckle and end-of-stock sensors, can be hard-wired to the controller permanently.

3. Set Up a Sensor Lab

Companies embark on die protection implementation programs with varying levels of success. Whether it's a big-budget, plant-wide program involving a team of people or a one-person pay-as-you-save ROI-based implementation, some programs succeed while others fail. All programs and approaches are a little different, but there is one step in common among the successful users: Bench testing.

The best way to ensure that a sensor will work in the die is to try it out on the bench first. A well-stocked sensor lab will likely pay for itself the first time that one of those good-on-paper ideas proves to be ineffective in practice. The worst (and most expensive) place to prove out sensors is in the press when the die should be in production.

Your sensor lab should be in a quiet area of the plant. Many are in the QC department. It should be equipped with the following items:

24-VDC Power Supply. Virtually all die-protection controllers are 24-V systems, and nearly all electronic sensors can run on 24 V. To test sensors, you need to power them.

Voltmeter. Most electronic sensors feature LEDs that illuminate when the sensor is actuated; however, sensors often are installed in mounting blocks that make it impossible to see the indicator. A voltmeter will show you when a sensor actuates.

Accurate Positioning Device. Selecting a mounting location for a sensor required to detect material feed to within ±0.005 inch (in). cannot be done by the human eye. A 3-axis, micrometer-controlled staging table provides the precision needed to ensure that sensors will be installed in the right place.

Extensive Sensors Inventory. There's an old saying: "When the only tool you have is a hammer, every problem starts to look like a nail." If your bench-testing regimen is based on a limited number of sensors, you will be far more likely to select a marginal solution and shoehorn it into an application. An extensive selection of sensors for the test bench enables you to keep looking when something isn't quite right.

4. Establish Application Guidelines

Die protection programs will almost always fail if nuisance stops are allowed to occur on your machines. A nuisance stop is a machine stoppage that is initiated by the die protection system even though no real problem exists.

Nuisance stops almost always result in eventual die damage—but not directly. They cause machine operators to lose confidence in the system to the point where they will ignore real errors. In some cases, the nuisance stops are frequent enough to adversely affect production, and the operators turn the entire system off.

Here are some common causes of nuisance stops and how to avoid them.

Something as seemingly trivial as die wiring can make or break the entire implementation process.

•Sensors that must be installed at run-time. The only two things a press operator should have to do to set up the die protection system are to select the correct program on the control and plug in a single cable. If the operator is required to locate, install, and adjust sensors that you move from die to die, the likelihood of a correct setup drops precipitously.

Rather than moving a sensor from die to die, permanently install a sensor on each die that needs it. Compared to die crashes, sensors are cheap. Even without a die crash, the additional setup time required to install and adjust sensors will quickly offset any savings realized by not buying a sensor. To spin a phrase by Henry Ford, "If you need a sensor and don't buy it, then you will ultimately find that you have paid for it and don't have it."

•Adjustable sensors. A properly installed sensor will never have to be moved or adjusted. Problems arise when sensors are installed so that they're "in the ballpark," with the expectation that the press operator or setup person will do the final adjustment when the die is in the press. When your main goal is to just get production running so you can make parts, the final sensor adjustment often ends up being less than ideal. This can result in frequent nuisance stops or poorly protected dies. Proper bench testing can eliminate the need for run-time adjustments.

•Tolerances that are unnecessarily tight. Modern electronic sensors are amazingly precise and accurate. When an inexpensive off-the-shelf proximity sensor has a repeatability of less than one-hundred-millionths of an in., it is easy to install sensors that will stop the press with misfeeds as small as 0.001 in. However, just because you can doesn't mean you should. If your feeder can hold a tolerance of ±0.005 in. and you install your sensors to detect a misfeed of ±0.003 in., you are going to experience nuisance stops.

The whole premise of die protection is to detect die-threatening events and stop the press. If your die is designed so that the pilots can align the strip if it is misfed by ±0.020 in., any feed progression within that 0.040-in. window is not die threatening and should not be detected by the feed sensor(s). You should use up all the slop you can when you install the sensors. This will make setups more forgiving and nuisance stops less frequent.

5. Develop an In-house Champion

In addition to making proper connections, establishing a sensor lab, and following application guidelines, it is very important to assign a champion to ensure the success of your die protection program.

While controller and sensor manufacturers can provide helpful initial guidance, they cannot fully implement your die protection program. For that, you will need to develop an in-house subject matter expert to be the program champion. Most successful die protection programs have one person responsible for spearheading the program, selecting and testing the sensors, wiring the dies, and programming the controllers. In fact, to gain knowledge in "all things die protection," your champion can access a variety of resources such as the tips offered this article and a comprehensive online Die Protection Clinic.

By following key guidelines and having dedicated in-house support, you can set up your die protection program for success.

Jim Finnerty is product manager at Wintriss Controls Group, www.wintriss.com. Finnerty has more than 40 years of experience in the metal stamping industry. He is responsible for new product development as well as die protection and sensor technology. Finnerty created the Wintriss Die Protection Clinic to provide in-die sensing information and training and has helped manufacturers implement die protection programs for over 25 years. He has presented at trade shows, conventions, and technology conferences and authored dozens of articles on controls and monitoring technology for the stamping industry.