

By Roger Patton

Editor's Note: This article is Part I of a two-part series on stamping in-die operations. Part II, which is a case study of a fabricator that installed an internally designed in-die welding system, will appear in the September issue of The FABRICATOR®.

The domestic stamping industry faces unprecedented challenges, including foreign competition, alternative processes, just-in-time (JIT) delivery schedules, zero defects requirements, close tolerances, abrupt market shifts, and price-sensitive customers. Additional pressures emerge from investments in capital equipment, relatively high labor costs, and mounting levels of risk.

How can a stamper compete? From an operational perspective, one effective strategy can be to combine operations wherever possible, such as inserting fasteners in-die.

Most stamped components eventually become part of an assembly, and in most cases, these assemblies require fasteners. Self-clinching fasteners—which are being used with increasing frequency—become a permanent part of an assembly and reduce the amount of hardware to be handled down the line. By installing fasteners in-die, stampers gain an opportunity to expand capabilities, increase productivity, reduce labor costs—and if



Stampers can stamp and install fasteners on parts such as this busbar assembly on the same stamping line using in-die processes.

In-die processes empower double-duty stamping

Part I: In-die insertion of clinch fasteners

used with in-die inspection—enhance process control.

In-die System Basics

In-die fastening systems generally consist of five primary elements: the feed system, timing system, sensing system, control system (including the operator interface), and in-die tooling (including the die heads and anvil assemblies).

Feed System. Typical feed systems consist of vibratory feeder bowls with inline tracks and fastener escapements. The feed system's purpose is to orient, singularize, and then deliver the fasteners to the die heads on demand as dictated by the timing system.

A mobile system adds flexibility because it enables

quick placement for a production run and removal when not in use. A quick-connecting system may streamline changeover time.

Timing System. An array of sensors that link the action of the press and die with the feed system to maintain the necessary timing comprise the timing system. Its function is to maintain synchronization of the feed system with the press, adjusting the feed rate and timing of the feed system so that the fasteners are fed at the appropriate time.

Sensing System. Integrated with the timing system, the sensing system senses the presence of every fastener before installation and then senses for the proper installation of the

fastener in the installation station.

The control system uses the feedback from the sensing system to verify that the process is running properly and that fasteners are installed correctly. If at any time during the process the sensing system detects a fault, it alerts the control system, which stops the process. Without a sensing system, the operation would run blindly. Dies would be damaged, and parts would be defective as a result.

Controls and Operator Interface. The control system is the backbone that unites all subsystems, including the feed system, the die, and the press. The control system also interfaces and communicates with the press operator.

In-die Tools. The tools require close scrutiny. Each set of tools must be uniquely crafted for the individual characteristics of the piece part and the die in which they will operate.

In most circumstances, it is best to engineer tools into a die during, rather than after, the design process. Uncomplicated designs and few moving parts enhance dependable operation. Modular construction and portability allow the unit to be attached or removed, simplifying troubleshooting and repair. A quick-connect to the feed system allows maintenance or replacement without pulling the die from the press.

Installation

Evolving technology offers

the means to introduce in-die fastener feeding systems into almost any operation. Factors to consider include *type of fasteners* to be installed; *number of different types of fasteners* to be installed; total *amount of fasteners* to be

shut height, and speed of the operation. For example, operations such as stud insertions from the bottom up typically require greater pressure pad travel and strip lift than required normally.

Performance Expectations

Cycle times of up to 60 strokes per minute (SPM) are typical. Faster speeds are attainable but require options that can add substantial cost. At some point the question about attainable speed changes from what is technically achievable to what is economically viable.

Because clinch fasteners can be inserted with in-die operations in many applications, it is difficult to generalize about performance data without knowing the specifics. Variables such as fastener type, fastener size, clinch profile, host material, and piece part configuration all affect the performance.

Almost any material type and thickness used in stamping operations can be used. Occasionally very thin materials do not meet the minimum material thickness requirements for some types of clinch fasteners. In addition, some materials are harder than the clinch fastener itself. By design, the host material must be softer than the clinch fastener to allow the fastener to be pressed into the sheet. This situation is encountered most commonly

with some of the harder stainless steels.

From a practical standpoint, an optimal in-die application includes one or two different types of fasteners and no more than four or five fasteners inserted per press stroke. They should be inserted in the same plane or on two planes. Each fastener type requires its own feeder bowl. For applications requiring many different fasteners, the system can get unwieldy and expensive because of the large number of feeder bowls that would need to be configured.

However, a configuration of feeder bowls with *multiple* feed lines is manageable and cost-effective. For example, a piece part requiring three each of two different fasteners would require a configuration of two feeder bowls, each having three lines of feed. Then again, a piece part requiring the same total number of fasteners, but each being a different fastener, would require six separate feeder bowls. Although this type of system could be built, practically, it would be a challenge to maintain and operate, not to mention the expense associated with six separate feeder bowls.

An application that requires three insertions of an M6 nut per press stroke, with all fasteners installed from the top, and adequate clearance for the die heads, anvils, and feed tubes at 60 SPM or less is a workable system. On the contrary, an application that requires five or six different

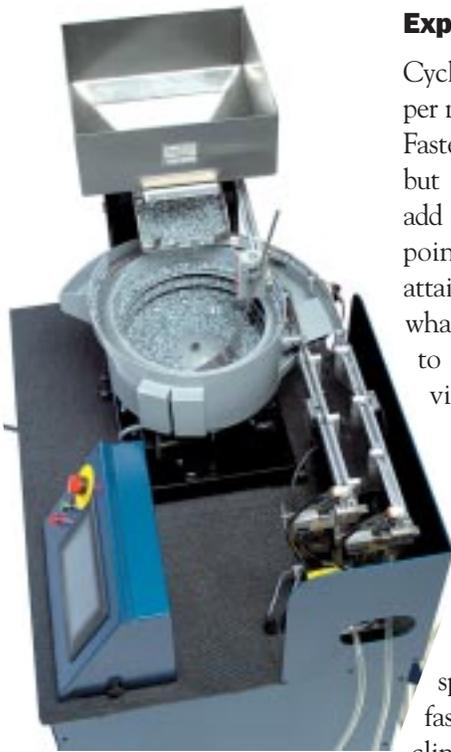
types of fasteners in 10 or 12 different locations with a required speed of 80 SPM would be unwieldy.

In these cases, special offline automated assembly machines may provide an alternative—if the volumes are great enough to offset the expense. On low-volume applications, a standard automatic feed press system may be an alternative.

Additionally, some systems are equipped with a closed-loop sensing system, onboard self-diagnostics, touchscreen operator interface, and a library of online help screens to simplify and minimize troubleshooting.

However, over the years experimentation and experience have shown that if the application utilizes the proper clinch fastener, the proper hole size in the workpiece, the correct host material, sufficient installation force, and adherence to critical dimensions (such as center-to-edge distances), the quality that can be achieved in an in-die insertion matches or exceeds that which can be achieved through any other method.

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A portable in-die fastener feeding system integrates modular construction, quick coupling of components, and in-press removable tooling.

installed per press stroke; *speed of the operation*; *direction of installation* (down from the top, up from the bottom, CAMs attached from the side, or on compound angles); and *footprint of the tooling* required to insert the fasteners.

These factors can have an effect on die parameters such as the die station used for the insertions, stripper travel, pressure pad travel, strip lift,