

Speed Up Die Changes Safely

Fast, safe die changes produce more parts and more profit. Here's what to consider for today, as well as a look into the pressroom of the future.

By Art Klein, Editor

"In order to make maximum use of their presses," says Paul Pfundter, CEO, Red Stag Automation (Crivitz, WI), "quick die change has progressed from simple die clamping and positioning to complete changeovers of entire systems for maximum manufacturing flexibility. In many systems, special tooling and fixtures are involved. These systems are making use of space above the shop floor to minimize floor space use and maximize volume."

Considerable mechanical and software engineering is necessary to implement today's quick die change concepts. "Many components weigh from 7000 to over 60,000 lbs (3150 to 27,000 kg). We find our customers want production levels of 75-85%, with six to eight changeovers a day."

Although many people talk about just-in-time delivery, Red Stag has found it necessary to queue purchased items and raw material. "It has been our experience," Pfundter reports, "that production scheduling is subject to instant change. It's our opinion that quick die change has taken on a completely new perspective and importance."

Red Stag's experience has been that the complexity of each customer's environment calls for the flexibility to use standard components when developing a customized system. "It's important that we have full knowledge of our customers' short- and long-range goals, so we can operate as an extension of their engineering groups."

Quick die change calls for total understanding, from top and middle management, to factory-floor personnel. "There must be a company-wide commitment to a quality system with long-term flexibility and short-term payback on the investment," he concludes.

The preceding comments illustrate why quick die change is important. When presses are not making parts, they are not making money. In this era of reduced inventories and the constant need to make small batch sizes, stampers need to change dies more often. The less time a die change takes, the faster the press can start producing again.

The effect on the bottom line is determined by how long the press is idle. Nonproductive time starts from the moment the last part in a production run is made to the moment the first new part pops out of the new die set. Yes, there are real costs in bringing a new die to the press so it is in position to be quickly loaded. And, of course, there is the expense of returning the first die to storage and hauling out the third die to be ready for quick installation. So the problem divides itself into two parts: getting dies to and from storage, and how to get them in and out of the press quickly.

In and Out of the Press

Besides the fact that a quick die change system will reduce part-to-part die changeover times, it also needs to function safely, with minimum risk to operators.

One facet of providing a safe die change environment involves moving and locating dies under controlled conditions with minimal effort. When dies were moved in the past, it meant skidding metal against metal. This required prying, pushing, and pulling dies into and out of the press with fork lifts, chains, prybars, and sledgehammers.

If, however, this same die was supported on ball or roller lifters, it could be moved safely and easily, and possibly controlled and located by one person with a fraction of the effort.

Ball-type lifters riding in a nest of ball bearings allow movement in any direction, while reducing the amount of force required. A 1000-lb (450 kg) die would require only 20 to 40 lbs (90 to 180 N), or only 2 to 4% of the die's weight. Roller-type lifters allow movement in one or two directions, and reduce the effort to move the same die to 10 to 30 lbs (45 to 133 N) of force, 1 to 3% of the die's weight.

Once the die is in position, it must be securely clamped in place. The clamping force must be sufficient to overcome the die's weight, as well as the acceleration, stripping, and ejector forces working against the die clamps. The two most common ways to create this force are by manually torqued bolts and hydraulic clamps.

If the die is clamped manually, T-bolts must be torqued to provide a safe and consistent preload level. But if we're talking about quick die change, manual clamping is not consistent with "quick." Besides, human operators are not nearly as consistent as a hydraulically operated die clamping system.

Hydraulic Clamping

A properly designed hydraulic clamping system provides safety and security by ensuring that each clamp is creating the same force at every point and at every die change. The same high clamping forces can be repeatedly applied to the die externally, internally, and in hard-to-reach places.

Pressure applied to each clamp is monitored with a gage and pressure switch that are tied into the press' emergency-stop circuit. If a 20% drop in clamping pressure occurs, the press is shut down.

The number, size, and location of clamps should be evaluated so that clamping forces can be placed as close as possible to the forces they must overcome. In many applications, clamps can be applied externally along the die's edge. Others may require installing internal clamps if the loads are greatest internally.

Hydraulic Safety Circuits

Unexpected events occur. What if power is lost or a hydraulic line breaks? If the clamping system has been designed with the appropriate safety circuits, the die will not move. Clamping pressure can be maintained with zero-leakage, directional control valves and pilot-operated check valves. Pilot-operated check valves allow flow in one direction (toward the clamp). But if a hydraulic line upstream of the valve fails, pressure is maintained between the valve and the clamp until pressure is applied to a separate line to open the valve and release the pressure holding the clamp closed.

Check valves can be provided for each clamp. They can also be located in the bed and slide circuits near the clamps. Several methods are used to apply these safety devices in a clamp circuit. Different safety levels are available at different costs.

One method is for a press' slide circuit to have four clamps, each equipped with integrated check valves. If a pressure line breaks at one clamp, the break is detected by a pressure switch at the pump, and the press automatically shuts down. All four clamps remain locked in place to hold the die.

Another approach is to provide a separate check valve for each clamp. If the pressure line breaks at the clamp, the press shuts down and the die will be locked in place with the remaining clamps. One advantage of this system is that one hydraulic line rather than two runs to each clamp. This is an important consideration if the clamp is to be manually positioned.

Mechanically locking clamps are available that use the wedge lock principle. A hydraulic piston drives a tapered wedge inside each clamp, creating the clamping stroke and mechanically locking the clamp. A wedge lock clamp provides an extra level of safety.

Automating a die clamp system provides additional safety levels. Electrical controls, interlocks, and sensors ensure that the die change system's moving parts are at the right place at the right time. Sensors can indicate whether a traveling clamp is at the die or the home position, or whether a clamping piston is in the proper clamped or unclamped position. In a press, sensors can indicate that the press slide is down on the die, the die is located horizontally and resting on the bed, or the slide is at bottom dead center.

Pressure switches signal that the valves are shifted and clamping circuits are at the proper pressure. Hydraulic reservoir sensors monitor oil and temperature levels.

Installing a quick die change system is only one aspect of its use. Maintaining it so it continues to operate safely is another. Training provided by the system supplier should address this issue.

To and From the Press

The use of automated die handling systems is still in its infancy, but is growing as stampers learn that getting dies to and from the press quickly is a vital part of reducing part-to-part idle time. An automatic storage and retrieval system (AS/RS), in combination with pre-staging/maintenance automation and advanced die change equipment, eases the task of moving and storing dies.

Many stampers are running out of room. Demands for shorter batch runs with many different parts, JIT deliveries, and growing customer lists mean more stacks of active dies need to be managed. Alternatives to building new facilities are being evaluated, and vertical die storage in an AS/RS may be the right solution for many facilities.

In addition to consolidation, storing dies close to the press line saves time. An AS/RS creates a fast, more direct route between die storage and presses. Dies are better organized and their location is known. In completely automatic systems, storage slots in a multi-tier rack are automatically accessed by an elevating die cart when a die is needed.

An AS/RS also lets stampers separate die change and die storage/pre-staging functions. They can occur simultaneously: retrieve and pre-stage a die set for a future changeover while a current changeover is in progress. The result is that hit-to-hit changeover time can be measured in minutes rather than hours, even between small batches and during unexpected schedule changes.

The fact that dies are captured and retained within a controlled environment enhances safety. An elevating die cart, when used with a multi-level die storage rack, uses safety latches to prevent it from accidentally lifting or lowering. This feature also ensures that the die cart platform is lined up

correctly with the rack slot before the die is removed. All dies are mounted on a standardized subplate for uniform handling within the system. Each slot in the rack is equipped with rollers to facilitate die loading and unloading. Mechanically actuated retainers in the rack slots ensure safe die retention.

Die Washing, Too

Die washing is an essential part of preventative die maintenance, and critical to maintaining stamped part quality. An automated die-washing chamber also reduces washing time. Clean die surfaces prolong die life, and make it easier to achieve first-part acceptability. One of the most time-consuming parts of die changing occurs when cranes are used to move and separate die halves for cleaning.

Bar codes can be used to identify dies, their production history, and required wash programs and parameters. Cleaning fluids, lubricants, and rust inhibitors can also be applied automatically and captured for reclamation.

This system facilitates routine die cleaning and storing immediately after each production run, so dies will be ready to be moved to the press when needed.

Included among the choices of equipment for efficient die movement and storage are:

- Die tables to provide cost-effective die change capability in situations where floor space and/or economic constraints prohibit using die carts. Adjustable-height tables can service two adjacent presses of varying heights. The table itself can be used for die storage and can be moved by fork truck or crane.
- Self-powered die carts to allow rapid die movement in and out of presses without fork lifts or cranes.
- Die subplates to provide a common interface between die, press, and die change equipment. Subplates permit a common mounting surface for all existing dies, allowing them to roll into and out of the press, die cart or die table, and storage racks quickly and accurately.
- Die turnovers and separators to allow easy and fast access to dies for preventative maintenance, repair, and inspection.
- Automated wash systems for extended die life can be integrated into the system.

With this pressroom equipment, die change time can be substantially reduced for greater productivity.

Multi-Use Storage/Retrieval System

Even higher overall stamping uptime and productivity can be achieved when storage/retrieval racks and automation are used for materials and work-in-process, as well as for dies. Coils, blank stacks, finished or partially stamped parts, and empty pallets or die subplates can be accessed easily and safely. Material can be automatically retrieved when the supply is low, avoiding production stoppage.

Cost justification is also improved when the system can do double or triple-duty. Turnovers that handle die halves for inspection and/or cleaning can also be used as a bundle turnover to invert

stacks of blanks, e.g. LH to RH blanks. Die carts can also transport blank stacks on pin pallets or a palletized coil from storage to the press line.

Pressroom of the Future

In the pressroom of the future, totally integrated die/material handling and production will be the norm. Raw material in standardized containers and incoming tooling will flow through temporary storage; press lines; secondary operations, such as dimensional inspection and laser trimming; required assembly operations; then to shipping, in one seamless, automatically managed, computer-controlled circuit.

Automated guided vehicles (AGV) will be used extensively to transport work-in-process and tooling, and deliver the right material and related dies to the appropriate press or press line on a just-in-time basis. Outbound shipping containers will be standardized with incoming material pallets so that common receiving and shipping equipment can be used.

Standardized press and automation controls will allow all processes to communicate and reduce the need for operator involvement in surveillance or troubleshooting. Standardization will also reduce integration costs and yield higher overall reliability.

A pressroom control system will track all operations in real-time, with instant feedback to upstream processes or suppliers through electronic data interchange, or newer e-commerce protocols, when variances occur. Inventory control will reach new levels of efficiency. Extensive data will be captured and reported at each step in the process via sensors in the dies, presses, and automated systems. Reactive maintenance will be replaced by predictable, preventative maintenance.

Each press control will receive analyzed data on an ongoing basis, and then decide whether to proceed with the process, make an adjustment, or stop and alert the operator to a process failure. "Root cause" identification and problem solving analysis will be provided.

Advanced simulation software will allow testing process changes without wasting time and material, ensuring that decisions made by the computer or human operator will produce the desirable effect. Many of these innovations are available today.

Plan for Quick Die Change Systems

It's up to the user to establish criteria when planning a quick die change system. Here is a guide to factors to consider, and to what part of the system each applies.

Criteria	Applies to:
Establish die change target time, resources, and constraints	Overall planning
Standardize clamping height	Powered clamping
Establish minimum and maximum tool sizes	Clamping layout Roller Layout Die changer
Establish maximum tool weights	Die lifters Die changer

Prepare smooth tool bottom surface	Die lifters Die changer
Prepare quick locating jigs (dies and press)	Quick tool positioning in press
Standardize tool sizes (die plates)	For some automated clamping and die changers
Develop area floor plan	Die changer

Ultra-Heavy Die Cart Cuts Die Change Time at Hydroforming Facility

A large Midwestern automotive hydroforming fabrication facility purchased a four-directional, 60-ton-capacity (54 t) die handling cart from AeroGo Inc. (Seattle, WA). The cart transports dies to and from large-frame hydroforming presses, as well as loads and unloads at presses in an environment where conventional equipment failed.

This die cart loads standard- and custom-sized presses, rolling press bolsters, and die storage racks throughout the facility, eliminating the longer times and costs required to use outside rigging services to remove and set dies. It is used in areas where crane access ranges from limited to nonexistent. Dies to 110" deep and 200" side to side (2.8 X 5.1 m) can be handled. Limited, allowable floor-loading stresses, and very tight operating and press access aisle space dictated a four-directional machine that could turn and maneuver within its own chassis perimeter dimensions.

The cart is a 72-volt, battery-powered, solid-tire, platform-style industrial vehicle with steerable four-axle and wheel assemblies. It is controlled by an on-board PLC, and a full system and maintenance operator-control interface. The operator can steer the vehicle in five steering modes, in addition to four-directional operation, for maneuverability. Individual wheel assembly synchronization is done electronically, without requiring complex mechanical linkages.

The 14' wide by 16' 8" long (4.3 X 5.1 m) cart travels in a 14¹/₂'-wide (4.4 m) aisle, which includes the large dies within the die cart's envelope. The reduced die platform height, which was critical in accessing some of the presses, is 19" (483 mm) lowered, with a raised height to 24" (610 mm).

To solve the problem of limited floor loading, four rolling axle and support assemblies are located at the corners of the chassis, spreading the load as much as practical. Axle assemblies are equipped with a continuously monitoring and compensating pressure-sensing system that varies wheel loading immediately at each wheel position. This feature maintains loading distribution on the floor, regardless of the operating surface's local undulations.

Four independently controlled hydraulic columns, one at each corner of the vehicle, lift the entire truck and die. This allows the operator to adjust the die platform to any level, despite local floor-to-press slope variance, to ensure a matched-continuous level-to-level die transfer. This feature is controlled and monitored from the operator's interactive viewing screen.

The platform's leading edge and loading sides are equipped with optical sensors and large-diameter locking pins for anchoring and precise positioning in front of the presses, rolling bolsters, and die storage racks. The fixed and anchored universal cart latch allows vertical movement for bed positioning, but will not allow the die cart to shift left or right of center, or slide away from the press during loading or unloading.

So far, the AeroGo Hydroform Die Handling Cart has out-performed expectations, and reduced die changeover time dramatically, without the use of outside riggers or under-capacity handling methods.