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The Concept of QDC

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The metal forming industry once enjoyed the luxuries of long production runs, high inventory levels and extended die change times. In recent years, to survive in today's competitive worldwide market, manufacturers are reducing inventory costs by running smaller batch sizes and making shorter production runs. One way to maximize press uptime in an environment like this is to implement faster more effective die changes.

A quick die change (QDC) means that the material for the next part is in place, the automation is set-up, and the die is located and clamped in position, the same place, the same way, every time, in the shortest time possible.

When QDC is implemented, companies will enjoy the benefits of:

- **Reduced Inventories**, due to smaller quantity runs and more frequent changeovers.
- **Improved Product Quality**, due to repeatable positioning and clamping forces.
- **Improved Lead Times**, due to quick changeovers and improved product quality.
- **Increased Machine Capacity**, by improving product quality and reducing machine downtime.
- **Improved Competitiveness**, through just-in-time deliveries and better service to customers.
- **Reduced Labor Costs**, die changes can often be done by the machine operator.
- **Improved Safety**, the dies are under control and roll smoothly in and out of the machine during the die change. With automated systems, if the die is not clamped properly the press simply will not operate.

There are six steps required to successfully implement a quick die change process:

1. Create a quick die change team
2. Select and analyze a press and its dies
3. Analyze the present die change process
4. Research and implement a quick die change process
5. Evaluate the benefits of the now implemented quick die change process
6. Follow-up and repeat the process

Step 1: Create a quick die change team

Select a team for this project and appoint a team leader. Advice and input from individuals with the following responsibilities will be valuable:

- Upper Management
- Manufacturing Engineer
- Tooling Engineer
- Production Supervisor
- Maintenance Supervisor
- Accountant
- Set-up Personnel
- Press Operator

Step 2: Select and analyze a press and its dies

Each QDC application is different. There is no single method that is best for all applications. The most appropriate method to be used for each press is determined by carefully examining all production requirements and related data. The following is some of the information that needs to be reviewed.

- What are the present and long range production requirements?
- What is the goal for die change time?
- How is the press room laid out?
- Which presses are involved?
- How many dies are used in each press?
- What are the minimum and maximum sizes and weights of dies?
- Present clamping method; the quantity and size of the bolts used?
- Clamping points: locations, shape, clamping heights, depth of ledge?

Step 3: Analyze the present die change process

First, carefully review your present method of changeover. You have to know where you are now to decide what steps are needed to achieve your goals.

- Analyze every step and the sequence required to make a die change.
- Break down each step to help determine how it can be reduced or eliminated.
- How much time is required for each step? To get accurate times, casually observe a set-up team on several occasions. Obviously an authority figure standing near the press with a watch or a video camera will produce figures less than the actual times occurring day to day.
- Who is involved in the die change process?
- What is required? What tools? What material?

Step 4: Research and implement a quick die change process

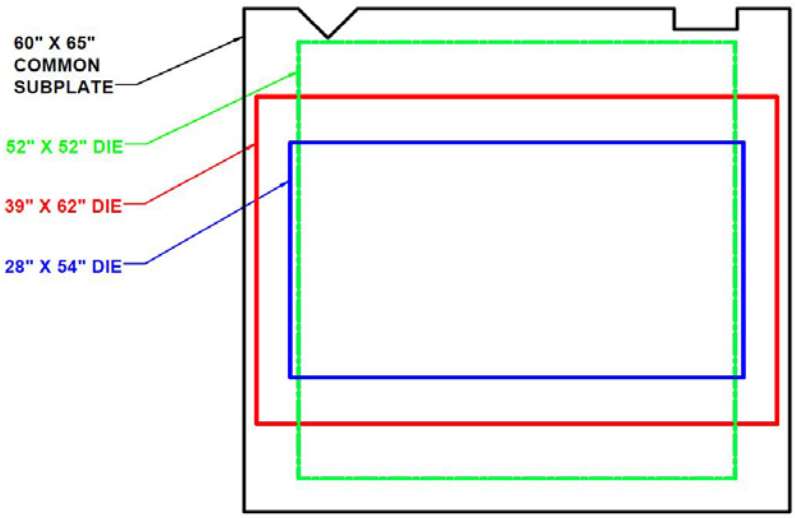
After the present die change process has been analyzed, look for ways to improve the process. The objective is to minimize the steps required and not to duplicate your work. Develop ways that will make the work easier and faster.

Start with things that are simple and low cost:

- Have new die(s) prepared and staged in advance near the press
- Die storage areas should be located near press
- Minimize raw material handling
- Have clamps and tools prepared before the press shuts down for the die change

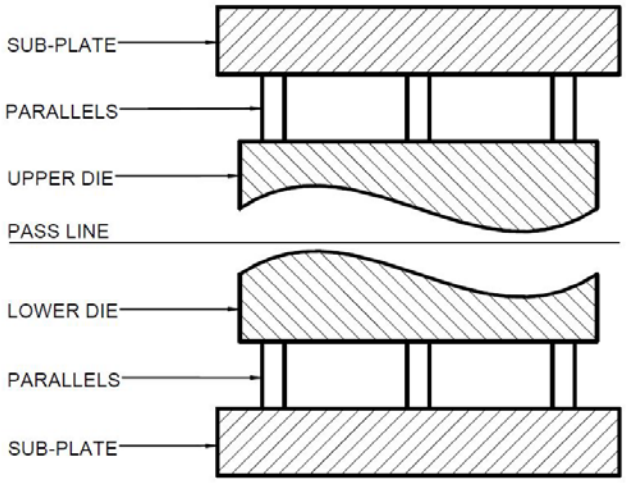
Die Standardization must be evaluated to achieve your quick die change goals. The variety and sizes of dies that have been accumulating in plants everywhere make changeovers time consuming and tedious. Since standardization was not a consideration when the dies were designed and built, one method of standardization is the use of sub-plates and parallels.

❖ **Subplates:** the use of subplates allows dies of different sizes to be mounted on a common plate. This provides many advantages:



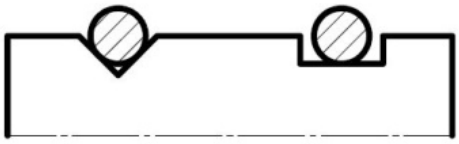
- Location
  - Standardized front to back dimension for use with positive stops and locators for the final die positioning.
  - Standardized left to right dimension allows the use of side rails or rollers for guiding the locating.
  - Center line of die aligned with center line of press and feed. This assists in aligning automation and clamping. Prying and jacking of the die into position is not required.
- Clamping Point
  - Standardized clamping height and clamping locations for the addition of hydraulic clamping.
- Smooth Roller Surface
  - Provides a smooth surface for the ball or roller lifters to roll against rather than the various holes and cut-outs normally found on the bottom of dies.
- Cleanliness
  - Subplates keep the bolster, T-slots and lifters clean, since the press bolster is only exposed during the die change.
- Pre-staging
  - The use of subplates provides the opportunity to prestage the die on the subplate while the press is running other parts thereby minimizing press downtime.

❖ **Die Parallels:** The use of die parallels also help to achieve setup repeatability and quick die change goals by standardizing shut heights and pass heights.



❖ **Die Locating Methods:**

➢ Notch and V: With the use of standardized Subplates the die is rolled into the press until two locating pins at the rear of the bolster come in contact with a notch and a V machined in the subplate. This aligns the die both front to back and left to right.



➢ Centerline Keyways: A keyway cut in the bolster and mating with a key extending beneath the die ensures positive left to right alignment during die change. For example, this method should be considered when a T-slot in the bottom of the subplate passes through the heads of clamping cylinders located in the bolster. A stop in the end of the slot will align the die front to back.

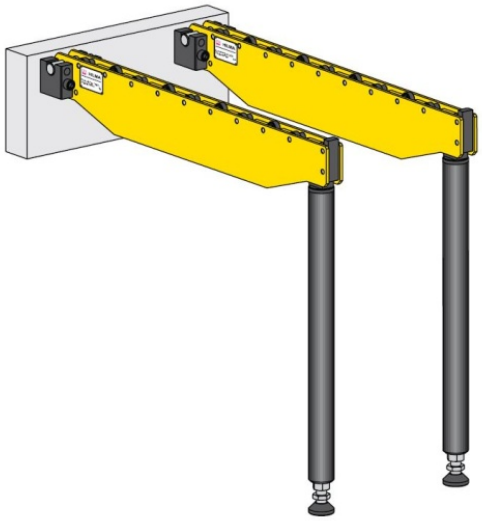
➢ Side Guide Plates and Rollers: Guide plates and horizontal rollers mounted on the edges of the bolster can also ensure left to right alignment during die movement, if the dies or subplates have been standardized.

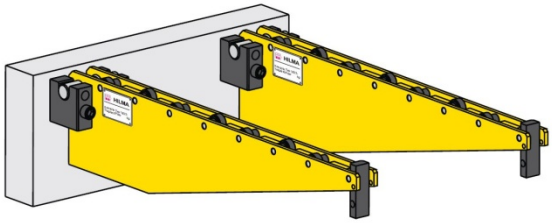
➢ Hydraulic/Pneumatic Locating Pins: Hydraulic pneumatic locating pins can be used for preliminary alignment while the die is still on the die support or for final alignment on the press bolster.

➢ Tool in Position Switch: Proximity switches are often mounted directly in the die stop to provide a “Tool in Position” signal to the press controls.

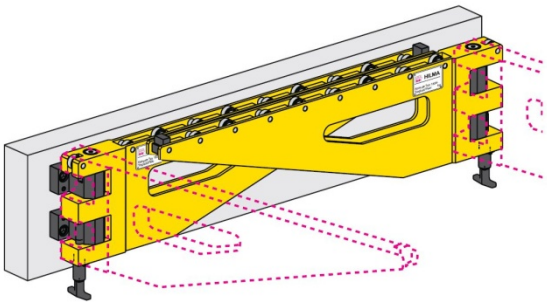
❖ **Die Movement:**

- To the press: Whether a die weighs 1,000 or 50,000 lbs, set-up personnel have problems changing dies. Fork lift trucks and overhead cranes have been common ways to transport dies. However since the fork lift truck is a multi purpose vehicle called on for many jobs, many plants now use dedicated die carts which can usually delivery the die directly to the edge of the bolster.
- At the press: If the die is transported to the press by a fork lift or overhead crane, it can be loaded on the die supports. The die supports or die consoles are arms that extend out from the press bolster. With the die on these arms, it can then be pushed into the press.
  - Removable Supports: Removable die supports can be lifted off for storage or used on other presses.

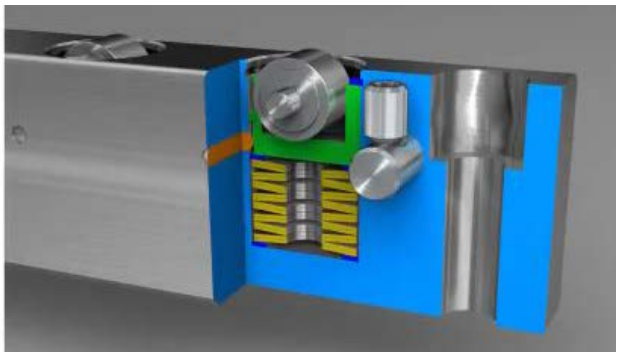
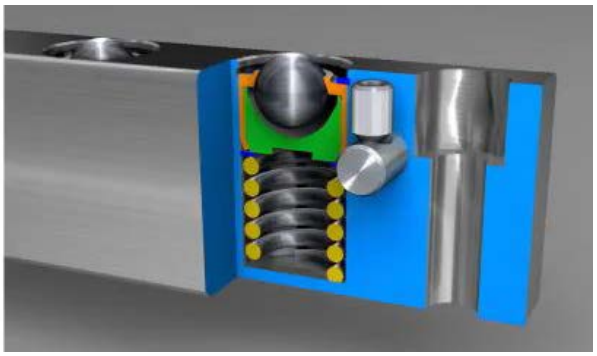




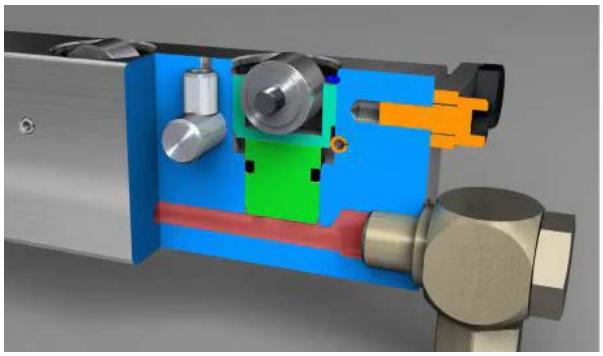
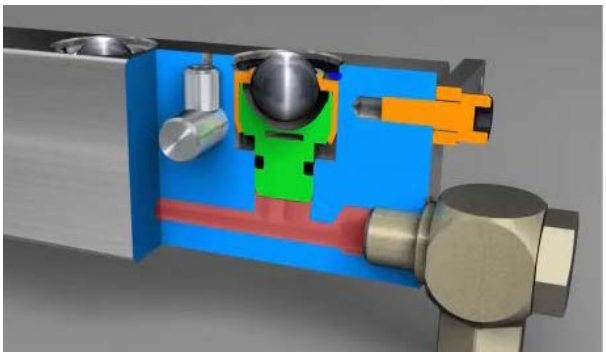
  - Fixed Mounted Supports: Fixed mounted die supports are hinged so that they can be simply folded out of the way until the next die change.



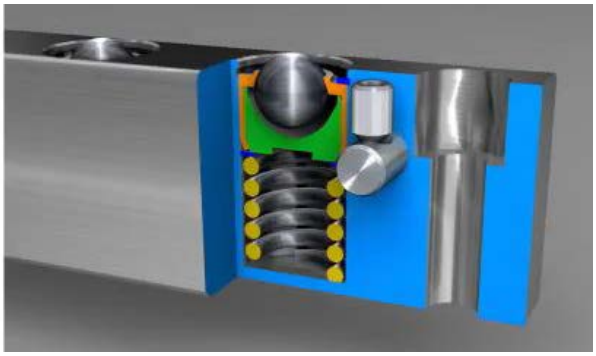
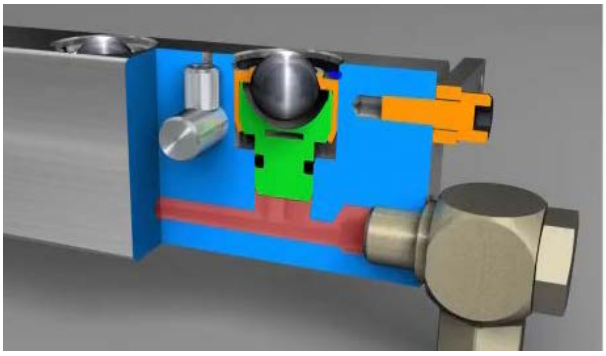
- Inside the press: With the die ready to move onto the bolster, modern die change systems utilize ball or roller lifters to roll the die into position. The lifters can be operated by spring, air or hydraulics.
  - Spring Lifters: Spring loaded die lifters do not require external plumbing as pneumatic or hydraulic lifters do. Spring lifters are especially suitable on smaller presses. Spring loaded ball or roller inserts can be located anywhere on the bolster. Spring loaded rollblocks can be inserted into existing T-slots.

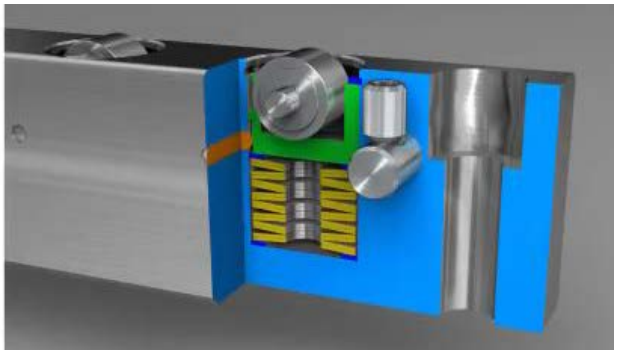
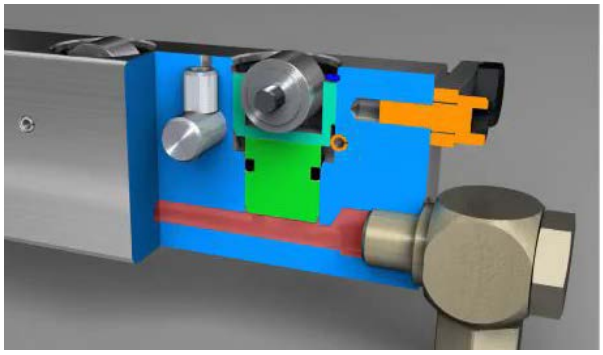
  - Hydraulic Lifters: Hydraulic lifters can support light or heavy dies during the die movement. Once in position, the die is simply lowered onto the bolster. To protect the operator and the equipment, a circuit relief valve should always be a part of the hydraulic circuit in case the rollblocks are accidentally overloaded.

- Ball Lifters: Ball type lifters allow movement in any direction. They have rolling resistance of 2 to 4% of the die weight depending on the surface condition such as hardness, smoothness, holes, etc. If the die weights are over 1,000 to 1,500 pounds, it is recommended to harden the bottom of the die or install hardened wear strips. This reduces the tracking (or brinelling) possible with the single point ball contact.

- Roller Lifters: The use of dual direction rollblocks allow movement either front to back or left to right. Roller lifters have twice the lifting capacity of a ball lifter with about one half of the rolling resistance (1 to 3%). Since the load on the lifter is distributed across the roller there is not an issue with brinelling on the bottom of the subplate.

- **Pros and Cons of Different Clamp Types:** When evaluating the goals of achieving quick die change, the issue of clamping must also be addressed. There are different types of clamping systems available.

  - Conventional clamping with bolt and strap:

    Advantages

    - Low cost
    - Very adaptable
    - Minimum space required
    - Clamp force maintained without the need for a power unit
    - Simple design
    - Low maintenance

    Disadvantages

    - Clamping is very time consuming
    - Manual operation only
    - Accessibility to all clamping points can be difficult
    - Number of pieces required for clamping
    - Clamp forces cannot be monitored

  - Self locking over center clamping system:

    Advantages

    - Clamping force is maintained without power unit
    - High mechanical retention force

    Disadvantages

    - Clamping force is stroke dependent
    - Minimum clamp height variation
    - Short stroke
    - Large sizes

  - Self locking wedge clamp system:

    Advantages

    - Clamp force is maintained without power unit

- Repeatable clamp force
- Clamp force is dependent on torque or the hydraulic actuator
- High mechanical retention force

Disadvantages

- High investment cost
- Clamping locations and height must be standardized

- Mechanical and hydraulic/mechanical clamps:

Advantages

- High forces
- Low torque required to tighten
- Some available with load force indicators
- No hydraulic power unit required

Disadvantages

- Manual operation only
- Accessibility to all clamping points can be difficult

- Hydraulic clamping system

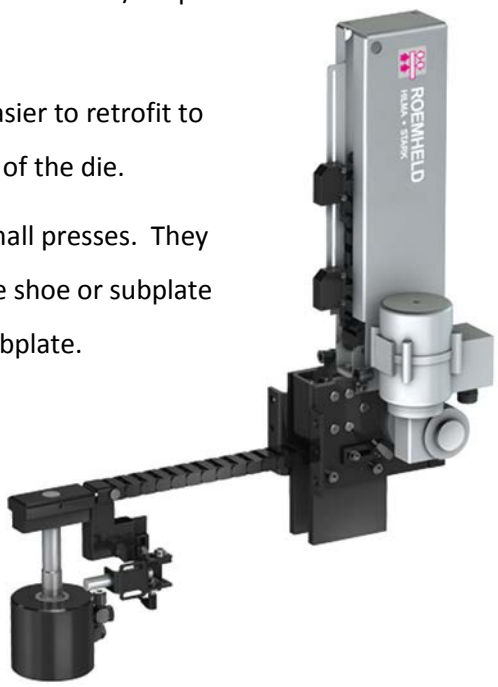
Advantages

- Clamp force is uniform and repeatable
- Safe clamping with pilot operated check and zero leakage valves
- High forces possible from compact clamps
- Clamp functions such as pressure and position can be monitored and tied into press controls

Disadvantages

- Clamping locations and height must be standardized in most cases
- High investment cost

❖ **Hydraulic Clamps:** Hydraulic clamps can be categorized as either external/adaptive or internal/integrated.

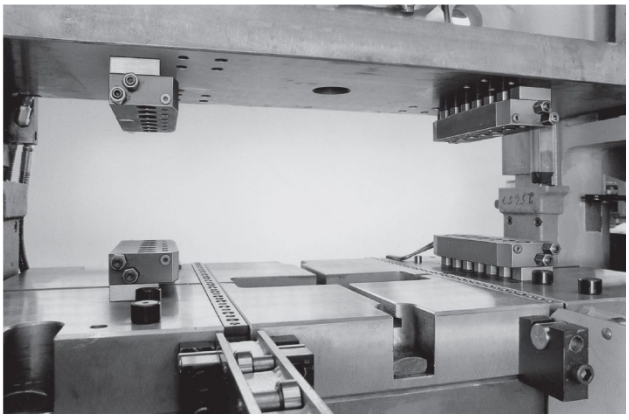


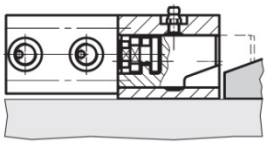
➢ External/Adaptive Clamps: External/adaptive clamps are easier to retrofit to existing press and dies because they clamp along the edges of the die.

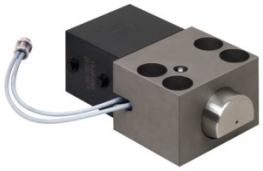
- T-Slot Clamps: T-slot clamps are suitable for large or small presses. They clamp directly on the edge of the die shoe or subplate or in U-shaped slots on the die or subplate.

Since the T-slot clamps can be manually located or automatically positioned in the T-slot, this type of clamp can accommodate various die sizes and can save the cost of standardized subplates. Automatic positioning can be accomplished with a pneumatic or an electric drive depending on the application.

- Fixed Mounted Clamps: Fixed mounted clamps are bolted directly on to the bolster or slide.





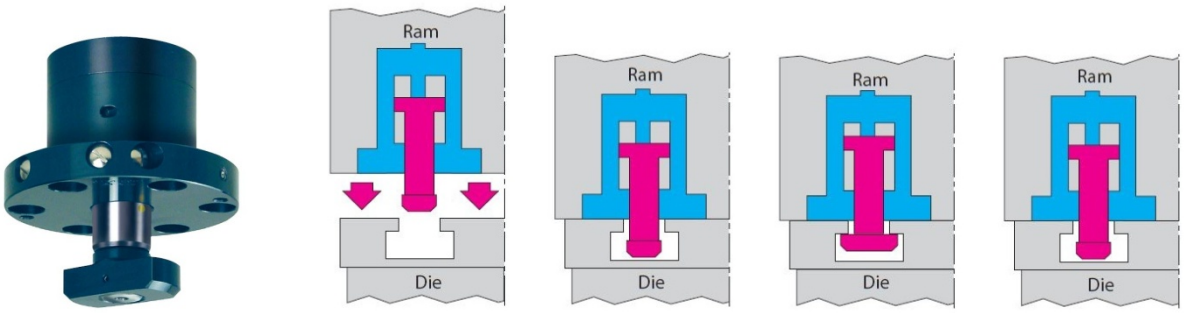


Clamping on standard subplates means no clamp movement. This reduces the die change time since the clamps do not have to be moved into position. With clamping bars, the die or subplate passes under the pistons during die change. Mechanically locking wedge clamps that clamp on either a parallel or 20° tapered surface can also be used. When unclamped, the clamping head retracts fully into the housing for unobstructed die change

- Internal/Integrated Clamps: Internal clamps are integrated into the bed or slide and are therefore located closer to the forces which may otherwise cause internal die deflection. Internal clamps are often used in high speed applications, deep draw dies, progressive dies and lamination dies.

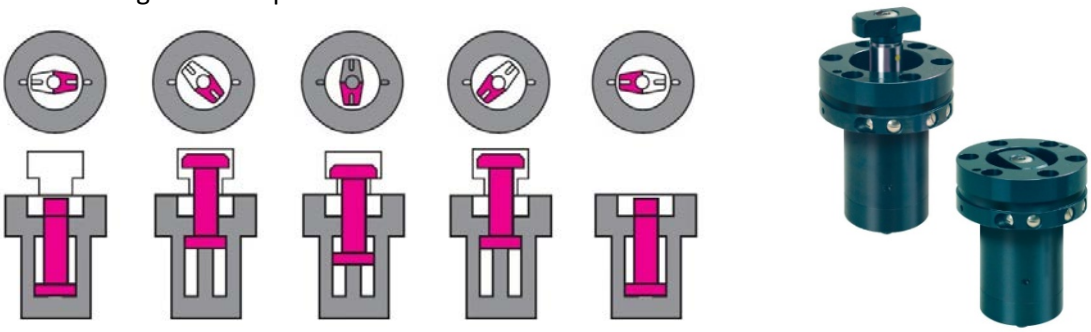
  Internal clamping is more costly and can be more difficult to install, however the benefits can often be justified. On large presses there is often extra shut height available which would allow for a ram adapter plate to be used instead of extensive machining to the press ram. Clamps can then be mounted on the ram adapter plate.

  - Swing Clamp:



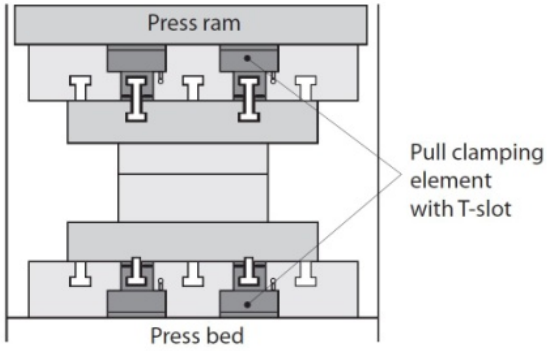
The swing clamp is for clamping the upper tool on the press slide. It can be recessed into pockets machined in the press slide or when provided with an extended shaft, the clamp can be mounted above the slide ledge. Proximity switches monitor the clamp and unclamp positions.

  - Swing Sink Clamp:



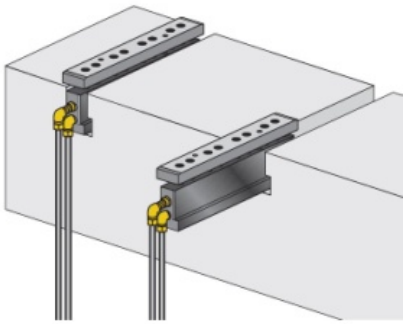
For clamping on the press bed or slide, this clamp provides unobstructed die movement since the clamping head pulls below the surface during die change. Proximity switches monitor the clamp, unclamp and changeover positions.

- Pull Clamps:



Pull clamps have a simple inward pulling motion. They can pull on a slot cut in the subplate, or on T-clamping bars attached to the die or subplates.

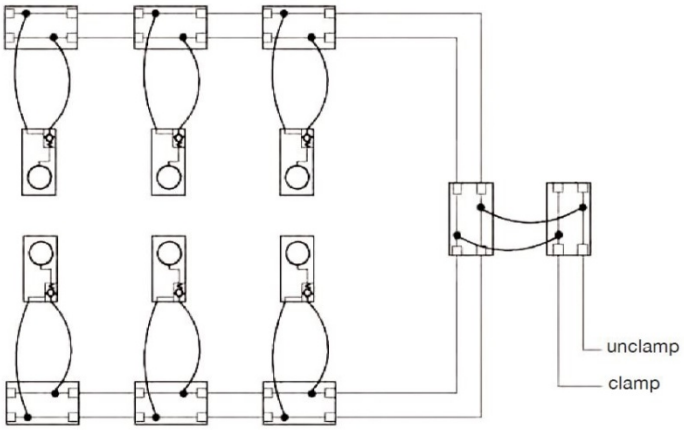
- Double-T Clamps:



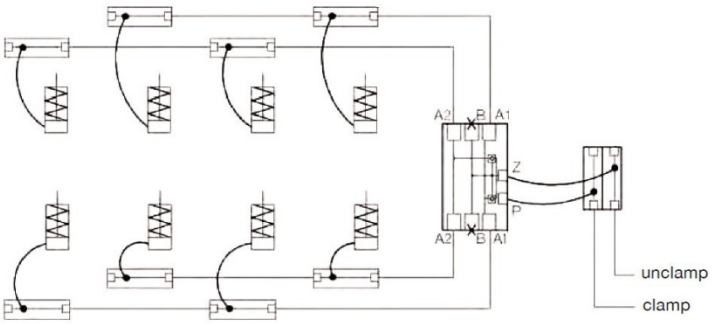
Double T clamps are for clamping on the bed or slide if mating T-slots are cut in the tool as well as the bed or slide. If the double T clamps are equipped with rollers, the die can be rolled into the press on these dual purpose roller/clamps.

- Hydraulic Clamping System and Press Controls: After the clamping method and the required clamp force for the application is determined, safety circuits and integration into the press controls must be reviewed.

  - Hydraulic Safety Circuits:
    Separate pilot operated check valves for each clamp provide a very high safety level.



    Pilot operated check valves providing a dual diagonal hydraulic safety circuit also ensure safe clamping for either the bed or the slide.



  - Electric Controls: Different signals to the press and clamp controls may be required, depending on the level of automation desired.

    - Pressure switch
    - Clamp position
    - Tool in position
    - Slide on tool
    - Slide at bottom dead center
    - Continuous/Run
    - Inch/Setup
    - Press enable

Step 5: Evaluate the benefits of the now implemented quick die change process

After all the options are weighed and decided on, and the first quick die change system has been installed, it should be evaluated by the QUICK DIE CHANGE TEAM.

- Are the new principles for die location and movement providing the desired results?
- Is the clamp system safe and effective?
- Are there issues that the operators might have with the new system regarding operation, safety, or maintenance?
- What is the new time required for a die change? Can it be further improved?

Based on the labor savings, increased press utilization, reduced inventories, reduced scrap, reduced rejected materials, and improved safety levels, what is the cost savings over a one year period?

Step 6: Follow-up and repeat the process

If your payback is as expected and if you have implemented a safe, efficient QUICK DIE CHANGE system, then move on to the next press and repeat the process.

Conclusion

The concept of quick die change is simple; minimize the time from the last good hit on one die to the first good hit on the next die. How the quick die change process is executed is what's difficult. From discussing the many aspects of implementing a quick die change system, it is obvious that there is no single answer to a particular problem. Each situation is unique and requires a specific solution that deals with all of the factors at hand.

The world is shrinking; we not only have to compete with the plat across town, but also across the ocean. Through the implementation of an efficient quick die change system, we can enjoy the benefits and become more competitive in the world wide market.