TRANSFER PRESS AND DIE OPERATIONS

Transfer presses have several distinguishing features that suit them for many types of medium to high volume work. Most operations use precut blanks, although there are combined operations in which the first stations are coil-fed where blanking and other operations are transfer operations.

A Large Three Slide Transfer Press

Figure 1. A four-column, three-slide transfer press with a force capacity of 4,600 tons (40.922 MN). Verson Corporation
Many different sizes of transfer presses are used. The first type of transfer press, the eyelet machine, because the first application produced small metal items such as eyelets for shoes. Today some small transfer presses are termed eyeleting machines, although great varieties of parts run on them.

Large transfer presses have force capacities of 3,500 tons (35.136 mN) or more. Transfer press operations have several common factors. These include:

1. There is an individual die for each operation.

2. Reciprocating transfer feed bars on each side of the press move the parts between the dies with mechanical fingers.

3. The feed bars run in synchronism with the press motion.

Figure 1 illustrates a very large specialized transfer press. The automotive and appliance industries are the principle users of this type of machine. All stamping operations required to complete large parts as automotive hoods and roof panels are completed in such presses. Flat blanks are de-stacked and automatically fed into the right end of the press. The transfer feed bar fingers move the parts from die to die. The completed stampings emerge from the left end where they are placed in storage racks or conveyed to the assembly operation. ¹

Transfer Feed Motion

Two types of transfer motion are used. The simplest system uses dual-axis motion. Only in and out motion is used to grasp the part. The second axis of motion transfers the part from die to die.

Figure 2 shows the motion of a tri-axis transfer feeder bars for indexing parts between dies in the transfer press. In older designs, the transfer feeder bars are mechanically driven synchronously with the slide motion. The fingers inserted into the transfer feeder bars hold the parts during indexing. In some cases, the fingers use pneumatic jaw clamps to grasp the parts. Wherever possible, simple scoops that rely upon gravity are used.

Tri-axis Transfer Feeder Bar Motion Curves

Figure 2. Transfer press feeder bars and fingers showing a tri-axis transfer feeder bar motion sequence. First, the part is clamped (1) or caught in a shovel type lifter. Next, the part is lifted out of or off the lower die as shown at (2). Then the feeder bar advances the parts to the next die stations, (3). Once in position over the next die the parts are lowered into position on the lower die half (4). When in position the grippers or shovel type lifters unclamp and/or withdraw, (5). Finally, the feeder bars return to the start position as the ram descends, (6). Auto Alliance International

Comparison of Dual and Tri-Axis Transfer Feeds

2 D. Smith, “Quick Die Change”, Chapter 21, Automatic Die Change at Mazda, The Society of Manufacturing Engineers, Dearborn, Michigan, © 1991. The 1991 material was contributed by Ray Hedding, Stamping Plant and Area Manager, and David D. Couch, Stamping Plant Staff Member, Mazda Motor Manufacturing (USA) Corporation, Flat Rock, Michigan, at the time of writing the case study as reproduced in the book. This case study is based on the paper, “Automatic Die Change: Success Through The Integration of Teamwork and Technology.” The paper was presented at the SME clinic "Effective Techniques and Tooling for Quick Die Change", December 5-6, 1989, Nashville, Tennessee. The Mazda Flat Rock, Michigan facility is now known an Auto Alliance International and is operated as a joint venture of Mazda and Ford Motor Company. This reference covers other aspects of the Auto Alliance pressroom facility such as computer integration of the stamping process, automatic stock storage, stock retrieval with automatic guided vehicles, and a detailed explanation of the automatic die exchange process.
The application of dual-axis transfer feeder bar motion is limited to relatively flat parts having only shallow formed features. The lack of up and down motion results in the parts being dragged across the top of the lower die surfaces when transferred. The system works very well within these limitations. The advantages compared to a tri-axis system are lower initial cost, less maintenance expense and faster cycle times.

Tri-axis transfer is needed for parts having deeply formed features. Here, the part must be lifted out of a die cavity or a die forming detail before transfer to the next die can occur.

**Transfer Drive Methods**

There are several basic systems for actuating transfer feed motion. One method, which is still in use, is to drive the transfer directly from the press crankshaft. Gears and cams are used to transform rotary motion to the reciprocating action needed for part transfer.

Another mechanical drive system that is popular for both new systems and retrofit applications uses plate cams attached to the press ram. The mechanism is driven by cam follower rollers.

Both pneumatic and hydraulic cylinder driven systems are built into multi-station dies. Many clever designs have been locally fabricated in press shops. The hydraulic systems are more costly, but provide precise control. The motion of pneumatic systems tends to require frequent adjustment.

Fitting hydraulic transfer mechanisms to existing dies is a well-developed technology. Success factors include the use of electronically controlled hydraulic servo-systems that have precise programmable motion. ³

Many new transfer designs are powered by electrical servomotors. In the author's opinion, this is the best technology for most new designs. The technology includes a combination of a high output servomotor, microprocessor-based electronic control, and solid-state power supplies. These are all mature technologies, which are in widespread use in other industrial equipment such as machine tools and robotics.

The trend is to power all large new transfer press feeder bars with electronic servo drives. The Verson Corporation has been a leader in developing these systems. Verson servo drives have been successfully retrofitted to presses without existing transfer mechanisms and to machines with worn out mechanical drives. Electronic servo drives have the advantages of ease of programming the motion curve and mechanical simplicity.

³ J. Hoening, “Fitting of Transfer Mechanisms to Existing Dies”, SME Technical Paper TE87-790, Society of Manufacturing Engineers, Dearborn, Michigan, © 1987. Examples of transfer retrofit including fluid power applications are provided.
EXAMPLES OF TRANSFER PRESS OPERATIONS

Often, transfer presses are operated in conjunction with other manufacturing systems. For example, a transfer press may be part of a manufacturing cell where assembled modules or completed goods are produced. Quick die change is increasingly emphasized, especially to reduce lot sizes.

Swing-Out Transfer Bar Carrier Assembly
When a transfer mechanism is retrofitted to an existing press, exchanging dies can be complicated by the need to remove one or more feed rails or transfer bar carrier assemblies. The feed rail or transfer bar carrier assembly can also make minor die maintenance work in the press very difficult. 4

Swingout transfer bar carrier assembles easy die maintenance and changeover. These patented transfer swingout assemblies can be mounted to the press column, bolster or to a die sub-plate.

Swingout Transfer Device Mounted to Press Column
Figure 3 illustrates a swingout transfer bar carrier assembly. The dies, that are used to produce a speaker basket stamping, are mounted on a common sub-plate assembly having parallels to permit scrap removal by means of in-die conveyors. The scrap is discharged out of the rear of the press. The last transfer station places the finished stamping onto a gravity chute, which conveys the part into a parts container.

Electronic and Mechanical Protection Devices
Transfer finger part sensing permits the press to be automatically stopped in the event of multiple parts in one station, scrap interference, or loading problems. The transfer mechanism is driven by plate cams attached to the press ram. Spring-loaded clutches protect all three motion drives. Electronic proximity switches initiate a press emergency stop in the event that a clutch should trip due to an overload.

Both the two bolster outriggers and bolster shown in Figure 3 are equipped with hydraulically actuated rollers to permit sub-plated dies to be changed by a means of a powered die-cart or fork-truck.

4 D. Smith, video training series, “Quick Die Change”, Society of Manufacturing Engineers, Dearborn, Michigan, © 1992. Tape four of the five tape set shows the HMS transfer system illustrated in Figure three of this document in excellent detail. Tape one has Figure eight of this document, as well as other figures from reference two not reproduced here, depicted as video animation, which greatly aids clarification of the concepts.
Example of Swing-Out Transfer Bar

Figure 3. A swingout transfer bar carrier assembly that provides complete access to the die for maintenance or die changing. The pivoting transfer is mounted to the column of a 220-ton (1957 kN) Niagara 84-inch (2.134 m) wide straightside press. HMS Products Co.

Figure 4 illustrates a swingout transfer bar carrier assembly that mounts to a die sub-plate for transfer dies used to produce stampings of automotive seat parts. The dies run in a conventional straightside press.

The HMS transfer systems are popular for retrofitting to existing presses. The dies and transfer fingers must be accurately located. The fingers are doweled in place to assure repeatability. To run different products, the transfer feed bars may be exchanged.

A bolster-mounted swingout transfer bar carrier assembly is shown in Figure 5. The simulator platform is fabricated of steel plate and carefully machined to duplicate the dimensions of the press bolster.

Electrical servo motor drive is supplied for the die-to-die transfer if the dies are widely spaced. A servo drive is also needed if a sort press strokes would result in an extremely steep driving plate cam angle.
Plain crankshaft or eccentric driven presses have a sinusoidal motion curve. The slide velocity is at its slowest rate when the die-to-die transfer must take place. Driving this motion axis with a servomotor avoids the problem of requiring an extremely steep plate cam angle to accomplish the die-to-die transfer at this point in the press stroke.

Swing out Transfer Feeder Bars on a Subplate

Figure 4. A swingout transfer bar carrier assembly that mounts to a die sub-plate.  
_HMS Products Co._

Success Factors In HMS Transfer Systems
The HMS transfer retrofit system has been used with excellent success by manufacturers who are willing to follow a few simple rules. The system does not lend itself to jury-rigged modifications. Success factors include:

1. Supplying HMS with parts from each station that have the die centerline accurately scribed.

2. Maintaining exact uniform feed pitch spacing for all dies on a subplate or die shoe.

3. Correcting the root cause of any misallocation problem rather that modifying the fingers.
An HMS Transfer System on a Simulator Platform

Figure 5. A swingout transfer bar carrier assembly suitable for bolster mounting. It is attached to a simulator platform used to tryout the completed transfer assembly with the lower dies in place. The cone-type die locating devices used to insure correct die positioning are seen in the center of the simulator platform. *HMS Products Co.*

**MULTIPLE SLIDE STRAIGHTSIDE PRESSES**

The straightside press shown in Figure 1 is an example of a highly specialized custom-built machine known as a Verson Transmat™. Total machine weight may exceed 2,500 tons (2268 T). The three slides and four columns are customized for the type of work to be performed. Large multiple slide presses have a number of advantages including:

1. By making a machine having a number of columns and slides, shipping the disassembled press over highways with specialized transport trailers is practical.

2. Each slide can be designed for the required force.

3. By using multiple slides, ram tipping can be minimized.

**Design Considerations to Avoid Ram Tipping**
The Verson Transmat® is an old design that has proven to be dependable. The press shown in Figure 1 is mechanically driven. New Verson designs are built with electrical servo drives. Verson servo drives can also be retrofitted to older mechanically driven transfer presses. Verson retrofit applications include presses built by other manufacturers.

The center slide in the illustration is designed for a heavy single-station forming operation. Placing a die having high force requirement, such as a stretch form or reforming operation on the end of a long press slide can result in severe ram tipping. Die damage, accelerated wear, and quality problems can result. This is often an unexpected problem in applications where large single and double slide transfer presses are specified.

The load on the slide should be as balanced throughout the press stroke. This is an important consideration in the older Verson design. Some builders and users may have been unaware of this problem.

Presses imported from the orient have been considered technological superior to North American machines based on claimed technological innovations. In the writers experience, many of these machines have given satisfactory service. However, some oriental presses have had spectacular failures die to failed eccentric drives traceable to poor quality castings.

In addition, many machines have had to be reinforced with tons of plate gussets and other welded on structural stiffeners in order to obtain a reasonable limit of vertical deflection under load. In some cases, the lateral rigidity has had to be increased in this way. Welded repairs should not be made to press beds, crowns, uprights, rams or other assemblies unless the parts are subsequently normalized to relieve the stresses set up during welding.

When troubleshooting transfer press problems, ram tipping is sometimes found to be the cause of poor quality work and excessive press or die wear. A solution may be to add a compensating load on the lightly loaded end of the slide. Nitrogen cylinders or rubber die springs may prove successful to provide the counter-force needed to balance the load.

AUTOMATIC TRANSFER PRESS DIE CHANGE AT AUTO ALLIANCE

Auto Alliance is an integrated automotive stamping and assembly facility located in Flat Rock, Michigan. It is jointly owned by Mazda and Ford Motor Company. Large transfer presses are used to produce stampings that are assembled into Ford and Mazda automobiles.

In order to reduce inventory storage costs, automatic die change is used to enable short part runs. Figure 6 illustrates a stamping line designed for ADC.
Block Diagram of Transfer Press Line

![Block Diagram of Transfer Press Line](image)

**Figure 6.** Block Diagram of transfer line includes a blank de-stacker, a double action press with a mechanically linked loader and extractor, a part turnover, and a 2649-ton (23.565 MN) transfer press. *Auto Alliance* 5

The slides automatically lower to the present die heights and stop at bottom dead center to permit the upper dies to be automatically clamped. The slides are then raised to the home position and both the loader and extractor are repositioned. Finally, the die cushion is pressurized, bringing it to the operating height. This completes the automatic die change sequence for the double action press.

Next, the moving bolster unclamps and the safety gates rise. Once the safety gates are locked in their up positions, both moving bolsters with dies in place simultaneously move out of and into the press. The bolster is clamped hydraulically to secure its position inside the press, all pneumatic lines are pressurized, and the safety gates close.

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5 R. Hedding, Stamping Plant and Area Manager, and D. Couch, Stamping Plant Staff Member, Mazda Motor. Manufacturing USA Corporation, Flat Rock, Michigan. This integrated stamping and automotive is now known as Auto Alliance. This case study is based on the paper, “*Automatic Die Change: Success Through The Integration of Teamwork and Technology.*” The paper was presented at the SME clinic "Effective Techniques and Tooling for Quick Die Change", December 5-6, 1989, Nashville, Tennessee.
The events that occur during an ADC follow an exact sequence. Briefly, both the loader and extractor are fully retracted and the die cushion is lowered. All press slides are lowered to bottom dead center and the upper die clamps are released. The slides then rise to top dead center and the computer selected die height adjustments are made for the new job to an accuracy of ±0.004-inch (0.10 mm), while the new loader mechanism cups and jaws are selected automatically.

**Automated Blank Storage and Transportation**

![Block diagram of material ordering communications network showing sequence of stock retrieval events. At (1) is the AGV material-ordering terminal where the stock is ordered. AGV system control computer (2) locates the material. The material is loaded onto the stacker crane (3) and placed on the AGV carrier. The material (4) is transported to the line; finally, the pallet (5) is unloaded from the AGV carrier to the blank destacker. *Auto Alliance*](image-url)

*Figure 7.* Block diagram of material ordering communications network showing sequence of stock retrieval events. At (1) is the AGV material-ordering terminal where the stock is ordered. AGV system control computer (2) locates the material. The material is loaded onto the stacker crane (3) and placed on the AGV carrier. The material (4) is transported to the line; finally, the pallet (5) is unloaded from the AGV carrier to the blank destacker. *Auto Alliance*
Automated Blank Storage and Transportation
The flow of material is controlled by an automatic guided vehicle (AGV) system, which features both automatic storage and retrieval. This system offers quick response times and high repeatability. Repeatability is a measure of the capacity of an operation to achieve the same outcome of events under similar conditions. In this example, high repeatability refers to the AGV system capacity to control the position of the pallets with very little variation in their location.

An automatic stacker crane stores material after it has been blanked and until it is required for use by a line. When a line requests the material, it is done so through a terminal at the line. This terminal is directly linked with the automatic guided vehicle system's control computer. The computer then locates the material in the storage system where it is picked up by the automatic stacker crane and delivered to the line by the automatic guided vehicle carrier.

Upon delivery of the full pallet, the carrier will also retrieve the empty pallet from the blank de-stacker and return it to the system. A block diagram of this system including the material ordering communication network is shown in Figure 7.

Layout of Die Storage Area and Transfer Press Line

Figure 8. Layout of die storage area in relationship to transfer press line equipped with air moving bolsters. Two moving bolsters are supplied for each operation. As the bolsters at position A move into the press, the bolsters inside of the press (position B) move out of the press to position C. The die change is completely automated, and requires less than five minutes. Auto Alliance
Moving Press Bolsters
Two moving bolsters are supplied for each operation. These operations include the double action press, turnover, and both transfer press slides shown in Figures 8 and 9.

This layout allows the external staging of each operation while production is still running. Once a die change is required, the moving bolsters simultaneously move the new job into the press as the old job moves out.

Importance of Prestaging
Without the ability to externally pre-stage the moving bolsters, automatic die changes would not be possible. Automatic die changeover occurs in well under five minutes in some cases when all preparatory work is correctly done.

There are four main elements involved in externally pre-staging transfer press line. They are:

1. Installation of the die locating pins, die cushion pins and die lifter pins.
2. Setting of the dies and the lower hydraulic clamps.
3. Installation of the transfer press fingers.
4. Installation of the turnover fingers.

Errors in prestaging the new job can have catastrophic results. For example, installing the wrong fingers may result in mechanical interference that can damage both the transfer fingers and dies. In the event that a die cushion pin is installed in a location that interferes with the lower die shoe, the force may be sufficient to break the casting.

Transfer Feeder Bar Changeover during ADC
After the automatic lowering of the transfer press die cushion and die lifters the transfer feeder bars are moved to their maximum width setting, disconnected and lowered to a rest stand for solid support during bolster movement.

As illustrated in Figure 9, each transfer feeder bar can be separated into six pieces. The short pieces, known as bar connectors, are in the area between the uprights of the press and remain in the press. The other three pieces move in and out of the press on the moving bolsters for each slide.

Figure 9 illustrates the transfer press feeder bar layout. Many automatic functions must work smoothly to insure automatic bolster movement and feeder bar exchange occurs during ADC.
Strict procedures must be followed to insure that all employee-prestaging activities are performed correctly. Success factors include:

1. Pre-programmed machine instructions must be precise.
2. Equipment maintenance schedules must be followed.
3. All employees must be trained to work together as a team.

**Plan View of Dual Moving Bolster Transfer Press**

![Plan View of Dual Moving Bolster Transfer Press](image)

**Figure 9.** Top view of transfer press layout illustrating transfer feeder bars. The bars are uncoupled, the bolsters moved and the new bars re-coupled by pneumatic cylinders during ADC. *Auto Alliance*

**Hydraulic Clamping**

The lower hydraulic die clamps are installed manually and pressurized. In order for the clamps, (which have a fairly short stroke) to function properly, it is necessary that both the height, slot width, and exact location of the lower die shoe clamping locations be machined accurately.

**Automatic Moving Die Clamp**

Figure 10 illustrates a complex automatic die clamping system attached to a press slide. An electrical motor with a gearhead drives the mechanism, which positions the clamp. With the die in the press, and the press closed, the motor drives a flexible track with a clamp on the end into position to clamp the upper die in the press.
This system is expensive and somewhat complex when compared to a clamp that simply swings into position. However, it permits automatic die change in transfer presses and tandem lines without the extra expense and weight of an adapter plate the width of the press ram.  

An Automatic Traveling Die Clamp

![Diagram](image)

**Figure 10.** An automatic traveling die clamp attached to a press slide. The components are: (1) press slide. The motor and gearhead (2). The track driving sprocket (3). A clamp in-position proximity switch (5). The upper die shoe with precision clamping slots milled on location (5). Hose connected to the hydraulic pressure source (6). The clamp cylinder is shown in the clamped position (7) and unclamped position (8).

Auto Alliance International

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D. Smith, *Quick Die Change Video Course*, Tape one, session four has animated footage of how the motorized traveling clamping head works. The case study is from Auto Alliance International, Flat Rock, Michigan. The workbook has a description of the clamp on pages 46 to 47. The same description is in the Facilitator’s Guide on page 73 to 74.
Employee Training
Great emphasis must be placed upon employee training. Proper training and education is essential to the operation and maintenance of a large complex transfer press operation. All employees are taught what to recognize, understand, and to be cautious about.

Program work sheets outline the sequence of work elements to be performed to achieve each task. Special instruction sheets are used when an unplanned occurrence or condition arises which requires physical interaction but is not covered in the program work sheets. This generally relates to some form of mechanical or electrical problem encountered.

Class instruction and examinations are given to prove competency before an employee is certified at a given job. Extensive training programs such as this provide Auto Alliance with a well trained, educated, and versatile work force. Without such training, large transfer press operations cannot be carried out safely, production schedules maintained, and quality parts produced.

DIE DESIGN FOR TRANSFER PRESSES

With a few important exceptions, dies for use in transfer presses are designed much the same as tooling used in individual and tandem press line operations. Important design considerations for successful transfer press operation include:

1. Maintaining all dies at common pass or load height.

2. The guide pins, heel block projections, and set-up blocks must be incorporated in the upper die to avoid interference with the transfer fingers.

3. All dies under the transfer press slide must be maintained at a common shut height.

4. Clearance must be provided in the dies for the transfer press fingers to pick-up and place the parts.

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CAD Design Considerations
The motion path of the transfer press fingers must be available to the die designer. It is essential that any interference problems be corrected in the die design process. The computer aided design (CAD) program used should tie in with a three-dimensional motion simulation program to determine that there is ample clearance for the transfer fingers and parts when transferred.

If die components such as cam slides and part locators are found to interfere with transfer finger motion during new die tryout, the required modifications will be costly. Manual part transfer may be required. This can require unexpected expenditures to meet point of operation safeguarding requirements, and result in inefficient operation.

Establishing and maintaining a common shut-height for all dies under the slide is an absolute requirement. The total press deflection under load including bed and slide bowing must be compensated for in determining the actual shut height for each die.

NOTES: ____________________________________________________________

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