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## **DEVELOPMENT OF STAMPING TECHNOLOGY IN AUTOMOTIVE AND PRODUCTION SPEED CALCULATIONS**

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**136** PRODUCTION  
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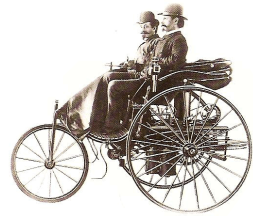
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# Abstract

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Automotive industry has developed rapidly in the last 50 years but before this development machinery was the most important substructure for this industry. For the centuries, people found new resources for living an easy life but to reach them, transportation was the first degree requirement. So they developed engines to do that. After that they make covers and seats to use it for transportation. In the beginning of this, they used hammers to make covers.

Humankind liked this easiness and some people had this vehicles. But it's not enough to produce this vehicle for everybody. That's why they understood that hammers and labor can not solve this problem and they started to develop machinery and it's called by 'press'. This system was enough to give shape to the steels and other components by minimum labor but they saw that big parts need strong transportation. So they developed robots to decrease labor for transportation. By the time robot technology was not enough to reach the production speed they want. So transfer press's been developed. In this development safety was more important than the speed. So automotive industry started to use more strong steels for production. But cold stamping press was not enough strong to produce that. So they developed hot stamping technology.

# Abstract

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This research summaries;

Technology and automation development in manufacturing, their technical details and their history.

Increasing production speed and control methods due to technological development

PLC's and communications (SCADA, Rapid etc...)

Safety improvements on all press technologies.

All intelligent manufacturing systems and their benchmarks

**Keywords:** Presses, technologies, communications, safety, capacities



# Press Production Speed Equation



## 1. Press Production Speed Equation

Too many press types and technologies have been developed in history but basic working methods're similar. So before analysis these; assuming a formula generally for press production will be useful (a result speed which includes spm-stroke per minute, rpm of all components of system and all loses);

$$\text{FSPM} = \text{SPM} - \Sigma\text{FL} - \Sigma\text{OL} - \Sigma\text{RL} \quad [\text{spm}]$$

(1)

FSPM - Final SPM value which includes all loses (reel spm)

SPM - SPM value which's been described on technical specification of press

$\Sigma\text{FL}$  - Feeding loses of production before stamping operation (like operator, conveyor, robot, destacker or another machine delaying)

$\Sigma\text{OL}$  - Operation loses during stamping operation (slide movement delaying like link-drive types, automation delaying like transfer types or robotic types, communication delaying like PLC's, press input and output degrees etc...)

$\Sigma\text{RL}$  - Removing loses after stamping operation (like finished part controls, boxing operation etc...)

# Press Types

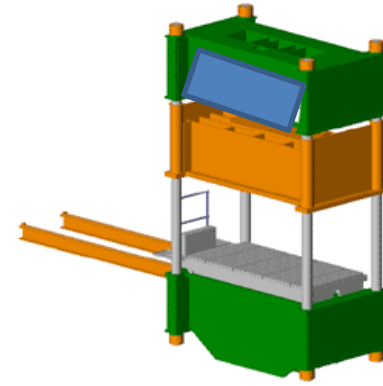
## 2. Press Types

### 2.1 Universal presses

Universal presses are characterized by their high degree of flexibility. They are suitable both for blanking and forming operations. In combination with individual, progressive blanking, compound and transfer dies, this opens up a wide range of application possibilities for the production of small to medium-sized parts. To increase the number of formed parts and so enhance the cost-effectiveness of the production process, universal presses are equipped with coil lines, scrap disposal systems and stacking units for finished products. Fully automatic die change plays an important role in ensuring economical production.

### 2.2 Hybrid presses

Mechanical hydraulic presses, also known as hybrid presses, represent a new development in the field of press engineering. This type of press combines the benefits of mechanical and hydraulic presses. The hybrid drive system allows gentle impact of the top die on the workpiece, and also optimum control of the force exerted during the forming process.





# Press Types

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## **2.3 Universal presses with modified top drive system**

If an operating sequence involves a wide variety of work processes such as drawing, blanking, bending, stamping or reducing, it is rarely possible to achieve ideal working conditions for the respective forming process when using conventional press drive systems. And if we talk about technological substructure; we can assume 5 different technology;

1. Manuel-tandem presses
2. Progressive presses
3. Robotic lines
4. Transfer presses

## **2.4 Manuel-tandem presses**

They are also a singular universal presses which only controlled by operator. It means feeding is directly linked to conveyor (or other tooling) and operators. So for manuel presses; we may assume FSPM like this;

# Manuel Tandem Line



# Manuel Tandem Line

$$FSPM = SPM - (|CD| + OD) - \Sigma OL - (QCD + BD) \text{ [spm]} \quad (2)$$

CD – Conveyor delaying

Conveyors are generally cycling with their own structure components. So;

$$CD = ((n_c \cdot D_c) / a) - SPM \quad \text{[spm]} \quad (3)$$

$n_c$  - Revolution per minute of conveyor motor / handwheel

$D_c$  - Diameter of conveyor handwheel

$a$  – Distance between 2 components which'll be stamped on conveyor

**NOTE : If  $CD > 0$  we'll take it 0. Because it means conveyor has enough speed so there is no delaying. If it's smaller than 0 we'll take absolute of the value. And if there is no conveyor it means components are in the box or a similar stuff. So there's a manual operation. It means it's operator delaying.**

OD – Operator delaying

$\Sigma OL$  – We may assume operation losses 0. Because there is no automation on manual press.

QCD – Quality control losses (another type of operator delaying)

BD – Boxing operation losses, it's also operator delaying too.

# Manuel Tandem Line

We can add all operator delayings to OD. So final form of calculation;

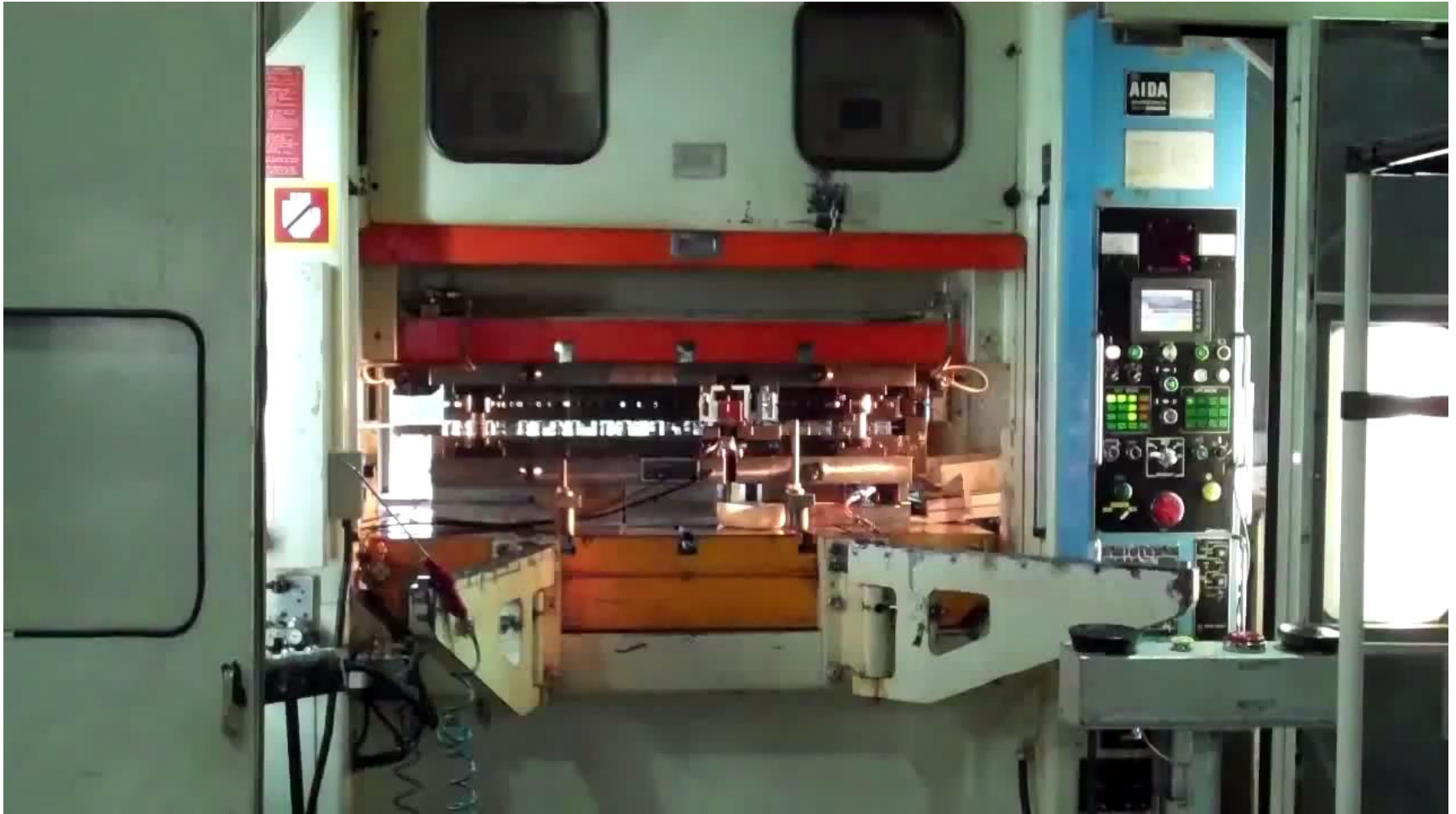
$$FSPM = SPM - (| ((n_c \cdot D_c) / a) - SPM | + OD) \quad [spm] \quad (4)$$

## 2.5 Progressive presses

These group have coil feeder unit and a high-speed press. So it can produce without feeding losses on high spm values. Progressive dies have all mold operation in only 1 mold. It means dimensions and stamping forces are not large like other stamping technologies. FSPM calculation;

$$FSPM = SPM - \Sigma FL - \Sigma OL - \Sigma RL \quad [spm] \quad (1)$$

# Progressive Press



# Progressive Presses

$\Sigma FL$  – Coil feeder and press have common link but they are separated type units. So each of them have their own SPM. Coil feeder step value should be enough to feed press SPM and input degree values're correct press speed

$\Sigma FL = 0$ .

$\Sigma OL$  – is a function of coil feeder radial speed and step of coil feeder. As we described a coil feeder which can enough to feed progressive press is main rule of this system so generally there is no losses on feeding in these systems. We can assume that this value equals to 0.

$\Sigma RL$  – There are always conveyors or outrun metal holes after the progressive mold. So there is no losses after the progressive operation. It means this value it zero too. So final calculating of progressive presses is like this;

$$FSPM = SPM \quad [spm] \quad (5)$$

So; we can say that this is the most effective system for stamping operation. There is only one disadvantage; dimensions of product. As we said we can not product gross parts in these systems.

# Robotic Press Lines

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## 2.6 Robotic press lines

“Robot” is a word which came from feudal age that used for the people who should work in the farms belong to wealthy people before their farm. Most bibliographies say the word’s from Russia but the thing is it’s started to use in Czechoslovakia. In 1920, a writer Karel Capek used this word in his theater which referred for an artificial humanlike creatures built for being inexpensive workers. This theater was “Rossum’s Universal Robots”.

After that; robots’ve been staged on industrial production. Today industrial robots and robotic systems are key components of automation. More than 1.1 million industrial robots are operating in the factories all over the world:

- Improving quality of work for employees
- Increasing production output rates
- Improving product quality and consistency
- Increasing flexibility in product manufacturing
- Reducing operating costs.

# Robotic Press Line

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# Robotic Press Lines

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Software of robots; In this age; most robotic systems use The RAPID program. The RAPID program templates for a robot executes a pick-and-place cycle for one of the configured flows in every loop. The selection of flow is made in priority order among the flows which currently are ready to execute, that is, having targets generated for the next operation on both the infeeder and the outfeeder. The robot movements and the I/O events on the infeeder and outfeeder are performed according to the configured operation sets and formats. The RAPID program templates includes functionality to generate safe intermediate positions for the movements between infeeders, outfeeders and the home position. To run a PickMaster project you need RAPID program modules and system modules, which are described in this section.

RAPID template modules: The PickMaster installation includes the following two RAPID template modules:

# Robotic Press Lines

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- PmMain, which is a program module that contains basic code to execute the operations in different work areas.
- PmUtility, which is a program module that contains home positions and intermediate positions.

The RobotWare option Prepared for PickMaster, together with the sub-option PickMaster 5, includes the following two RAPID template modules:

- PmProjMgr, which is a program module that contains basic code to execute the commands from PickMaster I/O interface.
- PmProjServer, which is a program module that contains basic code to execute the commands from PickMaster I/O interface, executed in a semi-static RAPID task.

# Robotic Press Lines

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## 2.6 Robotic press lines

PmMain module: This section describes the routines and variables in the PmMain module. The module contains the main procedure for the PickMaster RAPID execution, and it is where the program starts the execution. This section procedures are like these; Main, OperateSequence, Operate. Each module includes the routines. The routine is re-executed for every new pick and place cycle. The error handler is used to recover an error when running a pick and place cycle including a stack search on the master work area. To recover PM\_ERR\_JOB\_EMPTY, follow these directions:

- 1 - Move back the robot in the negative search direction.
- 2 - Eliminate the cause of the error, for example, fill up with new pallets.
- 3 - The position request DO signal is set on the master work area after an empty stack is detected. Generate a new job on the master work area.
- 4 - Recover the error in the error handler using RETRY. As a result the robot will start the new job and a new pick and place cycle is started.

# Robotic Press Lines

Sample of a routine code;

```
PROC Main()  
IF FirstMainLoop THEN  
MoveHomePos;  
FirstMainLoop:=FALSE;  
ENDIF  
PmWaitProjStart;  
OperateSequence;  
ERROR  
IF ERRNO = PM_ERR_JOB_EMPTY THEN  
RETRY;  
ENDIF  
ENDPROC
```

For FSPM calculation;

$$\text{FSPM} = \text{SPM} - \Sigma\text{FL} - \Sigma\text{OL} - \Sigma\text{RL} \quad [\text{spm}]$$

(1)

# Robotic Press Lines

$\Sigma FL$  – Feeding systems are generally destacker and centering system in press lines. These are the slowest point of the line. Destacker losses effect centering losses and it effects input robot's losses before the first press. So we can assume that feeding losses equal to input robot's losses ( $RD_i$ )

$\Sigma OL$  – Robots are works due to 2 order. Input and output. For robotic press lines this values are main flywheel's degrees. If it's well optimised robot goes to inside of press before  $360^\circ$  and  $180^\circ$ . So we can say delaying equals to variation of flywheel degrees. So we can say that only losses in here are robot delayings ( $RD$ ) due to communication adjustments (input-output degrees)

$$\Sigma OL = RD \quad [spm]$$

(6)

$\Sigma RL$  - Generally companies want to adjust final robot within not delaying to main system (press or others) . For welding or transporting plants there're always delaying because of final robots but for a robotic press line; final robot always take the part from last press and put it on a conveyor which placed in the nearest point to the robot. So there is no delaying for removing part from last press. So final form of calculation is like this;

# Robotic Press Lines

$$\text{FSPM} = \text{SPM} - \text{RD}_i - \text{RD} \quad [\text{spm}]$$

(7)

Robotic press lines are specific cell type press lines. They generally include more than 1 press and robot. So we can assume a more handy formula for these lines. Cycling time is the identifier parameter. So total cycle time is related to summary of robot and press slide's cycling time.

$$\text{FSPM} = 3600 / (t_{ri} + t_s + t_{ro}) \quad [\text{spm}]$$

(8)

$t_{ri}$  - Cycling time of the input robot which puts the part in to the press. Total cycle time doesn't include input robot's delaying. It's only related to output values. So input robot's cycling time always equals to 0.

$t_s$  - Slide's cycling time. It's respected to basic RPM value.

$t_{ro}$  - Cycling time of the input robot which puts the part in to the press. So final calculation is like this;

$$\text{FSPM} = 3600 / (t_s + t_{ro}) \quad [\text{spm}]$$

(9)

# Robotic Press Lines

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**Note: Output robot's cycling time always equals to slowest robot's cycling time. In the other words; in normal conditions final robot is the fastest one because of it doesn't need an output degree. But the slowest robot in the line sends its effect to the all robots on the next stations. So final robot shows same characteristics with it. So if we want to optimise cycle time, we should optimise slowest robot's values.**

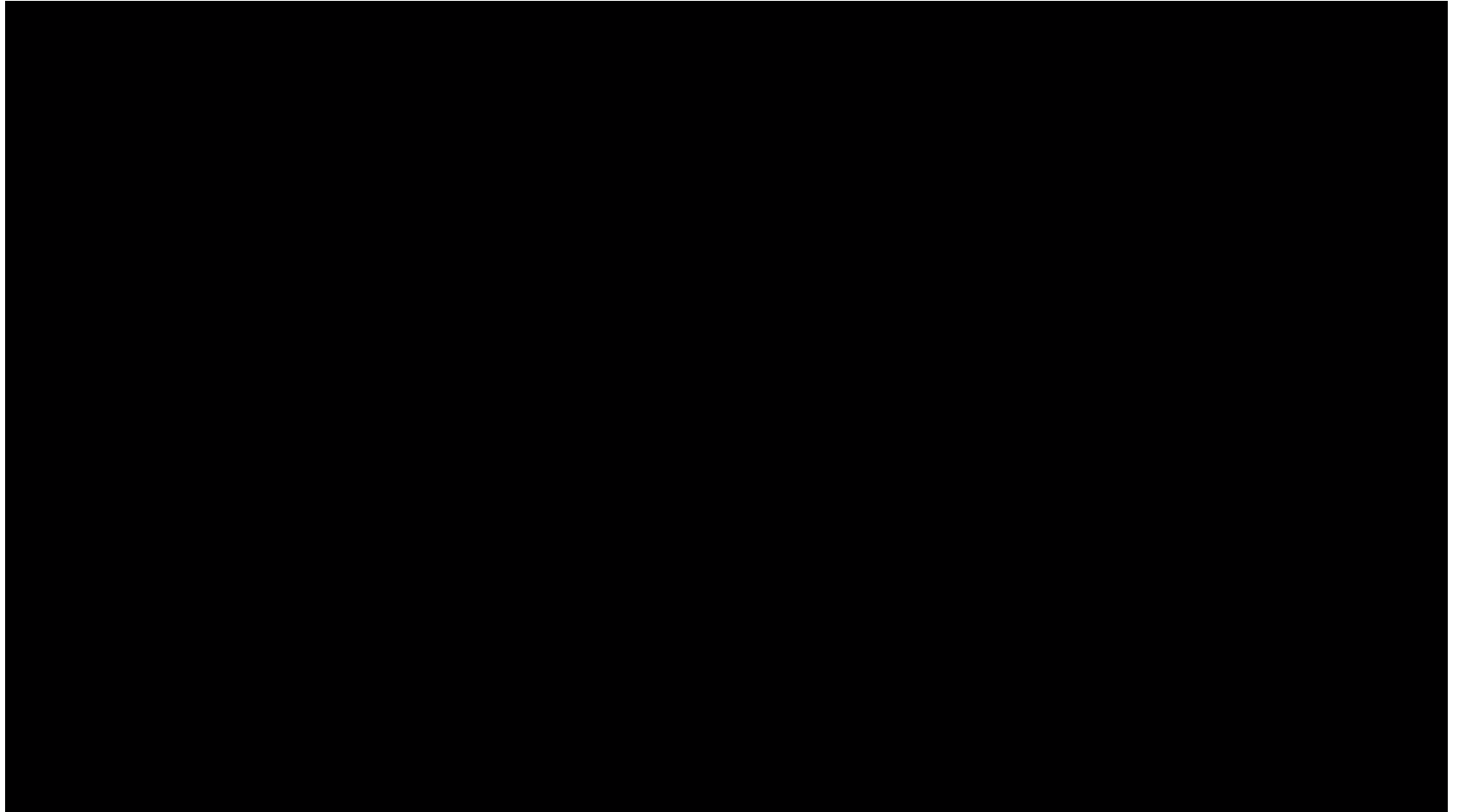
## 2.7 Transfer presses

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.

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.

# Transfer Press Line

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# Transfer Presses

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Large transfer presses have force capacities of 3500 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.

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.

# Transfer Presses

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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. 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. 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 Presses

For FSPM calculation;

$$\text{FSPM} = \text{SPM} - \Sigma\text{FL} - \Sigma\text{OL} - \Sigma\text{RL} \quad [\text{spm}]$$

(1)

$\Sigma\text{FL}$  – Feeding is always with conveyor or coil driver in this unit. In both situation they should be faster than press and transfer bars. So there is no losses on feeding system and it equals to 0.

$\Sigma\text{OL}$  – It includes transfer bar cycling losses. For best performance; there should be no delaying because of the transfer bars. It means; transfer bar movements on X,Y,Z axes should be minimum too. ( $L_x, L_y, L_z$ ) Y axis movement put in to words distances between molds. For minimum movement it should have minimum distances from the design of the molds. X and Z axes movements can be adfust by press operators.

$\Sigma\text{RL}$  – There's always conveyor on the output point of transfer presses. So this value equals to 0.

So final form of FSPM calculation is like this;

$$\text{FSPM} = \text{SPM} - (L_x + L_y + L_z) \quad [\text{spm}]$$

(10)

# Benchmarking

## 3. Benchmarking of Press Types

We can make a table to benchmark for press technologies. Due to all information on the former papers we choose categories, operators, machine park, costs, product mass and production rates and results are like these;

Table 1 . Benchmarking Press Types.

	Manuel	Progressive	Robotic Press Lines	Transfer Presses
Number of operator	5	1	3	1
Machine Park	5 press	1 press 1 coil feeder	5 press 7 robots 1 destacker unit 1 centering unit	1 press 1 feeding unit 1 transfer unit
First investment cost	Low	Low	Average	High
Operating cost	High	Low	Average	Low
Product mass	Large	Small	Large	Large
Production rate (spm)	3-5	10-70	4-9	10-25

# Safety

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## 4. Safety Issues

By the technological developments; safety improvement've developed too. They've been described below;

Overload devices

Safety cloumns

Safety sensors

Safety picketings- safety doors

Slide lockings

Cubic space scanners

Softwares for safety

# TEŞEKKÜRLER

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**THANKS...**

**GRACIAS...**

**MERCI...**

**DANKE SCHÖN...**

**SPASIBO...**

**XIE XIE...**

**SUKRIYA...**

**KAMSAHAMNIDA...**

**ARIGATO...**

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