## HANDBOOK OF DIE DESIGN FOR TRANSFER PRESSES



DESIGN, ASSEMBLY AND ADJUSTMENT OF TRANSFER BARS



#### INTRODUCTION



Until the transfer system of a multiple-die press is finally set in motion, many professionals of different areas have taken part in the process before.

However, as a professional works in these projects in an isolated way, he doesn't usually know the difficulties found by the other participants and, what's more important, how his work affects these other experts.





The main objective of this handbook is to **spread** the knowledge acquired in our area of specialization in order to **facilitate the whole work** of integrators, manufacturers of dies and final users (companies stamping metal sheets).

In the following pages, we highlight the most usual problems found by experts in fastening and handling areas, and we **propose a solution.** We wish this advice is useful for you so that you can use it in future projects for stamping processes.

#### TRANSFER PROJECT



Following the chronological order in design, assembly and adjustment of a transfer, we will review the technical aspects which directly affect to the fastening and transfer of a sheet between dies, and so to productivity, reliability and cost of the transfer.

- 1. Standards
- 2. Die design: geometry
- 3. Transfer: which information should we know?
- 4. Fastening systems for transfers
  - 4.1. Shovels
  - 4.2. Suction pads
  - 4.3. Pincers
    - 4.3.1. Which gripper finer should be used?
    - 4.3.2. Which pincer should be used?
    - 4.3.3. Points from where to fasten the sheet
- 5. Assemblies: rigidity, adjustment, degree of freedom, etc.
- 6. Pneumatic and electrical installation
- 7. Implementation of the pincer-holder bar to the transfer
  - 7.1. Adjustments and connections of assemblies
  - 7.2. Position of pincers
  - 7.3. Anchorage to the transfer
- 8. Adjustment
- 9. Signals of the process
- 10. We can check your project

#### Appendix I

Guide to design and assemble a pincer-holder bar correctly

#### **Appendix II**

- i. Sliding force
- ii. Travel of the press
- iii. Stroke of the transfer
- iv. Cycle of the transfer
- v. Holding force
- vi. Dimensions
- vii. Operating time
- viii. Weight
- ix. Types of minipincers
- x. Adjustment
- xi. Non-reversibility

#### 1. STANDARDS



It is an essential requirement to ask for the standards and specifications of the customer and to follow the instructions about:

- Press: dimensions, power, electrical & pneumatic specifications, etc.
- Die design: considerations, constructive criterions, etc.
- Transfer: strokes, bar dimension, fastening of the pincer-holder bar, etc.
- **Elements for the transfer bars:** mechanical, electrical and pneumatic components, etc.





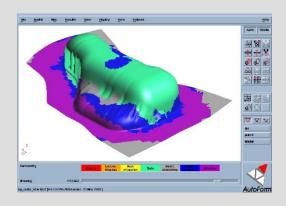




#### 2. DIE DESIGN: GEOMETRY



Dies always must fit the geometric specifications of the sheet to stamp. In order to design a die, you can get help from specific simulation softwares for stamping metal sheets, such as Autoform, Pam-stamp, etc. With them, you can quantify stress, lengthening of the material, fissures, etc., according to the shape and phases of the deformation of the sheet.



There are, however, a number of **geometric aspects** to be taken into consideration when designing a die:

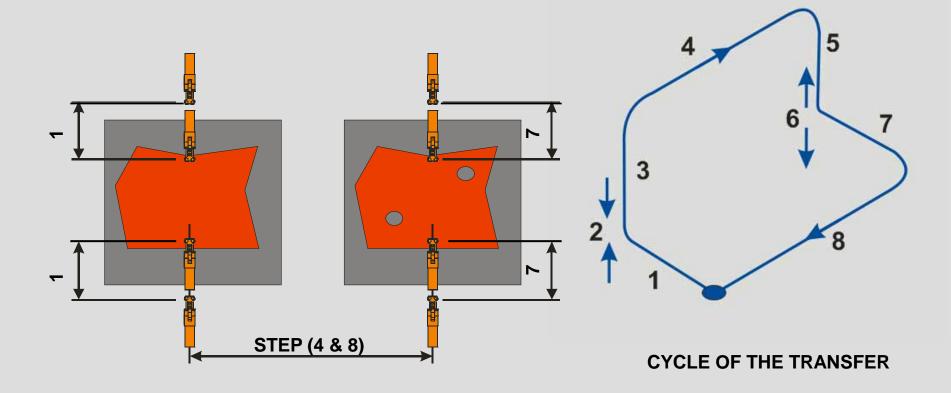
- Minimum size of the die
- No obstacles to enter the die
- Positioning of the sheet
- External margin of the sheet
- Minimum height between sheet and die
- Sheet collection and drop points
- Displacement at the three shafts of the transfer
- The sheet turns on its transverse shaft
- The part turns on its horizontal / vertical shaft

#### 2.1. Minimum size of the die



Dimensions of dies need to be as small as possible. We have to take into account:

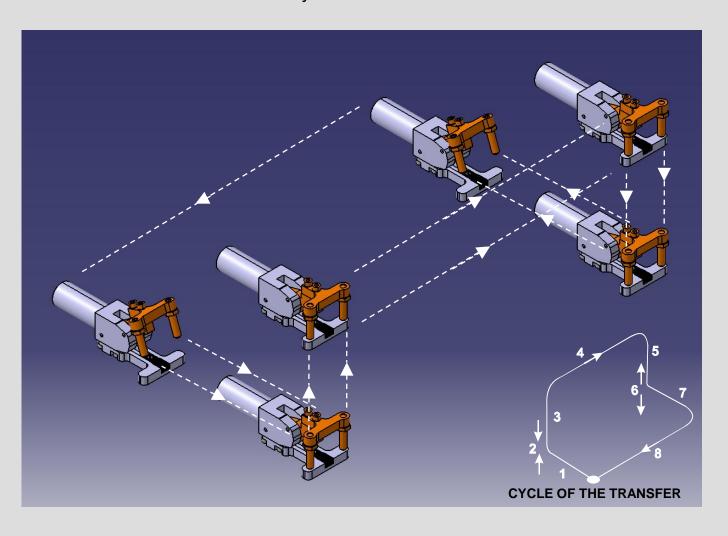
- distance between shafts of dies (step)
- external size of the die to the sheet



#### 2.2. No obstacles to enter the die



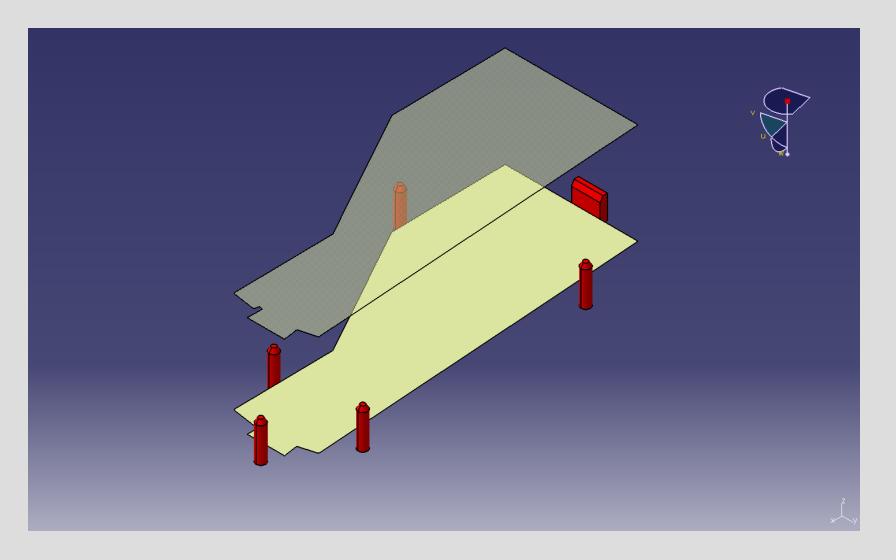
When the press is open, the lower part of the die must be free of any obstacles, such as guide columns, centring pins, slides, etc., so that pincers can move freely during the entry path, their displacement between dies and their way out at different levels.



## 2.3. Positioning of the sheet



The sheet to handle must be perfectly placed on the die, with no degrees of freedom except for the vertical one which allows it to be removed.

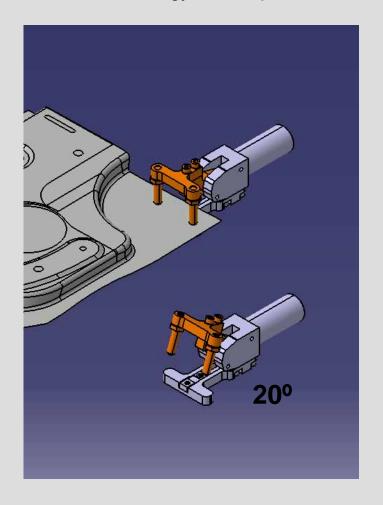


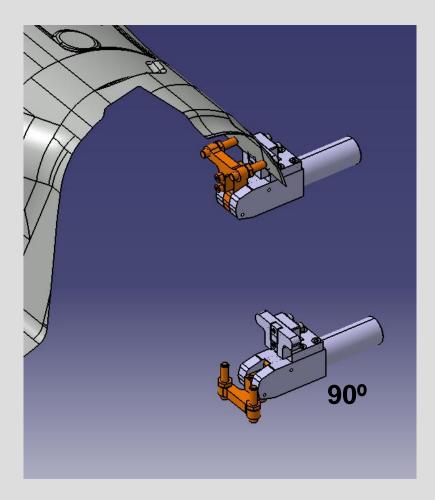
## 2.4. External margin of the sheet



The sheet that is being shaped at the different dies needs to have steady external margins or flanges, preferably horizontal.

If the sheet is fastened horizontally, we can use pincers with a smaller opening (20°), so the cycle is shorter and the energy consumption is lower.

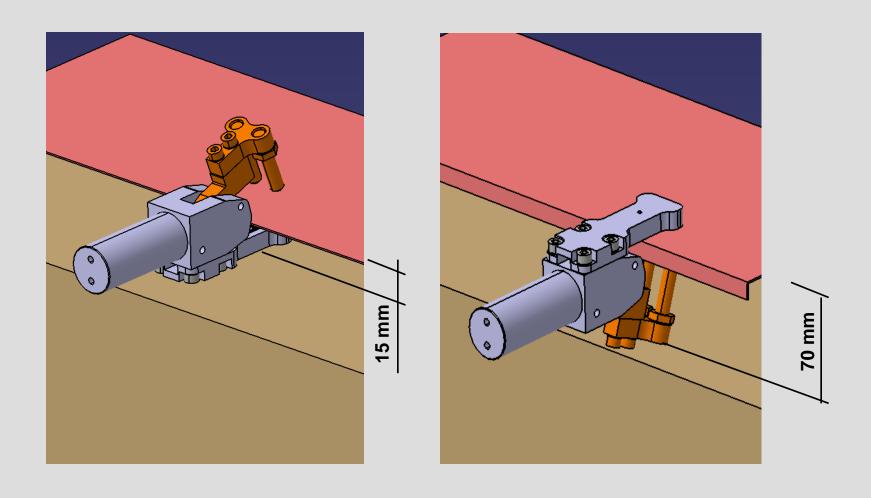




## 2.5. Minimum height between sheet and die



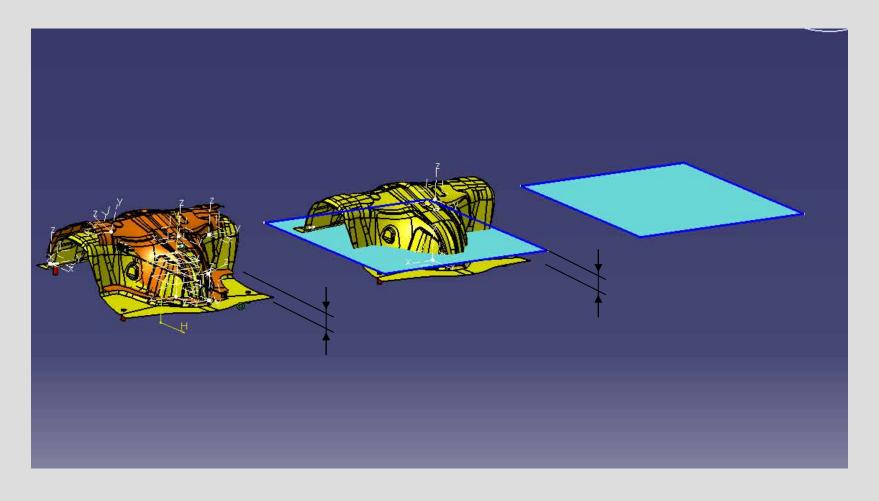
Once the sheet is stamped, there must be a minimum height ( $15 \div 70$ mm) between the lower part of the sheet and the die so that the pincer can enter and fasten the element.



## 2.6. Sheet collection and drop points



If the collection point of the sheet in a die is at the same height as the drop point of this sheet on the next die, linear displacement units will be avoided because the transfer will carry out the same stroke.



## 2.7. Displacement at the 3 shafts of the transfer



200

In some cases, it's possible to simplify the design of the die or the stamping process if we use **linear displacement units**. With them, displacement in any of the three shafts of the transfer can increase or decrease.

They are very quick but the cycle doesn't increase because the operating time is superimposed to the transfer cycle.

> Step of the transfer (±200mm max.)

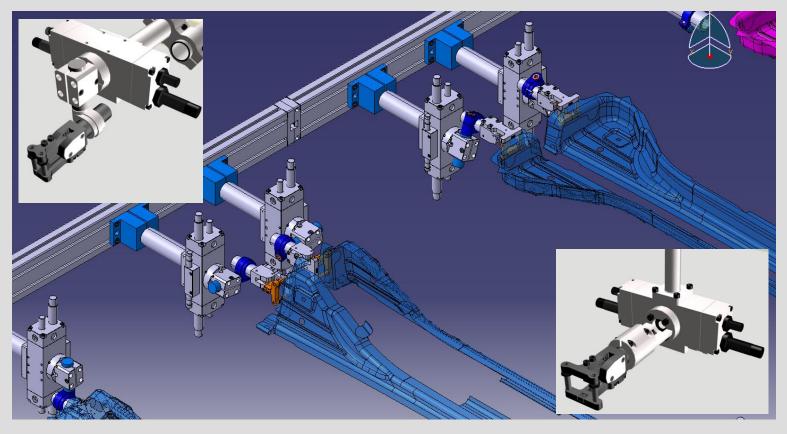
STEP STEP ± 200 STEP

Height between dies (±200mm max.)

#### 2.8. The sheet turns on its transverse shaft



The **turning unit** turns the part on a specific angle between a die and the next one. As it's possible to stamp on the other side of the sheet, dies become greatly simplified.



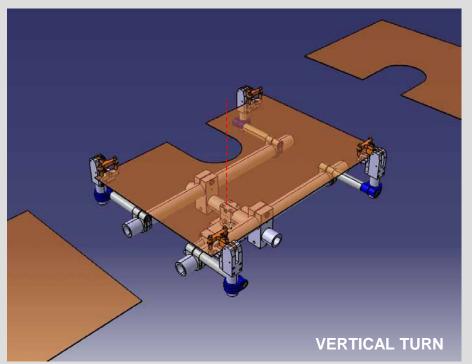
The turning unit turns the sheet on its rotation centre. In order to guarantee the sheet being perfectly fastened, pincers must be placed on the necessary radius of the rotation shaft.

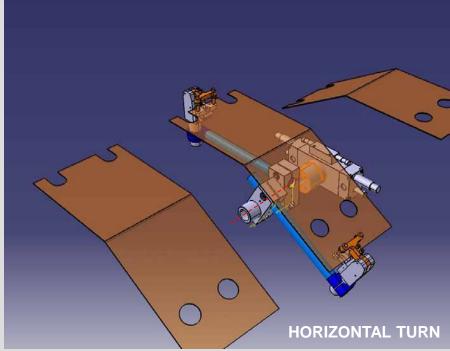
In case of using several turning units between adjoining dies, they should be aligned with the rotation centres of the sheet. Thus, height compensation would be disregarded.

#### 2.9. The part turns on its horizontal/vertical shaft



When a part needs to be turned on its horizontal shaft, **turning units** may be used on the profile of the bar as they permit to **adjust rotation between 0° and 182°** (see point 2.8.). Like linear displacement units, their operating time is superimposed to the transfer cycle.





Sheet rotations on a vertical or horizontal shaft (feed shaft) must be executed, if necessary, on static stations between dies.

## 3. TRANSFER: WHICH INFORMATION SHOULD WE KNOW?



Whichever elements will make up the transfer system to handle sheets, we will need to collaborate with the company stamping metal sheets.

To be more precise, we will need to know the following technical information of the transfer:

- Maximum strokes on the 3 shafts and end positions.
- Technical information of the transfer bar: dimensions, section, centering and type of fastening of the pincer-holder bar.
- Direction of travel with regard to the front of the press.
- Dynamic parameters: speed, acceleration, maximum load, simulation following the control of the transfer, if possible.

#### 4. FASTENING SYSTEMS FOR TRANSFERS



There are different options to handle pieces between the dies of a multi-die press. Naturally, each system has its advantages and disadvantages (see Appendix at the end of this presentation).

Simple system with no pneumatic connections. Handling with Prisk of losing position with high accelerations. shovels: ? To be centred during handling, sheets need to have sharp and steady edges on a horizontal plan. You can do without raising the sheet on the die once the piece is stamped. P High energy consumption. Handling with suction pads: P It can only hold the upper and flat side of the sheet. Low acceleration during handling. Maximum reliability: total fastening of the piece. Low energy consumption. Handling with Quick amortization thanks to its low consumption pincers: and its higher productivity.

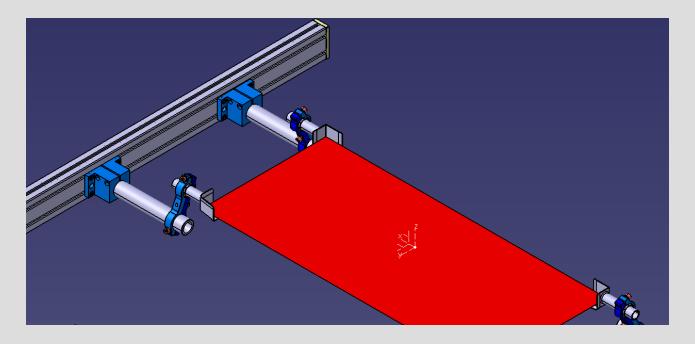
Less initial cost with regard to shovels (11.5%).

P Higher initial cost with regard to suction pads(86%)

## 4.1. Handling with shovels



Handling with shovels is a simple and economical system. However, the sheet to transfer needs to have steady and clearly defined external edges on a horizontal plan.



If you decide to use shovels, you will have to take into consideration the following points:

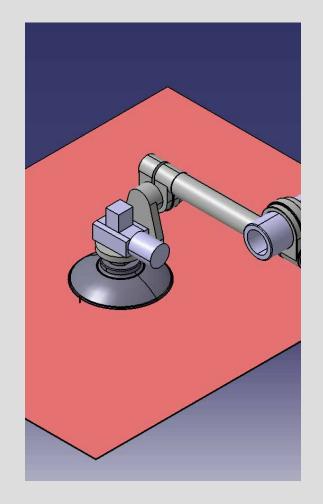
- Accelerations and vibrations may cause us to lose the reference of the sheet in high-speed displacements.
- A barrier sensor to detect the sheet should be added to control the process.
- Shovels cannot be used in turning operations or when fastening only on one side of the sheet (cantilever).

## 4.2. Handling with suction pads



With suction pads, it is not necessary to raise the sheet on the die once the part is stamped because handling affects only on the upper part. Nevertheless, using suction pads also demands:

- Higher fastening surface when holding the sheet (see Appendix II, i.)
- Higher retention force with accelerations (see Appendix II, i.)
- Higher vertical stroke (2 actions) of the press (see Appendix II, ii.)
- Higher horizontal stroke (2 actions) of the transfer (see Appendix II, iii.)
- Higher transfer cycle (2 extra actions) (see Appendix II, iv.)
- More operating time
- More air consumption



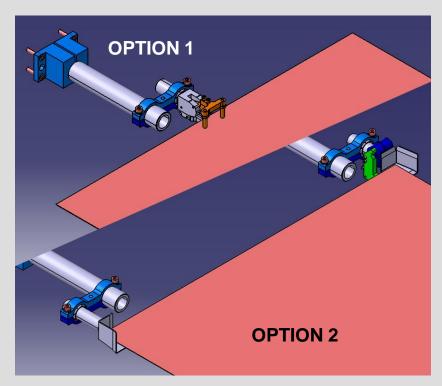
These requirements affect seriously to productivity and production costs.

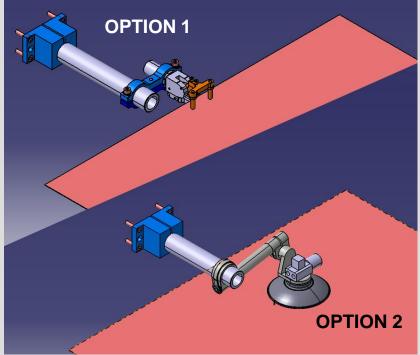
## 4.3. Handling with pincers



At first, **pincers** have a higher cost regarding suction pads (86% approx.). However, they are **quickly amortized** thanks to its low consumption and its higher productivity. And, compared to shovels, pincers are even **more economical** (11.5% less cost).

The best quality of the pneumatic pincer lies in its **complete reliability**: the part that is handled is fastened with no degree of freedom at all times. Sheets can even be transferred at high accelerations and vibrations with no risk of losing their position.



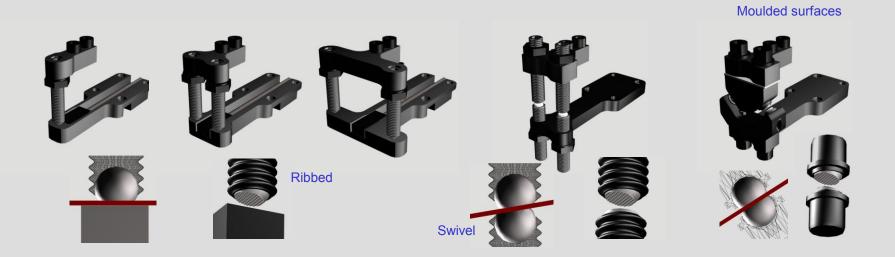


## 4.3.1. Which gripper finger should be used?



The shape of the sheet and the type of fastening will determine the gripper finger to use:

- Ribbed: it provides a high lateral retention
- Swivel (ball-ended screw): adaptable to the surface of the sheet
- Small surface: high specific pressure and possible mark on the sheet
- Moulded surface: special solution

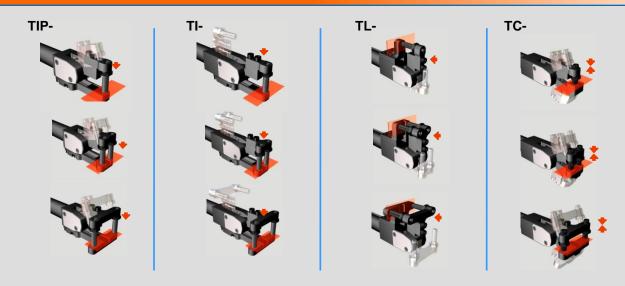


Our advice: use a standard gripper finger in order to avoid designing and manufacturing special elements. The centering of the sheet before and after the stamping process has to be determined at the die, on some external points of the sheet or on some interior holes.

#### 4.3.2. Which pincer should we use?



RANGE OF MISATI PINCERS



In order to choose the most suitable pincer for each application, we **recommend** bearing in mind:

• Holding force: it has to be high to guarantee the total fastening of the part and to avoid displacement

of the sheet or losing the position at high accelerations (see Appendix II, v.)

Dimensions: pincers should be as small as possible to adapt to shaped sheets and to facilitate their

access to small cavities of the die (see Appendix II, vi.)

Opening angle: it needs to be small to reduce the productive cycle and consumption (see Appendix II, vii.)

It should also allow to fasten the flange vertically or horizontally (see drawing above)

• Weight: the smaller, the less mass in movement, so productivity will increase (see Appendix II, viii)

• Non-reversibility: if the pincer is non-reversible, detachments and incidents are prevented

(see Appendix II, xi.)

• Adjustment: it is easier with ball joint mountings (see Appendix II, x.)

• Interchangeability: if range and fastening of pincers are standard, they will be interchangeable in case of

modification of the sheet (see drawing above)

#### 4.3.3. Points from where to fasten the sheet



It's better to use 2 small pincers than a bigger one. Parameters to bear in mind when it comes to determine the fastening points for a safe handling will be:

- Dimensions of the sheet
- Acceleration of the transfer

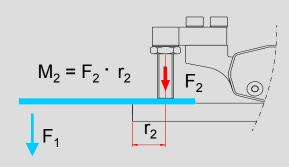
Weight of the sheet

Geometry of the sheet

1 pincer → cantilever

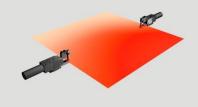


Pincers with a higher force and with extended response mountings that can withstand the torque reaction on the pincer should be used when handling cantilever sheets.





2 pincers → symmetrical



3 pincers → triangle



4 pincers → at the ends



#### 5. ASSEMBLIES



An assembly consists of a pincer and some standard mountings. These assemblies are mechanically held on a slot aluminium profile or pincer-holder bar, which, in any case, will allow them to be adjusted continually.

Each assembly must fulfil the following conditions:

- Rigidity of the mountings to the pincer → It's better to use a Ø40 tube than a Ø25-30 one and mountings that fasten to the profile double slot.
- Easy adjustment of the pincer → specially when using ball joint mountings.
- Degrees of freedom & accessibility → All necessary degrees of freedom –6 degrees maximum (3 displacements and 3 turns)— with the minimum number of mountings.
- Reuse of elements in future stamping lines.

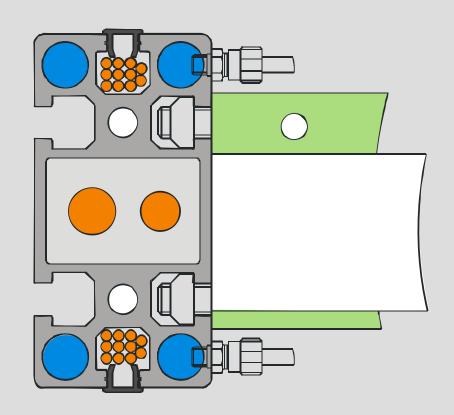


## 6. PNEUMATIC & ELECTRICAL INSTALLATION (I)



The pincer-holder bar has internal holes that channel the air to the pincers, turning units and displacement units. Electrical connections of these pincers and turning units detectors are carried through the exterior of the profile (with cover).

This kind of pneumatic connection grants an accurate synchronism in the closing and opening of the pincers as they are all run by the same solenoid valve.







Both pneumatic and electrical connections finish with a connector (which can change according to the customer's guideline) and go out by the end of the pincer-holder bar.

## 6. PNEUMATIC & ELECTRICAL INSTALLATION (II)



The pincer-holder bar might be used as a mechanical support for assemblies and as a conductor of all the connections to assemblies.

Thus, the profile is free from any external connection, which provides a better accessibility, higher protection and more simplicity to handle the pincer-holder bar when stored.





Example of electrical connector (M12x1) for the sheet detectors. It leads the wire that is connected with the exterior of the transfer (harding).

## 7. IMPLEMENTATION OF THE PINCER-HOLDER BAR TO THE TRANSFER



Before implementing the pincer-holder bar to the transfer, it is **very advisable** to check some parameters from the implementation drawings...

...plan view (see 7.1.)

- Suitability of the assemblies on each die, good accessibility and adjustment
- Pneumatic and electrical connections to the exterior
- Fastening points and centering of the pincer-holder bar to the transfer bar

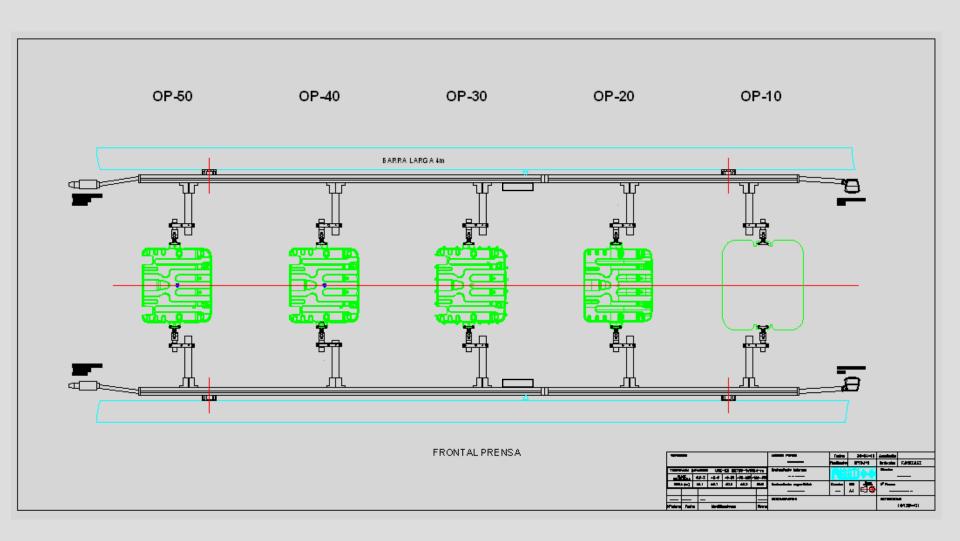
...elevation view (see 7.2.)

- Position for picking the sheet
- Liberalization of the pincer in a closed die
- Stroke of the assembly (in the area of the transfer bar)
- Fastening the pincer-holder bar to the transfer bar

Then, the pincer-holder bar has to be **anchored** to the transfer, always following the instructions and guidelines of the final customer.

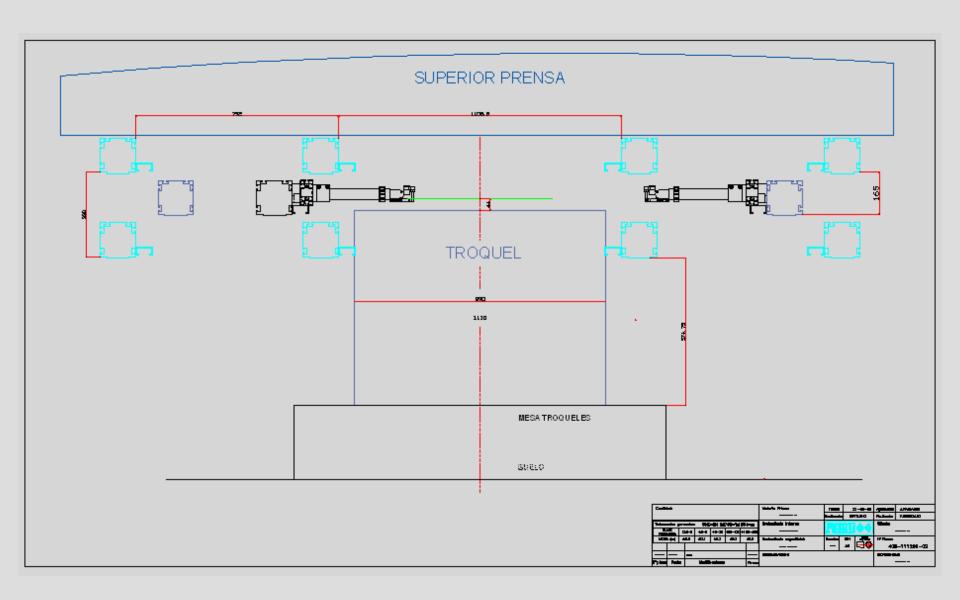
## 7.1. Implementation drawing (plan view)





## 7.2. Implementation drawing (elevation view)





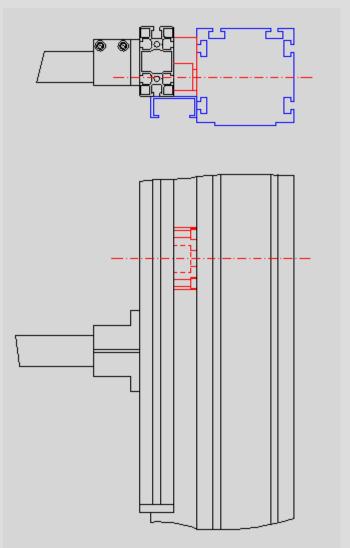
## 7.3. Anchorage to the transfer



Always according to the customer's guidelines, it will be defined the centering, support and fastening of the pincer-holder bar to the transfer bar.

This intermediate part will be fastened to the pincer-holder profile slots.





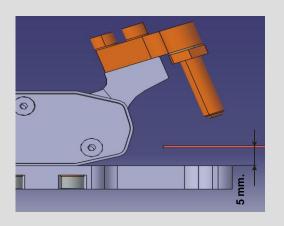
## 8. ADJUSTMENT (I)



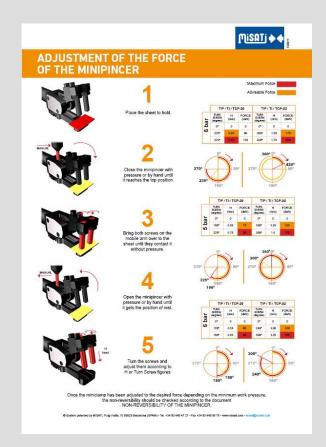
The starting point will be the initial conditions of the system:

- Open press
- Transfer bars in a lateral and lower position
- Stamped sheets on the dies
- Force adjustment on pincers depending on the thickness of the sheet

With the pincers open, we will move them closer to the sheet to handle and adjust the static reaction. If the mounting of the pincer has a ball joint, the adjustment will be easier.



At the point of entering, the recommended distance between the sheet and the reaction mounting of the pincer should be 5mm approx.



(available at www.misati.com)

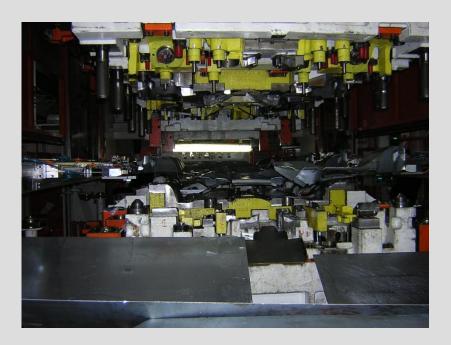
At that very moment, we can switch through the solenoid valve so that pincers close; simultaneously, the transfer rises. It's important to make sure that the centring pins of the sheet do not get lost until the pincer is closed.

## 8. ADJUSTMENT (II)



#### Then, it will be necessary to check:

- that, in its minimum elevation, the transfer can save any obstacles when moving. It's important to take
  into account the buckling of the sheet on the first operations, during high speed movements.
- that the sheet enters vertically over the centring pins of the next die. Pincers must not open until we
  are sure that the sheet is well-centred on the die.





If possible, make a press-transfer process **simulation** at the simulator or with PressLine Simulation, Pressim, etc. programs. This way, we can optimize the *lay-out* (conveyance heights, pincers evolution, etc.) and detect any possible errors and collisions before the *try-out* and production.

#### 9. SIGNALS OF THE PROCESS



It's an extremely important matter to control the position of the sheet at all times.

Conditions of the process need to be checked in each step: presence or lack of sheet, presence of double sheet, starting time, etc. These signals give reliability to the system.

The objective is to achieve a **constant and safe** production process with **controlled incidents**, even if it's at the expense of a higher speed.



Signal: presence of the sheet



Signal: closing & opening of the arm



Signals (double sheet): sheet + position of the arm

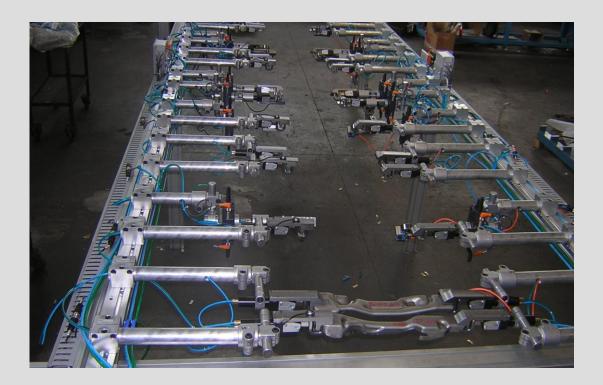
#### 10. WE CAN CHECK YOUR PROJECT



MISATI Technical Department is at your disposal to offer you technical advice and to check your application (with our elements).

As experts in the fastening and handling areas, we want to guarantee you that your application is correct and meets the requirements of good functionality and high level of achievement.

Only if manufacturers of dies, companies stamping metal sheets and integrators work all together from the beginning of the project, optimized transfers presses (highest production and reliability at the minimum cost) can be conceived.



#### **APPENDIX I**



This appendix tries to be a **GUIDE TO DESIGN AND ASSEMBLE A PINCER-HOLDER BAR CORRECTLY**...

To make the study and quotation of your transfer, we need this information:

- Guideline of elements for transfer bars.
- 3D file (Catia, STEP, IGES) with the different states of the part in each operation and elevation.
- Dimensions of the die in each operation and step between dies.
- Information of the press and platform height.
- Information of the transfer, strokes, dimension, centering and fastening to the bar.
- Technical information of the electrical and pneumatic inputs of the installation.
- Physical parts of each step of the transfer, if available and in case dies are already manufactured.
- Offers delivery final date.

# Appendix I. Phases of a project for a pincer-holder bar



Which gripper finger should be used? (see 4.3.1) Which pincer should be used? (see 4.3.2) Points from where to fasten the sheet (see 4.3.3) Assemblies (see 5) Pneumatic and electrical installation (see 6) Implementation of the pincer-holder bar to the transfer (see 7)

Mechanical, electrical and pneumatic assembly

#### **APPENDIX II**



Now, some technical aspects of the pincers will be added in order to better understand how they work.

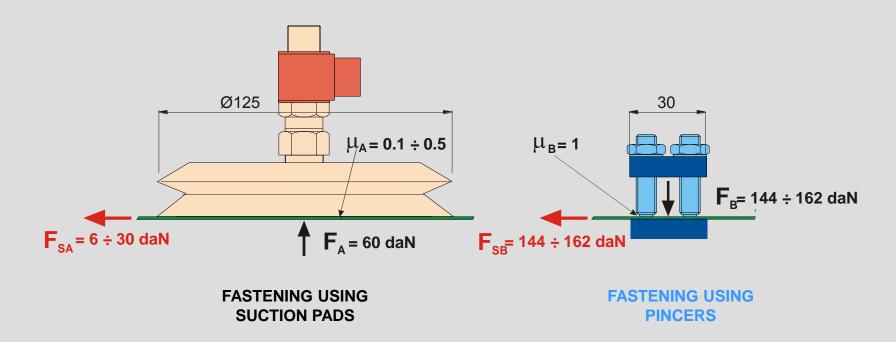
This information has been taken out from a more complete presentation that you can download from our website www.misati.com (tecnico@misati.com):

- i. Sliding force
- ii. Travel of the press
- iii. Stroke of the transfer
- iv. Cycle of the transfer
- v. Holding force
- vi. Dimensions
- vii. Operating time
- viii. Weight
- ix. Types of minipincers
- x. Adjustment
- xi. Non-reversibility

## Appendix II, i. Sliding force



If we compare the fastening force (F) and the friction coefficient ( $\mu$ ) of these two fastening systems (pincer and suction pads), we will see (...)

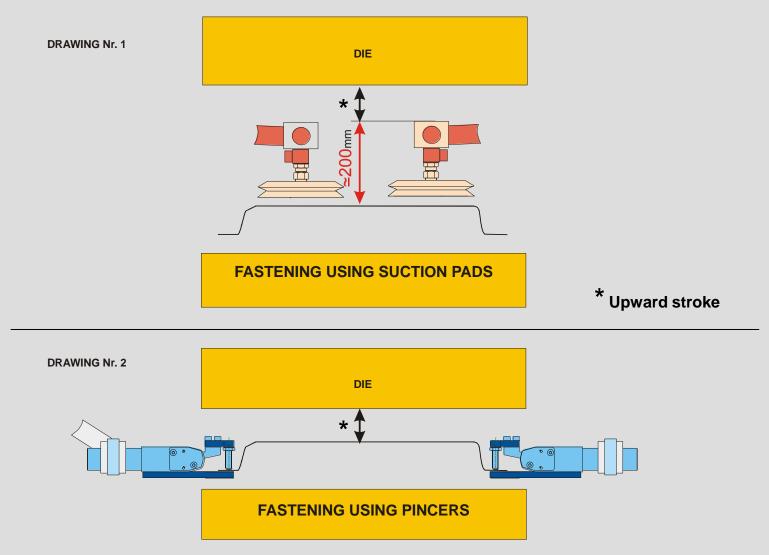


(...) that pincers give a higher sliding force (FSB). As there is no slide between the pincer and the sheet to handle, there is an increase in the acceleration of the transfer or the robot; therefore, production increases.

Other features to bear in mind when applying a pincer or a suction pad is the area taken, the non-detachment, the low consumption and the operating time.

#### **Appendix II, ii. Travel of the press**

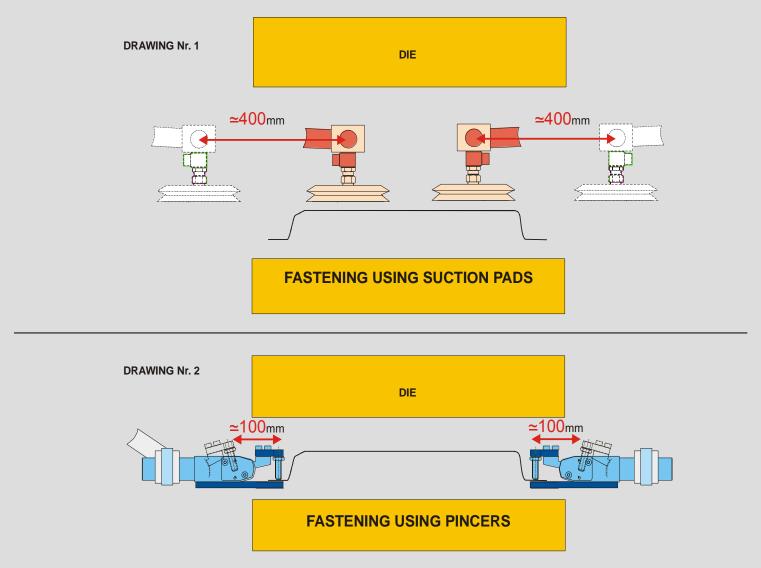




Unlike the suction pad, which has to fall on a flat and central area of the sheet, with the pincer it's possible to hold the sheet through the outer edge. As the displacement of the press is reduced, **production** increases.

## Appendix II, iii. Stroke of the transfer



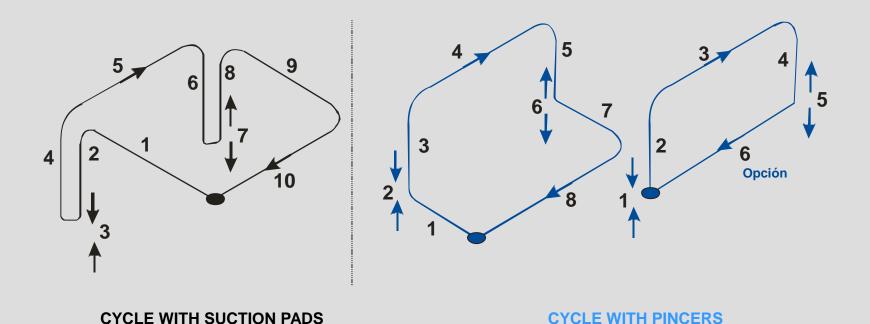


Transverse stroke of the transfer reduces when the sheet is held through the outer edge. As the distance to cover is shorter, **production increases.** 

## Appendix II, iv. Cycle of the transfer



With pincers it's possible to hold the sheet through its outer edge. As they do not need to go down to take the sheet, two **vertical movements** can be saved (# 2 & 8 of the cycle with suction pads). So, less movements mean an increase in production.

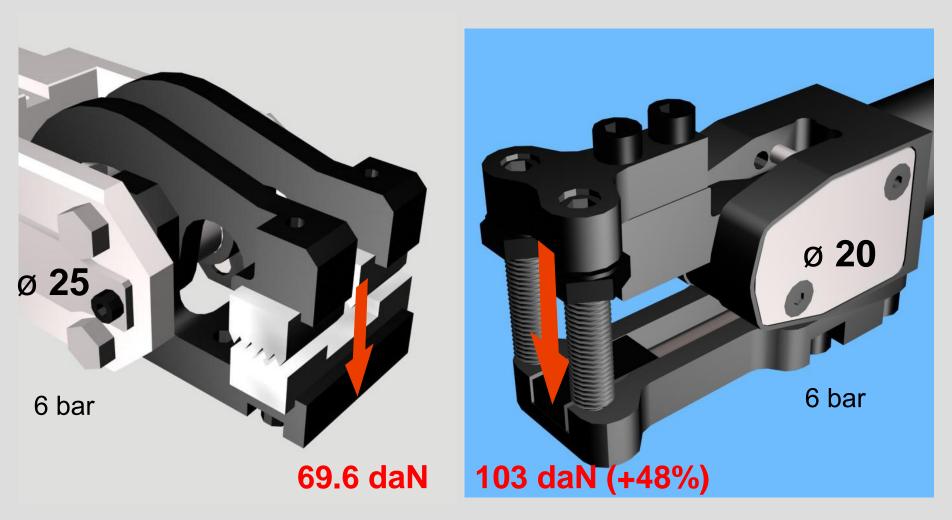


Optionally, movements 1 & 9 (according to cycle with suctions pads) could also be saved if the transfer could return with the pincer open at the same level.

Operating time # 2 & 6 also reduce the cycle of the transfer.

## Appendix II, v. Holding force



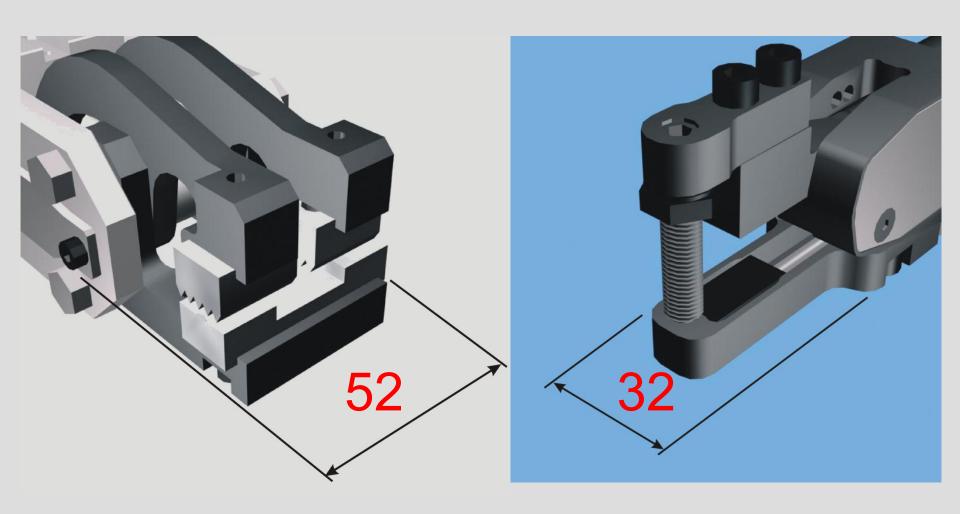


Our minipincers reach up to a 48% more force than other pincers in the market, so our minipincers guarantee the total safety when handling sheets and quicker displacements. You can use less and smaller pincers to to hold sheets.

Apart from reducing costs, production will also increase because the speed will be higher.

## **Appendix II, vi. Dimensions**

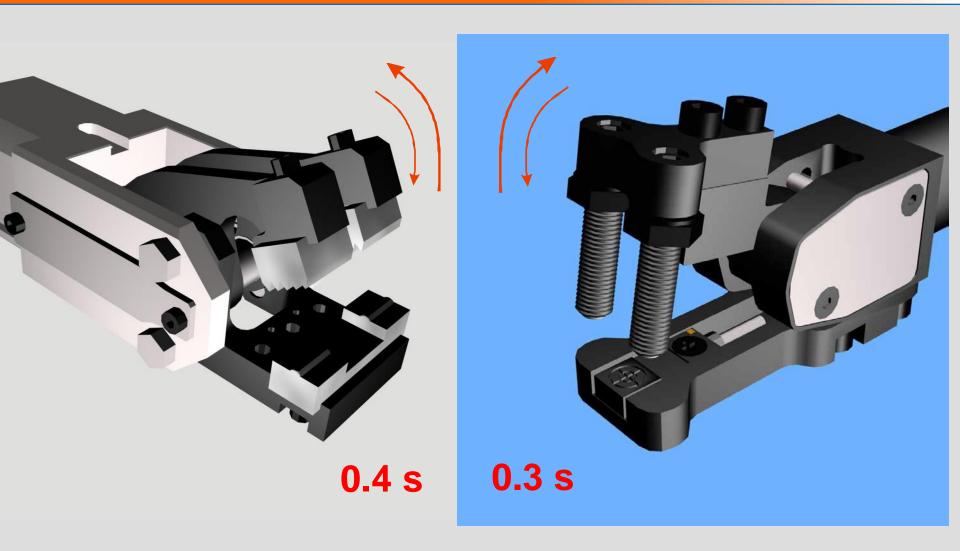




Misati minipincers have been developed as narrow as possible (up to 38.5%) so as to facilitate their access to the small cavities of the die: the number of hours working on a project is reduced.

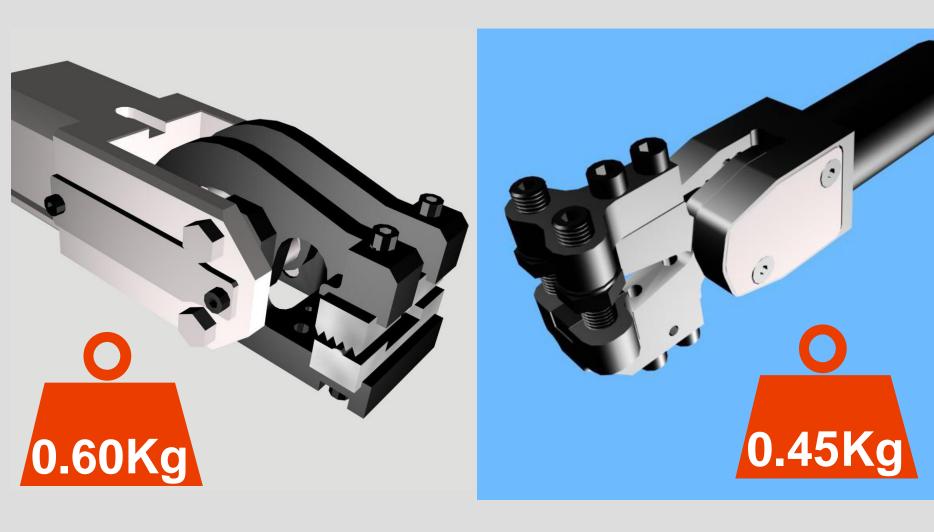
## Appendix II, vii. Operating time





The design of the mechanism of the minipincer transmits a high angular operating momentum to the movable arm (25% quicker than other pincers): there is a production growth in the transfer cycle.

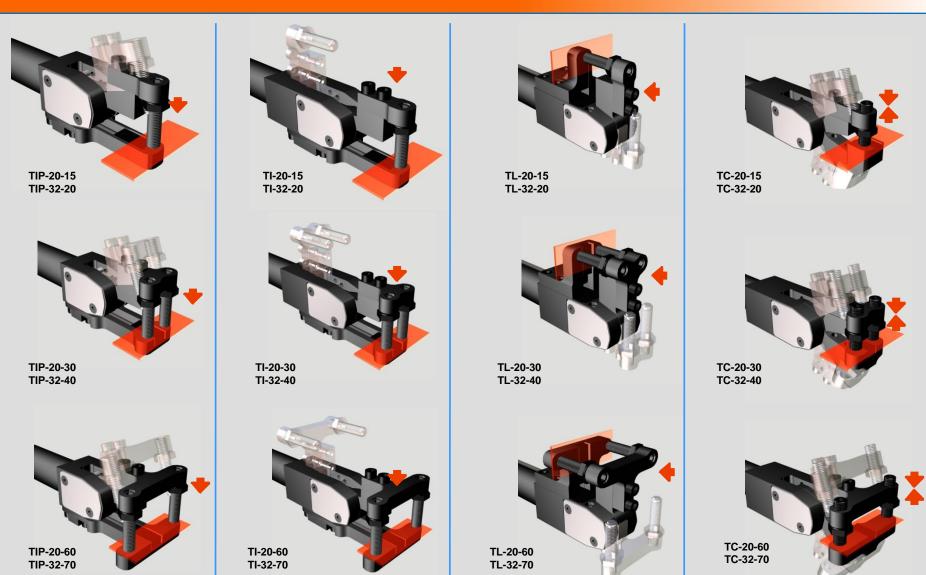




Thanks to the reduced weight of our minipincers (25% less), the speed & productive output of the system is higher. A lighter transfer consumes less energy and can move quicker.

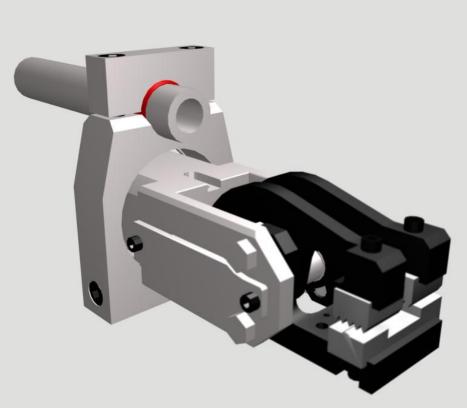
## Appendix II, ix. Types of minipincers

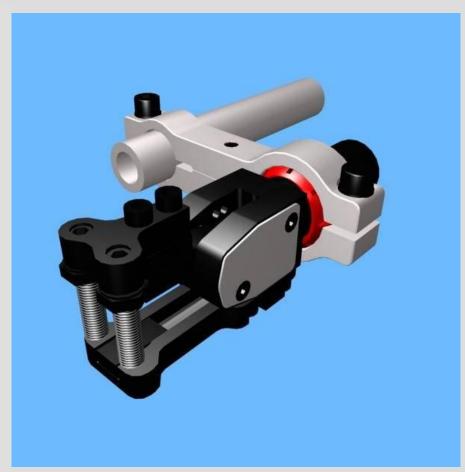




The same minipincer is used with different gripper fingers and openings: the spare parts stock is reduced.



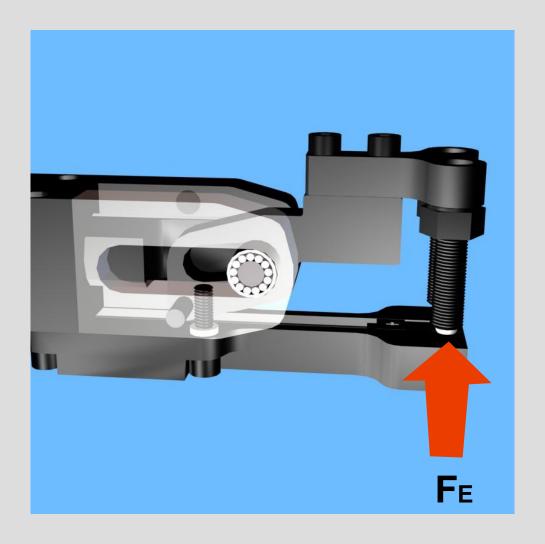




Using a mounting with ball-&-socket joint directly on the cylinder of the minipincer provides a more accurate adjustment: it's easier to make those small changes which can be very useful when adjusting the assembly. You can save time on design, on the adjustment and you can reduce the number of pieces.

# Appendix II, xi. Non-reversibility





Thanks to the design of the force mechanism, no extern force can open the movable arm. So, even though air is missing, detachments of the piece are prevented.

#### **SUGGESTIONS**



This handbook tries to be a tool that facilitates everybody's work, and so it may be improved.

Here it finishes our modest contribution as fastening experts, but it's still missing all the experiences from manufacturers of dies and companies stamping metal sheets.

We thank you any contribution, criticism, suggestion or comment you wish to send us. Please, write at

tecnico@misati.com

THANK YOU FOR YOUR COOPERATION!!