HOW TO MANUFACTURE A BARBARIAN ORGAN CARDBOARD PERFORATOR - version 2

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Little holes, little holes, little holes ....

WARNING

This new description cancels and replaces the one published in August 2012. Although operational, the first version has been subject to technical modifications aimed at achieving better reliability, particularly with respect to step losses and punch blockages in the low position, but also by adding an Arduino board for controlling the set.

1. PREAMBLE

Before we even finished building our own barbarian organ, we asked ourselves the crucial question "How to get books? "
The answer that immediately comes to mind is to buy them all at the raters. This is the name given to professionals. Indeed, this solution has many advantages:

- **It's simple - the books are delivered ready to use**
- **It's fast - just make a check**
- **The existing repertoire is very large**
- **The music is very well arranged**
- **If you do not find the cardboard in the manufacturer's catalog, you can give them specific orders (for a fee, of course)**

In return, there is a major disadvantage, namely the price.

The medium cost of a book means that unless you win the lottery, you will not be able to order much. A limited number of books quickly makes use of the organ (it's like having a nice stereo with only 1 CD, moreover with only one title ....)

How then how to get round this inconvenience?

"Simply by becoming his own supplier of Cardboards by manufacturing his drill". Moreover, having your own machine, you can punch books that would not be used often, and therefore do not really justify their purchase from a broker.

Example: you want to wish your friend Gaston a happy birthday. You prepare a little song on the air "Gaston y'a the phone that sound". Assuming it is the only Gaston you know, there is little chance of reusing the cardboard very often.

A note all the same to take into account: despite all the care taken in the realization of the perforator, and the creation of MIDI files to feed it, and unless you are an experienced musician, it will be almost impossible to obtain the quality and the musicality of the Cardboards resulting from the transcribers. It's a bit normal - everyone's job!

Also your repertoire will be based on a mix of books bought from a transcriber, and homemade cards.

As we did for the construction of the organ, we went on the Internet to enjoy the experience of other amateurs. Once again, thank you 300,000 times to Pierre PENARD and Jean Pierre COSSARD.

This file will be "limited" to the description of the manufacture of an automatic punch controlled by a computer itself controlled by a small software cleverly written.

The subject of formatting the MIDI files necessary to feed the software will not be processed.

It's up to you to search on the Internet or in your entourage the information necessary to treat these MIDI files.

Regarding mechanical motorering, we were lucky to have access to a "pro" milling machine. This is not given to everyone. In this case, you will have to find alternative solutions using the simple Black and Decker machine from Castorama.

We strongly advise you to read this entire document before you start. It would be a shame to have to stop construction along the way because of lack of knowledge, know-how, or tools.

We draw your attention to the fact that the mechanical part requires extreme precision to work perfectly. Last point: As for the organ, the realization and the settings will take time.

It is also advisable to obtain all components, knowing that the size of one can determine the size of others.

The builders: We keep the "dream team" which gave birth to the 2 organs of barbarism (a book of construction of the organs is also available).

Jean-Claude for the plans, the electronic card, and the tests

Jean-Marc for the mechanical part

The set involves distinct areas of expertise:

- **A purely mechanical part for moving the cardboard and the punch**
- **An electronic part for the control of the stepper motors (advance of the box, and translation of the truck) and for the control of the punch motor.**

The description that follows is based on the mechanical parts that we have recovered (example of the straight ball bearing) or that we have purchased (example stepper motors).

It will be up to you to adapt all to your components. Be that as it may, try to keep it as simple as possible by keeping the number of moving parts to a minimum.

In addition, it should be known that the machine will be subjected to severe tests with jolts due to the movements of the punch, and starting and stopping repeated stepper motors. So, plan on beefy. Who can do the least...

Note 1: This document is a complement to those presented and downloadable on the website of Pierre PENARD.

If our document leaves a lot of room for the actual construction, it does not include all the parameterization that is perfectly addressed by Pierre.

Note 2: This document can not be sold for 2 reasons:

1 - It cost us nothing except time. If we had to quantify the number of hours, it would be very expensive...

2 - It is largely based on elements communicated by Pierre PENARD and Jean-Pierre COSSARD. In these two people everything is free. At our house too!

Note 3: Despite all the care taken in the writing of this document, we can not be held responsible for any error or bad explanation that would require you to start the manufacture of a piece.

1 - 1 - THE PRINCIPLE OF OPERATION

To carry out the construction, it is better to understand the operation of the whole.

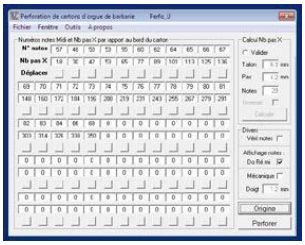
We start from a MIDI file adapted to the notes restrictions of the organ.

No matter the media (floppy disk / CD / USB stick) and the source (local / internet)

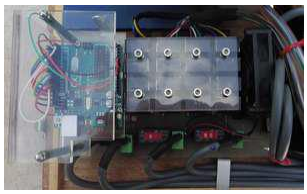
The MIDI file is "read" into the computer via specific software.

For the PC, no need for a racing beast. You just need a USB port to connect the Arduino board.

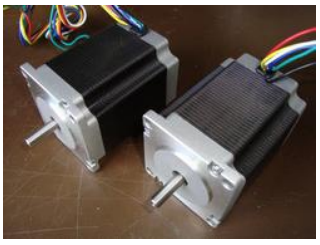
The program assigns each note the drilling coordinates.



These coordinates are converted into control pulses and sent to an interface card, which is not commercially available, so you will have to manufacture.



This interface board in turn drives two stepper motors to position the punch in the right place on the board and also to send orders to a third motor for punching.



The purpose of the operation is ultimately to obtain a famous liberating message.

(Perforation completed)

We recover at the exit the cardboard coveted.

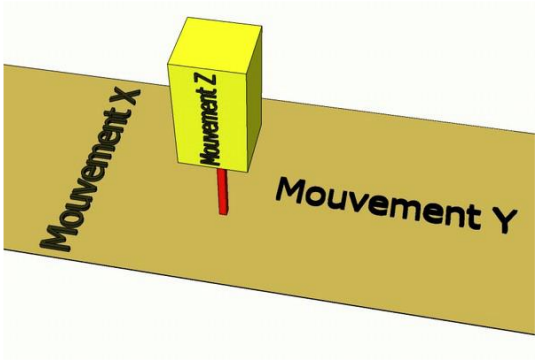
1 - 2 - THE THREE MOVEMENTS IN PRESENCE

To achieve the desired result, our drill must handle a combination of 3 distinct movements.

1 - Longitudinal movement Y = Cardboard advance (one direction)

2 - Transverse movement X = displacement of the carriage which supports the perforation system (two directions)

3 - Vertical movement Z = descent of the punch (automatic lift)



The software that drives the hole punch is smart enough not to move the Cardboard or cart as long as the punch is in the down position.

1 - 3 - THE EDGE OF REFERENCE

In the explanations that follow, there will sometimes be reference to the "reference edge". So to define immediately what it is and where it is.

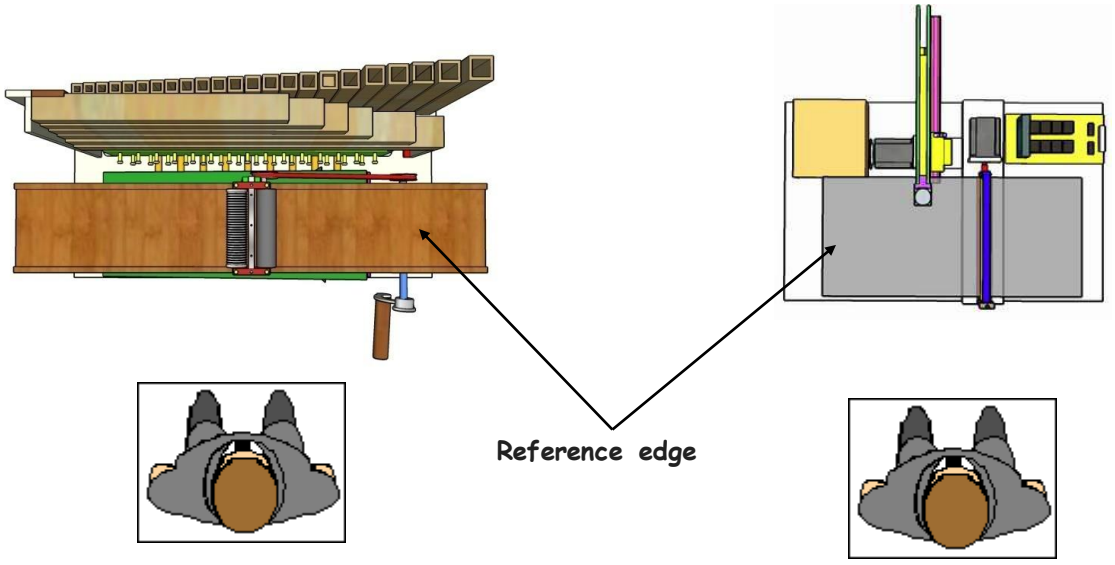
It is against this edge that will be applied cardboard music during its scroll.

The simplest is to make the analogy with the scrolling of the cardboard on the organ, namely:

- **We stand behind the machines (organ and perforator)**
- **The reference edge of the Cardboard will be on the opposite side, so low side**
- **The box will scroll from left to right**

Top view of the organ

Top view of the hole punch



1 - 4 - FORMAT OF ELIGIBLE CARDBOARDS

It is unlikely that you have a multitude of organs with different widths of cardboard.

Also, it would be normal to make a punch only able to pass books whose width corresponds to that of your organ.

But to the extent, where the only impact is the width of the scrolling path, it would be a shame to deprive oneself of being able to pass books of different widths.

We will still limit ourselves to 230 mm which corresponds to most Cardboards that can be found in France.

This will allow you if necessary to manufacture Cardboards for other people not equipped with the infernal machine.

2 - QUESTIONS TO BE ASKED BEFORE BEGINNING

Before you start making chips, you have to make quite technical choices:

- **Which solution to choose to operate the mobile cart?**
- **Which solution to choose for the movement of the punch?**
- **Which form of punch to choose: a square or a round?**

A careful reading of the topics on the Internet may cause some confusion in your head, because you see everything and its opposite.

We can think that all solutions are good but we think that some are better than others because we have tried several.

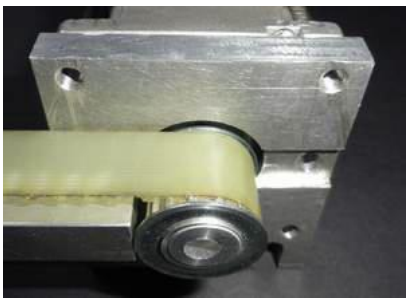
Our choices seem the most judicious, but that does not mean that the other solutions do not work - the proof is that some manufacturers have used them successfully.

2 - 1 - WHICH SOLUTION TO CHOOSE TO OPERATE THE MOBILE CART?

The mobile cart must translate smoothly, accurately and, if possible, as quietly as possible.

If we discard the ball screw which is quite expensive, we still have the choice between at least two systems very different from each other:

Driving by a toothed gear and a rack and pinion



Driving with 2 notched pulleys and a timing belt

Presenting both photos proves that we have tested both systems, which is why we are able to advise you which one to choose.

In version 1 of our performance, we opted for rack-and-pinion drive.

In practice this translates into a pretty delicate setting to get.

It is necessary to have an optimum spacing between the teeth of the pinion and those of the rack.

If the tolerance is reduced to a minimum, there is a risk of blockage. Conversely, with a larger tolerance, we lose precision in positioning the mobile carriage and therefore the punch.

It should not be surprising then that the software detects step losses, resulting in holes in the box at the wrong places.

Adjustment of the rack / pinion clearance also has a significant impact on the noise level.

In the version 2 described here, we moved to the toothed belt transmission.

- **On the right the drive motor with its pulley**
- **On the left a second pulley mounted on a tensioner system**
- **Between the 2, a toothed belt with a flange that will be securely attached to the carriage**

This is the solution most often presented on the net by those who have already made their perfo. So we can comfort ourselves by assuming that it is the right choice!

2 - 2 - WHICH SOLUTION TO CHOOSE FOR THE MOVING OF THE PUNCH?

All the drills that exist to date seem to work on the same principle with regard to moving the movable carriage (movement X) and for advancing the Cardboard (movement Y), namely the use of 2 stepper motors.

On the other hand, for the control of the punch (movement Z), there are several schools:

- **Pneumatic system with cylinder and air compressor**
- **Electromagnet system**
- **Electric motor-based system**

Again, we tested the different systems, and it is with full knowledge that we can now advise you.

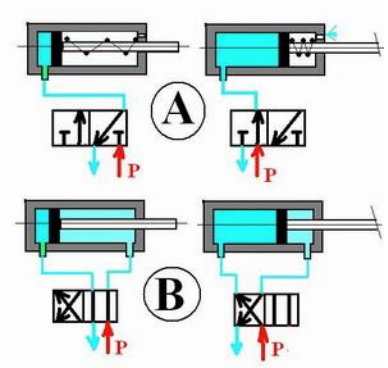
Our first choice has been towards the pneumatic system.

The advantage is the relative ease of realization insofar as the guide of the punch is made by the jack.

On the other hand, there are some disadvantages:

- **Cumbersome solution due to the compressor - ours was made from recycled parts from various sources (we must be able to find a muffler)**
- **Oil level management**
- **The oil that heats it does not smell very good**
- **Noisy system. During the first tests, these inconveniences stopped us a bit in our tracks.**

In any case, if we had persisted, we would have been faced with the return to the high position of the punch, namely:



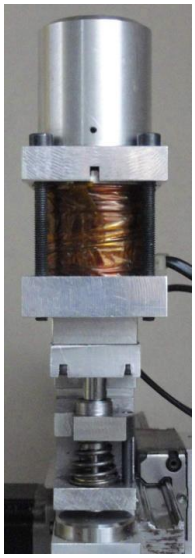
If you use a single-acting cylinder, you have to manage the recovery of the punch by finding the right spring not too strong to pierce the cardboard, but still strong enough to raise the punch.

We can then use a double-acting cylinder, but this complicates a little the pneumatic part.

Thinking we could manage the subject of the spring, we then turned to the system based on electromagnet, with the main objective of not needing the compressor, cumbersome, noisy, and badly scented....

After recovering the electromagnet in an electric stapler, we tested its strength in a makeshift setup. Good for the service...

We then made a nice aluminum support to hold the coil in place, as well as a serious guide system for the core, the end of which was hammering on the punch support.



Despite a very careful mechanical realization, we were still confronted with blockages of the punch in the low position.

Alignments were verified, including the correct positioning of the punch support matrix.

The machine has been spinning for a long time.

No, nothing to do, it was blocking randomly. In addition, depending on the cardboard used, blockages were more or less present.

A large number of springs have been tested. If the spring is a bit weak, you can always replace it with a beefier one. But one cannot with impunity increase the power of this spring, because its force comes to be subdued to the force with which the punch goes down.

The use of the solution of the electromagnet is still accompanied by some disadvantages:

- The shaking is quite strong, so the mechanics are subjected to severe tests.
- The system works according to the principle of the hammer, so this fact is quite noisy.

If you are not yet convinced that the electromagnet is not (in our opinion) the best solution, here is another disadvantage:

In its first use, the coil of the stapler is fed PWM (Pulse Width Modulation) mode, which corresponds to a succession of very short pulses. It is absolutely necessary to preserve this power supply at the risk of burning the coil if one feeds directly in 220 volts.

That's why, in the stapler we find a platinum with some electronic components. In the case of our drill, it is this circuit that calculates the control pulse time and not the software. As a result, we do not have control over this setting.

When an order of perforation is launched, we can see the punch go down, but the impulse being very short there is not enough time to see how far it goes. We assume that it has come down enough, but we are not sure.

In view of all the above, we have definitely opted for the control of punch by electric motor.

The principle is simple: an eccentric system fixed on the axis of the motor makes translate vertically the punch holder.

A limit switch must be provided to detect the high position of the eccentric and then block the motor at the appropriate time before it leaves for the next perforation.

2 - 3 - WHICH SOLUTION TO CHOOSE FOR THE PUNCH: A ROUND OR SQUARE?

Should a punch of round section or square section. This is a debate issue.

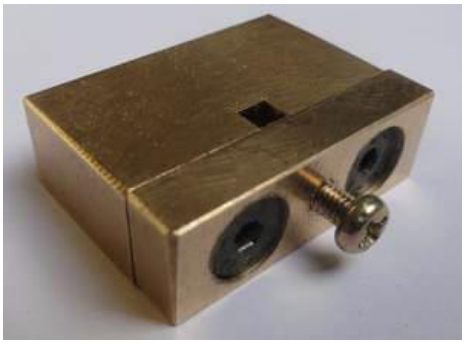
To convince yourself of this, type in your search motor "round or square punch for barbarian organ"

We recommend the solution of a round punch for the following 3 reasons:

- There is no need to worry about keeping the punch in a position parallel to the edge of the board.
- A round punch prevents burrs, which are themselves generating blockage of the punch.
- It is easier to make a round hole in the punch and die guide than a square hole

Here for info the two pieces we made in the previous version with the square punch.

Feasible but not simple ....



The punch guide

The matrix

Reminder of the solutions selected:

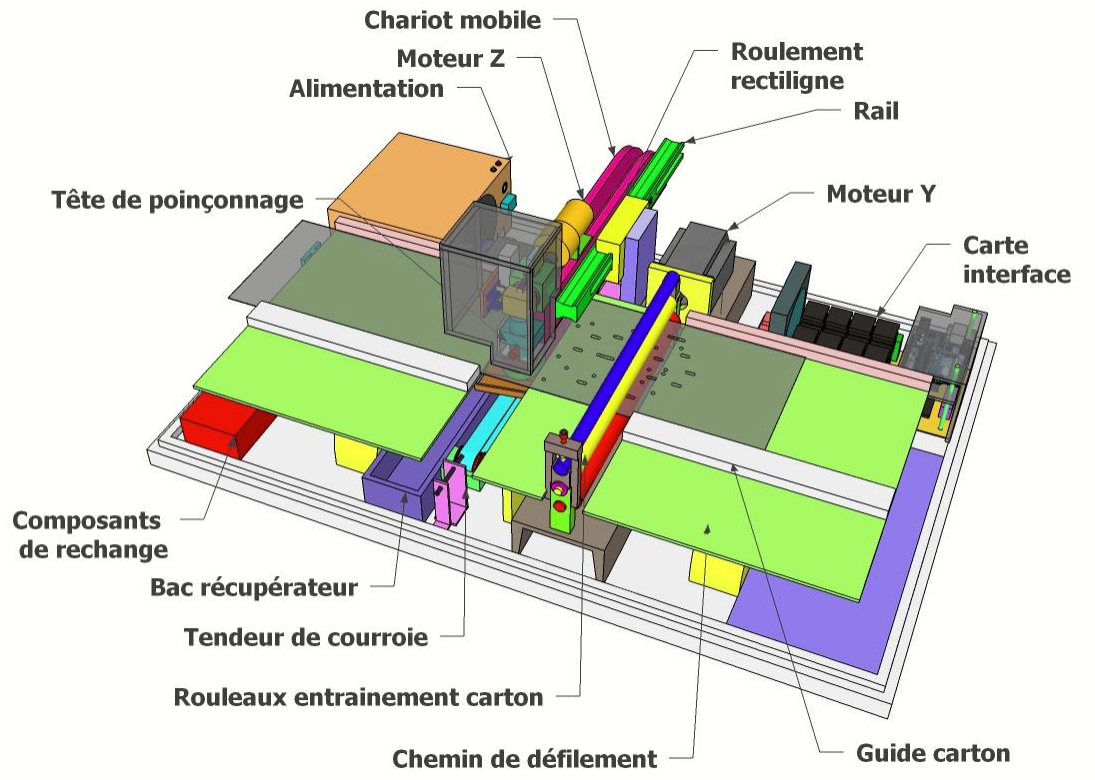
- Translation of the perforation head by pulley and timing belt
- Control of a round punch by electric and eccentric motor

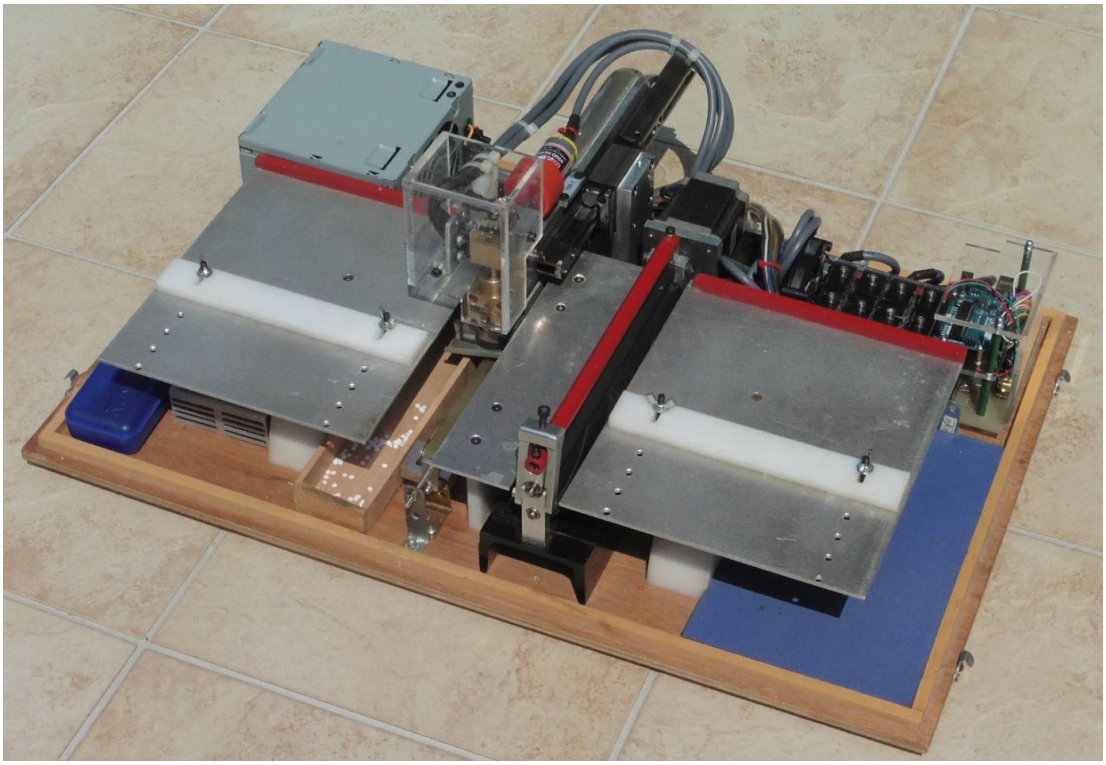
Dimensions and weight:

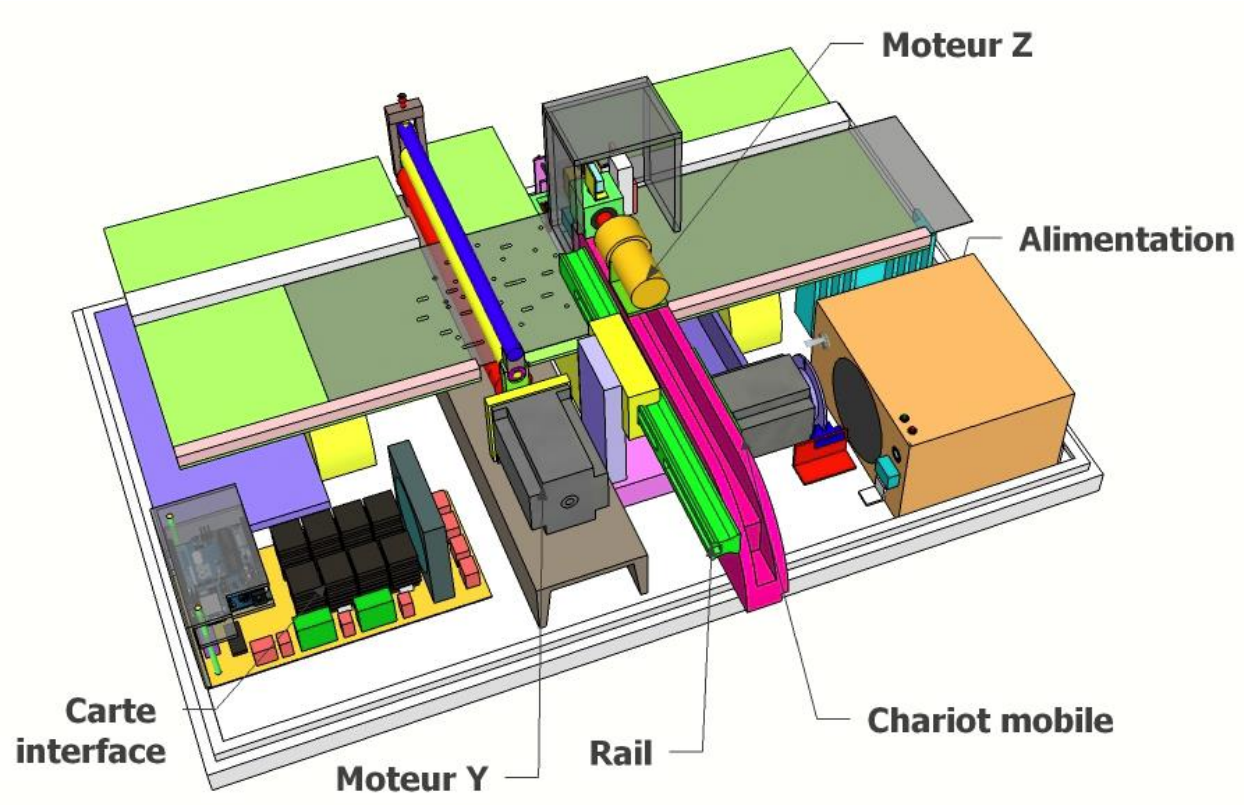
Dimensions = 700 x 220 x 460 mm (WxHxD)
Weight = 17 kg

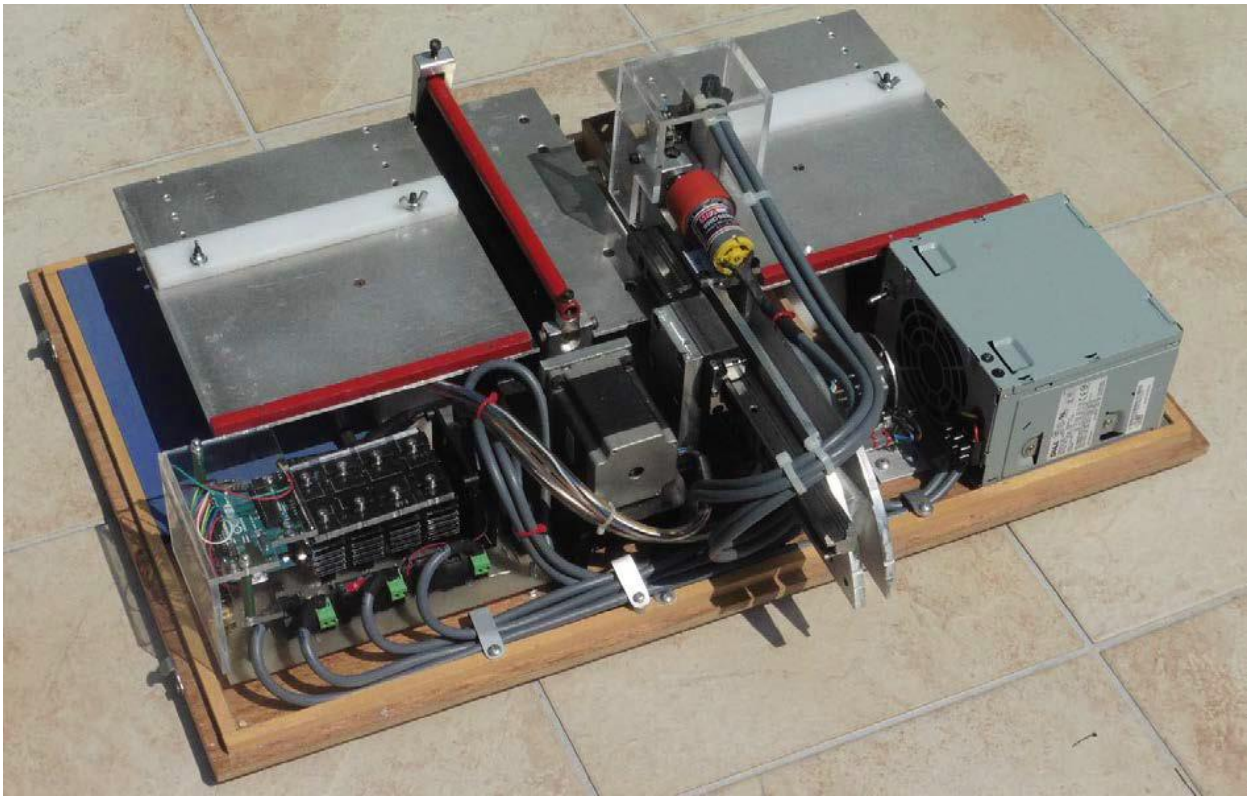
3 - SOME SKETCHES AND PHOTOS OF ENSEMBLE

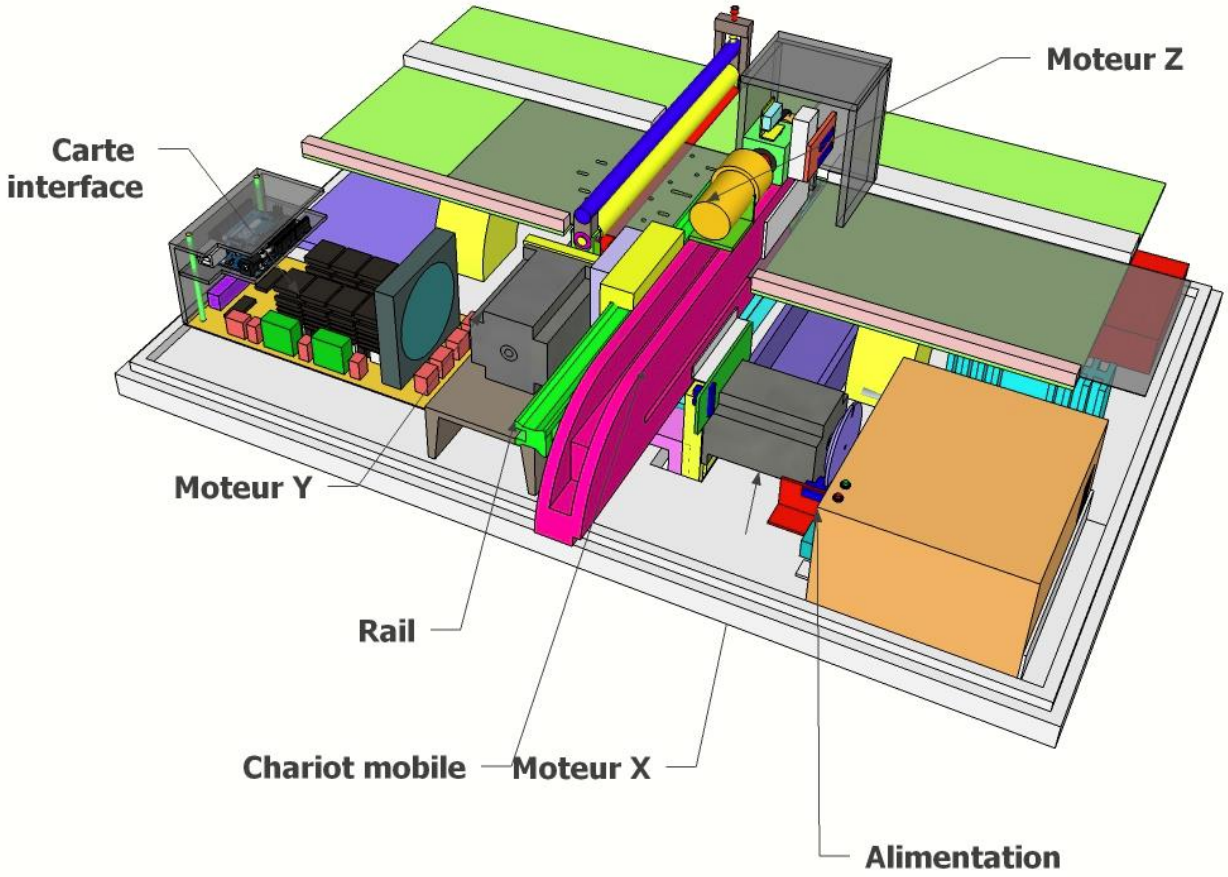
Here, drawn on the software SKETCHUP, some sketches of set and the corresponding photos:

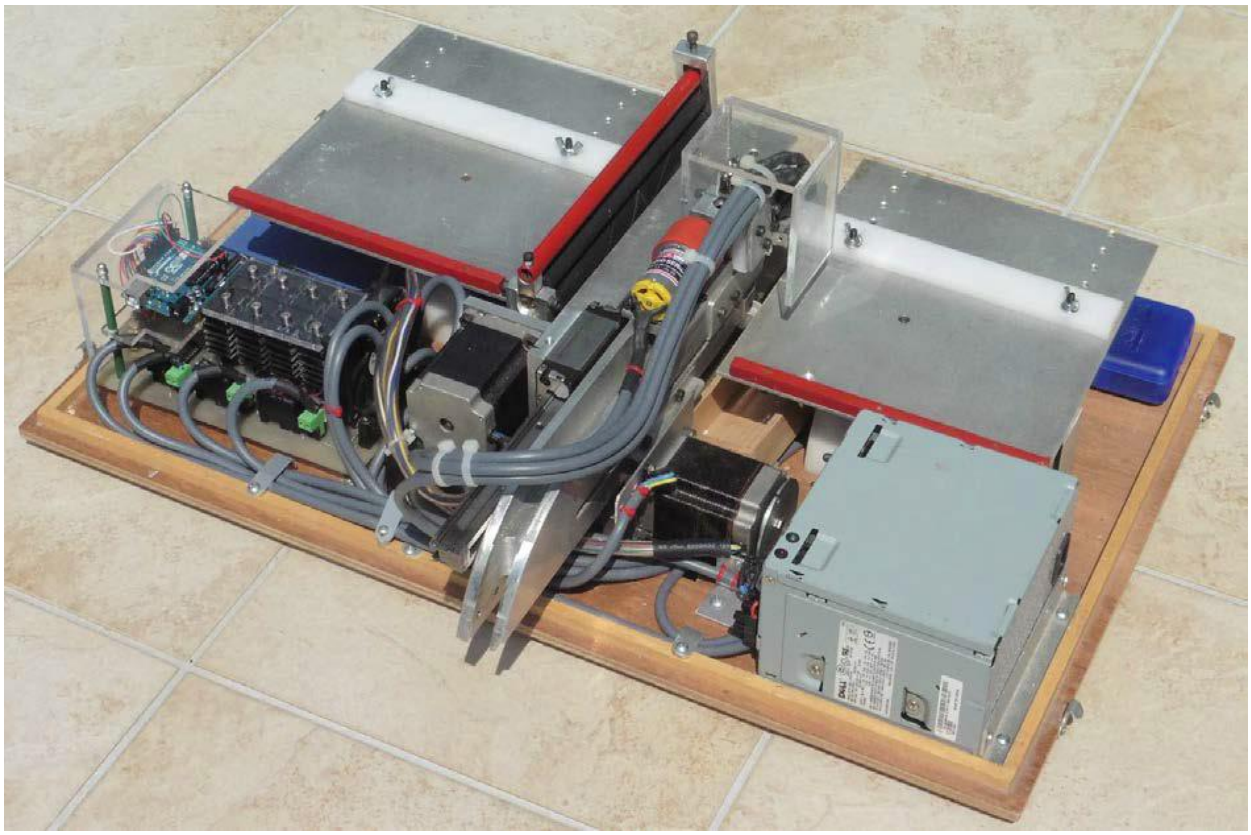





Moteur Z
Alimentation
Carte interface
Moteur Y
Rail
Chariot mobile




Moteur Z
Carte interface
Moteur Y
Rail
Chariot mobile
Moteur X
Alimentation



4 - ADVANCING THE CARDBOARD

4 - 1 - PHOTO OF THE SUBASSEMBLY

4 - 2 - PRINCIPLE OF OPERATION

This is the simplest movement to manage since the motor that drives the cardboard is not controlled by an opto-coupler. Unlike the motor that moves the punch, this motor will always turn in the same direction.

The cardboard must be driven very regularly by the rollers, hence the need for a perfect mechanical realization.

It is better to turn to a mechanical solution where the cardboard is pulled and not pushed. This therefore assumes that the rollers are placed downstream of the perforation head.

The set "motor + rollers" will be firmly fixed on steel rail.

A small stroke of paint protects the rail from rust and gives it a beautiful appearance

.

This rail will be fixed on a plywood board.
As and when, the other parts of the hole will be added. Unless you make an accurate calculation in advance, you can go on a large board, which will be reduced later.

4 - 3 - THE DRIVE MOTOR

To ensure the movement of the cardboard, it uses a stepper motor.

Not easy to get the right stepper motor that fits perfectly.

Also, to put all the chances on our side we invested in 2 new motors (one for the advance of the box, the other for the displacement of the carriage). Both motors are identical.

We found our happiness at SELECTRONIC. http://www.selectronic.fr

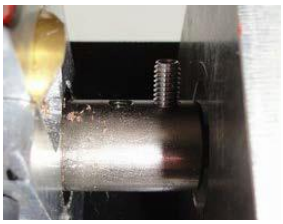
You will also find all the electronic components needed to manufacture the interface card.

Here are the characteristics of the motors:

Part Number	Step Angle	Steps/Revolution	Torque	Current	Voltage
15.6157-12	1.8	200	13 kg.cm	3A	3V

If you opt for this motor, you do not need to provide a gear ratio.

The perforation accuracy will be 1/200 of the circumference of the drive roller. This is enough, knowing that a precision of the order of 1/10 mm is sufficient.



The axis of the motor will be directly connected to the axis of the drive roller.

To ensure a perfect transmission, it is imperative to make a file with the file on the axis of the motor.

4 - 4 - THE COACH ROLLER AND THE PRESSER ROLLER

The coach roll is in the lower part, so under the cardboard.

The pressure roller is at the top, so on the cardboard

These rolls can be found on photocopiers. In this case, remember to recover the ball bearings at the same time.

The use of a sufficiently flexible drive roller will dispense with the need to provide for the rotation of the upper pressure roller by a set of gears.

In this case, the upper roll is only frictionally driven against the board.

It is strongly recommended to provide an articulation of the pressure roller. It is not essential but very useful.

This facilitates the introduction of the cardboard and also allows to begin the perforation of a cardboard, and by putting the software in pause, one can thus remove the cardboard to test it on the organ then to put it back on the perforator.

In this case, it is of course essential to note very precisely on the cardboard its location before it is removed. It also makes it possible to manufacture a cardboard in several times, thanks to the "save context" function developed by Pierre in the software.

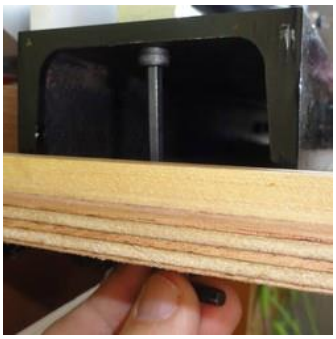
A locking system must be provided so that the upper roll is always under pressure on the Cardboard.

This can take the form of a stirrup articulated in its lower part, and blocked in its high part by a simple screw which comes in abutment.

4 - 5 - THE NOISE CONTROL

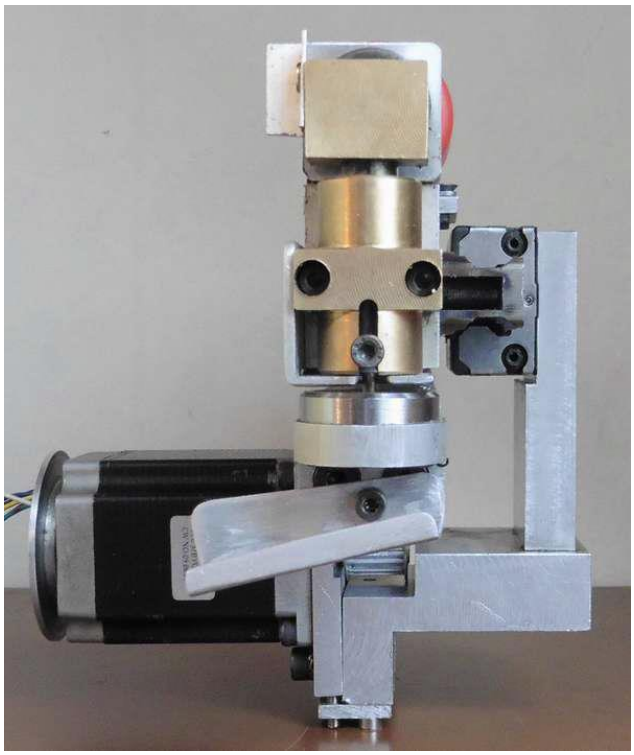
At the first start of the motor mounted on its base and connected to the roller trainer, we were surprised to hear a very unpleasant noise.

We manage to eliminate the noise as follows:

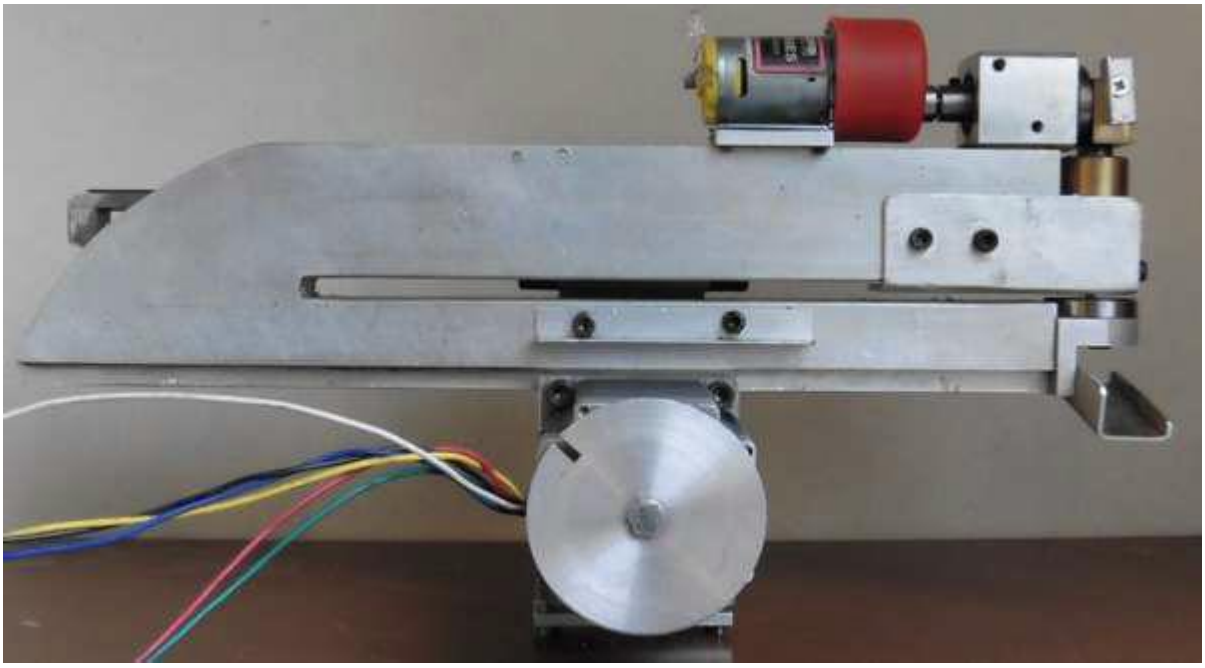


- **Unscrew slightly the two small brackets that hold the rollers in place. To do this, you must first drill the support panel vertically screws**
- **Let the motor run for a long time**
- **The brackets will then find their good position**
- **Lock the screws**

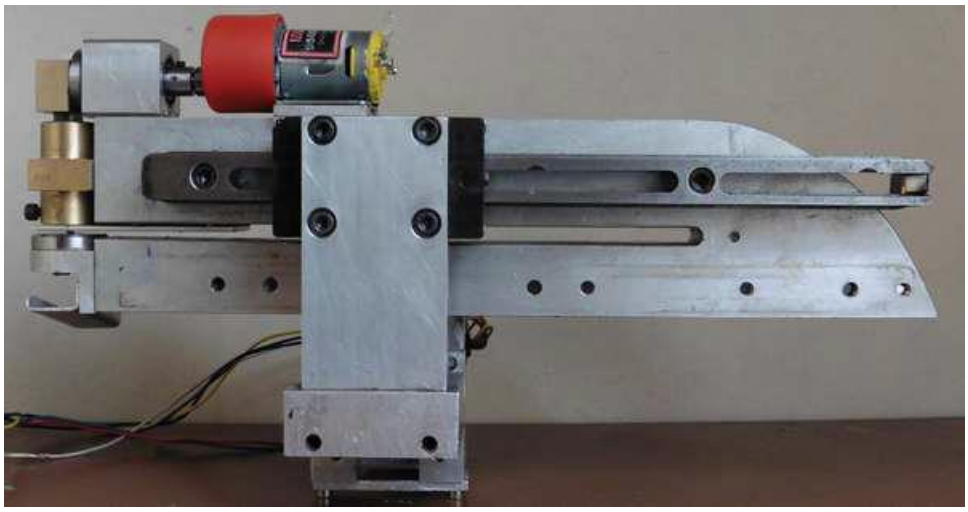
5 - 1 - PHOTOS OF THE SUBASSEMBLY



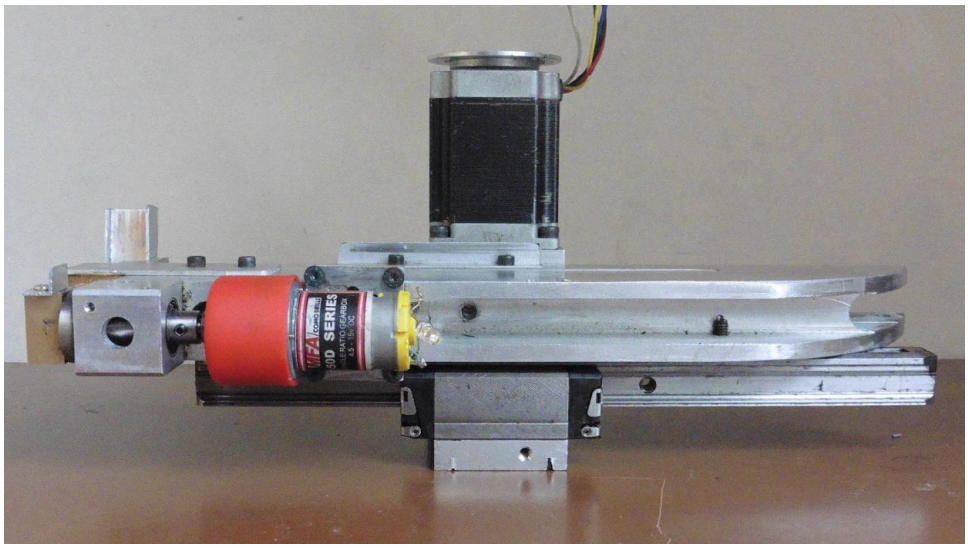
Front view



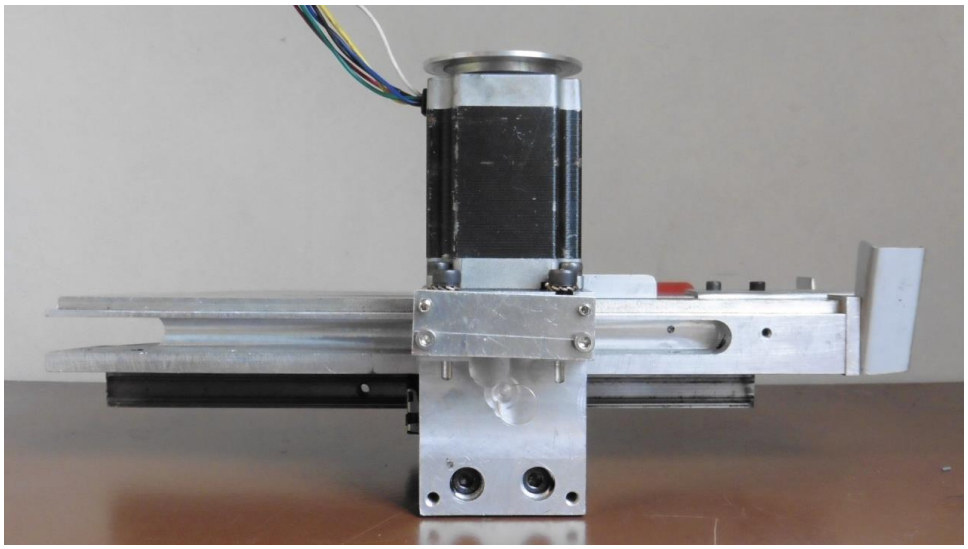
West side view



East side view



Airplane view



Bottom view

- **Total weight = 4.100 kg**
- **Weight of the fixed part = 2.00 kg**
- **Weight of the moving part = 2.100 kg**

Let's see each piece in detail now.

5 - 2 - THE "U" TROLLEY

Our carriage is machined in one piece in a 30 mm thick aluminum block to ensure a good rigidity.

A deep indentation is made in the middle to "swallow" the cardboard.

This cart will serve as a frame to hold several pieces in place:

- **The guide rail that slides in the straight bearing**
- **The fixing flange of the toothed belt**
- **The punch control motor**
- **The set "eccentric + guide punch + punch + unhooking + matrix + support matrix"**
- **Opto-couplers + brake switch for the punch motor**

The shutter angle of the linear position opto-coupler View cart on the drive motor side (dimensions are approximate for information only)

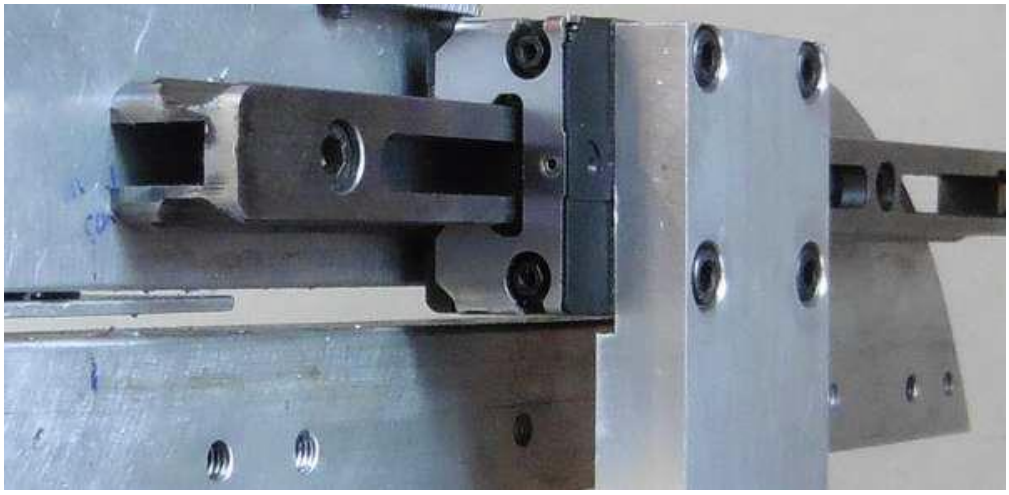
If the cart is too heavy, and given the kinetic energy it stores, it will be a little difficult to stop in the right place.

Also, it is advisable to lighten it either by making big holes across, or by removing some internal parts using a milling machine.

5 - 3 - THE GUIDANCE SYSTEM IN TRANSLATION

We made it beefy by using a rail and a straight ball bearing.

It's recycled. Know that it is hard to find even in very good haberdashery!



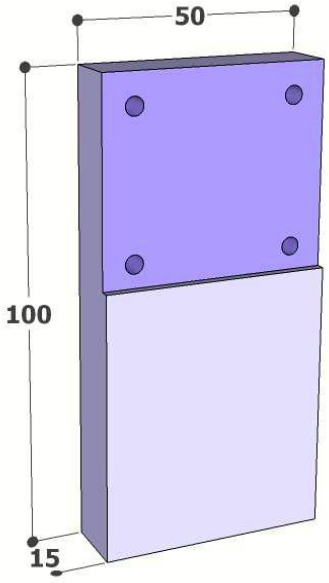
Unlike the previous version of our performance, we positioned the rail above the notch that swallows the cardboard.

In this way, there is no risk that a confetti or even tiny cardboard dust will become lodged in the straight bearing. The rail has been lightened in its central part. In this way, the mobile carriage will have less inertia.

5 - 4 - FIXING THE RECTILINE AND MOTOR BEARING

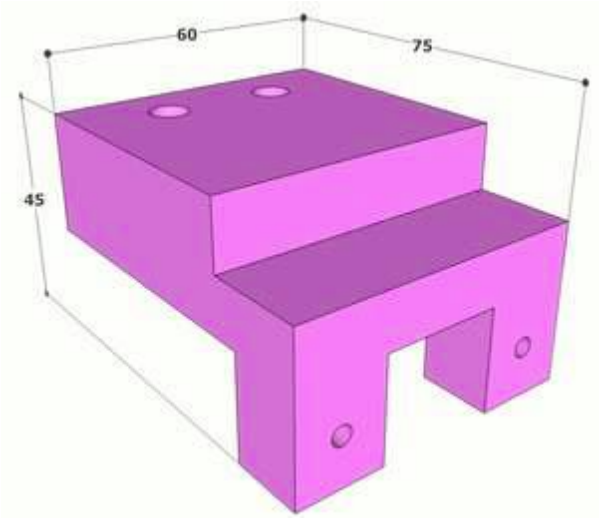
The straight bearing will be fixed on an aluminum plate.

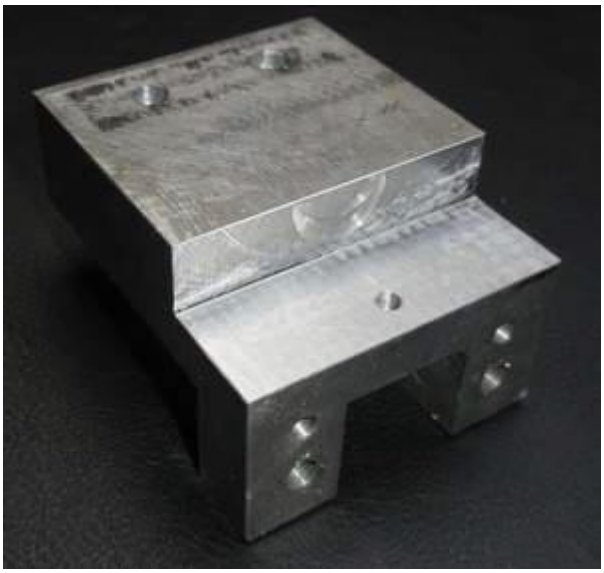
This plate must be thick enough to ensure a very good rigidity.



(Dimensions overall given as a guideline)

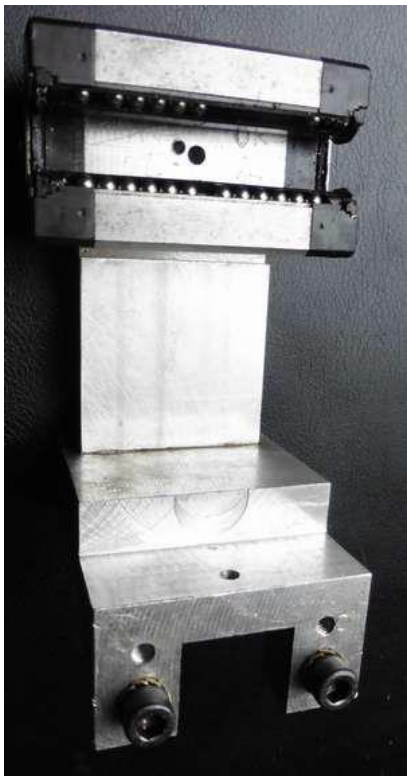
This aluminum plate is attached to an L-shaped support.



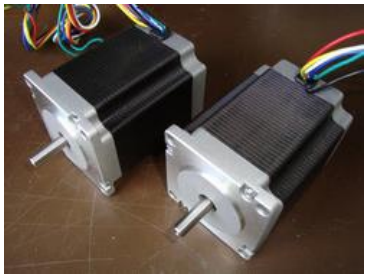


(Dimensions overall given as a guideline)

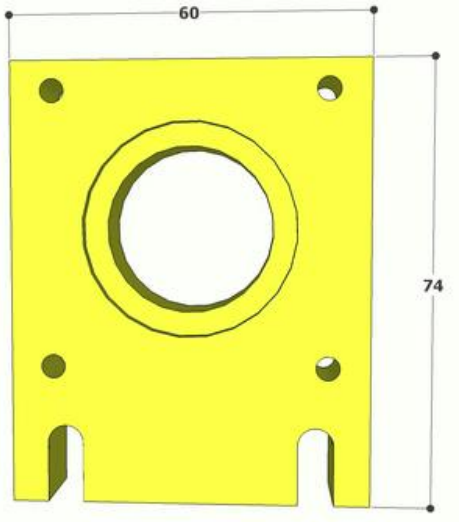
It is on this part that will come to fix the support plate of the translation motor of the trolley.



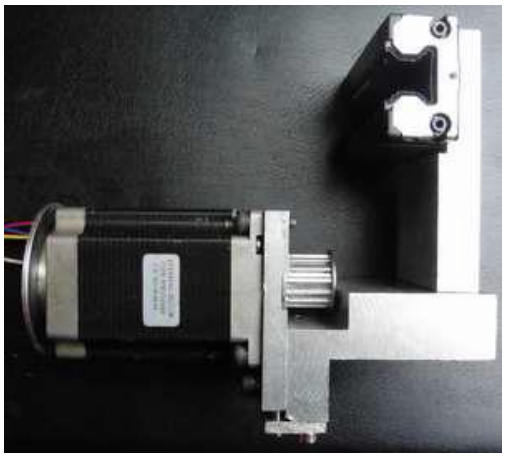
To set the moving carriage in motion, we used the same motor that drives the Cardboard.

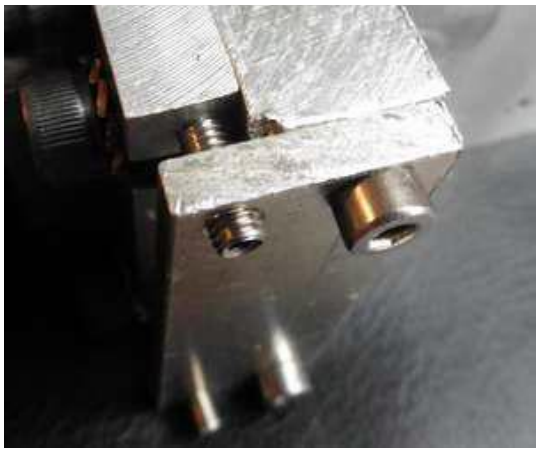


This motor is firmly attached to a second aluminum support plate.



(Dimensions overall given as a guideline)





Overview with a small bottom plate in the lower part of the main block, and equipped with 2 mini set screws that will better adjust the height position of the plate that supports the motor.

5 - 5 - BELT TRANSMISSION

It is a set composed of several distinct elements:

Two notched gears and a belt

Diameter +/- 20 mm

Calculated length +/- 620 mm
Width +/- 15 mm (adapted to the pulley)

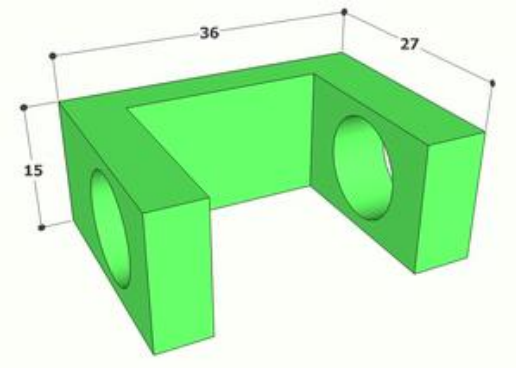
Motor side, the pulley must be perfectly integral with the axis of the motor whose vibrations have an unfortunate tendency to loosen the needle screw.

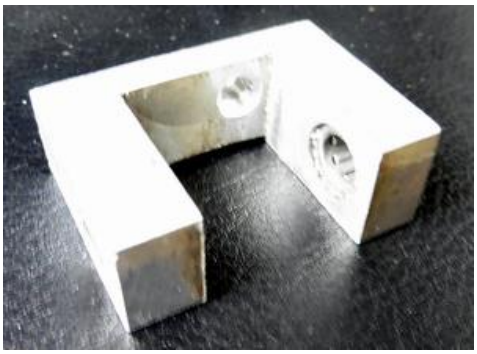
If the pulley turns on itself, the point of origin of the machine will move sneakily.

To prevent this, you must:
- **Make a file with the file on the axis of the motor**
- **Put a little "wirelock" on the needle screw**
- **Tighten the screw**

<u>Belt tensioner</u>

It is an aluminum screed. We pushed the luxury by inserting two mini needle bearings.





(Dimensions overall given as a guideline)

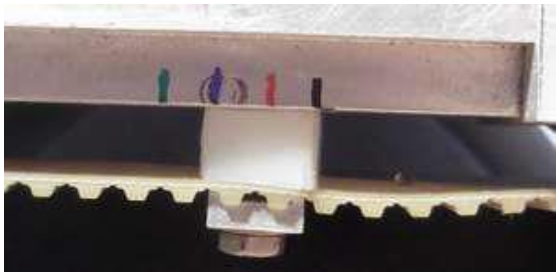
The yoke / pulley assembly is fixed on a hinge.

This allows him to move on 1 axis. One screw and two wing nuts adjust the tension on the belt.

If the belt is not tight enough, we will lose some steps.

If the belt is too tight, the motor will work hard and the noise will be greater.

<u>Attaching the clamp</u>: The belt is split in the middle. A clamp is made taking into account the spacing and shape of the teeth.



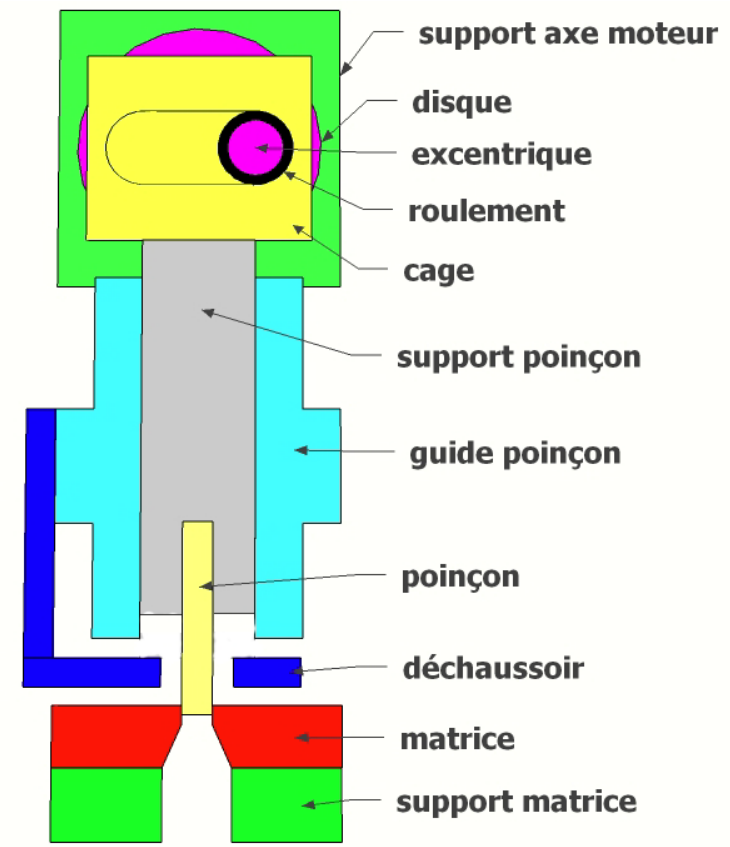
Care must be taken to ensure that the chosen fixing position allows the carriage to travel the full length of the carriage without abutting the toothed gears.

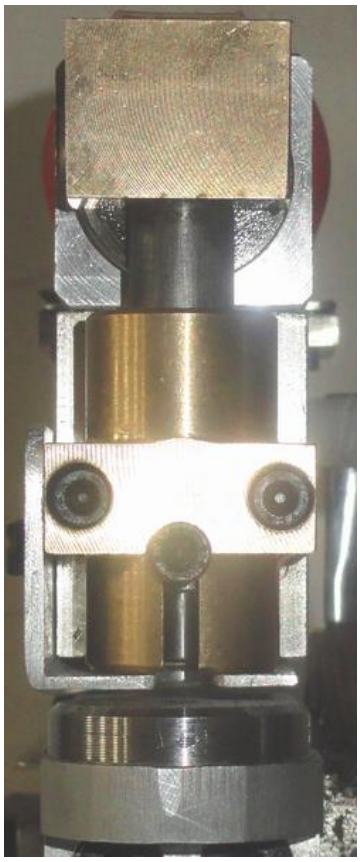
The correct position can be found by successive tests, marking the different positions already tested.

5 - 6 - THE PERFORATION HEAD

It is a subset that is composed of the punch, and its system of setting in motion.

A DC motor rotates an eccentric in a brass cage. At the base of this cage is fixed the punch holder which will slide in a punch guide.





Note: on the sketch above, the cage was turned laterally on itself to be able to visualize the eccentric fixed on the disc driven by the motor.

Let's look in detail at each part of this subset.

5 - 7 - PUNCH MOTOR AND FASTENING

We used a fixed gear motor with reduction ratio of 100: 1.

Either with luck, you find the motor in an old electric screwdriver out of order, either you order at Selectronic or Gotronic.

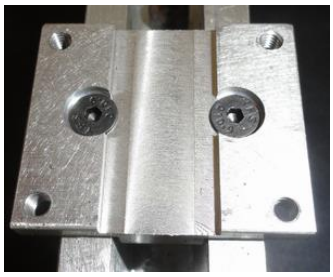
8W Motor - MFA 950D Series
Supply voltage = 12 volts
Maximum theoretical torque = 77 N.cm

At first, we had set up a motor of the same series, but with a maximum theoretical torque of 38.5 N.cm.

It's just right, and you run the risk of errors during the perforation cycle.

Before installing the motor, remember to remove the cover to check the tightness of the screws that hold the gear train.

On our motor, 2 out of 3 screws were almost out.



A fixing base for the motor is screwed on the uprights of the movable carriage. .

When you are going to drill the fine mounting plate that comes with the motor, take care to wrap the motor in a small plastic bag.

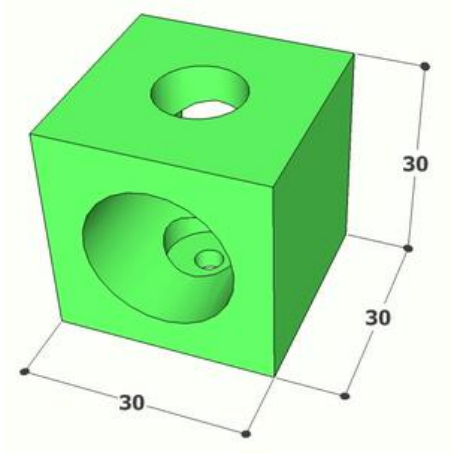
In the worst case, the magnets of the motor make attract the chips and these will be housed everywhere inside. This led us to purchase a second motor.

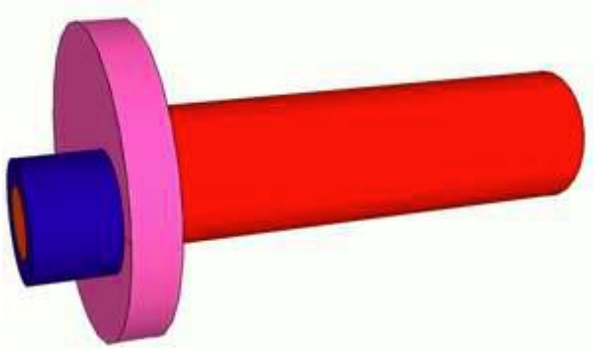
5 - 8 - THE ECCENTRIC SYSTEM

The shaft end coming out of the gear motor is connected to a larger diameter axel.

This axel passes through an aluminum block equipped at the inlet and outlet of two ball bearings.

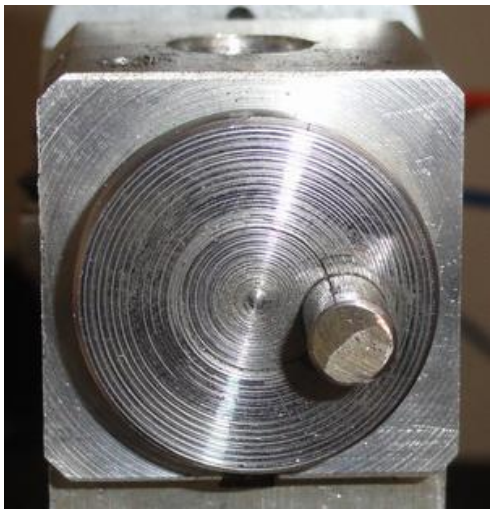
At the end of this axel was machined a disc thickness +/- 4 mm and diameter 25 mm.



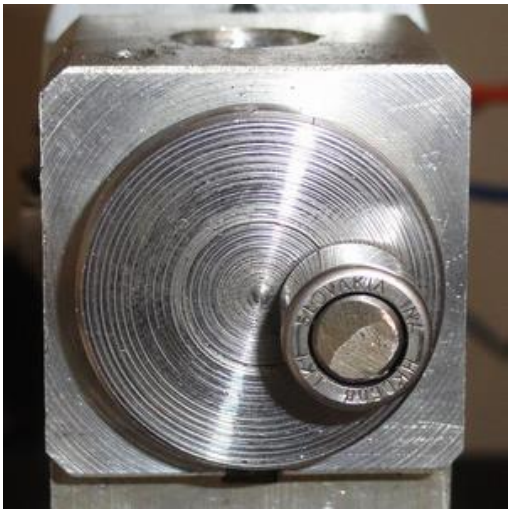


(Dimensions overall given as a guideline)

A hole in the vertical of the block allows to pass a fixing screw on the carriage before the insertion of the axis.



On the face of the disc, a hole is made eccentrically. A small piece of axis 6 mm in diameter inserted in force.

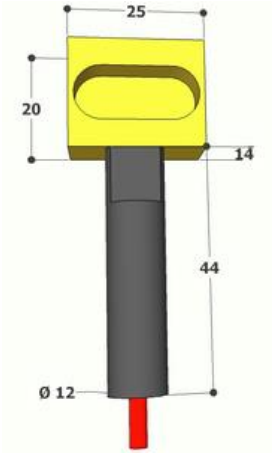


A mini needle bearing is slid on the axle

If the distance between the axis of the disk and the axis on which the needle bearing is fixed is multiplied by 2, the total travel of the punch is obtained. It is therefore a distance that is important. In our case, we have a gap of 6 mm which gives a race of 12 mm.

The eccentric cage is machined in a small block of brass.

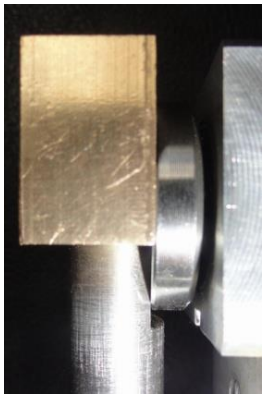
A milling cutter is made inside so that the eccentric can slide sideways.



(Dimensions overall given as a guideline)

The machining depth should be just above the diameter of the needle bearing.

The brass cage is made integral with the axis by a short section of wireed rod.



Once the 2 pieces are joined, it is necessary to make a flat part on the high part of the axis to not have the axis abuts against the disk which supports the eccentric.

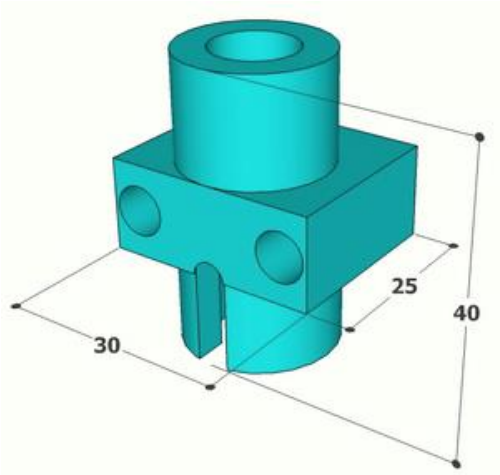
In its lower part, the piece is pierced to a diameter of 3.2mm which corresponds to the diameter of the punch.

A drilling with an M4 tapping can accommodate a screw that blocks the punch.It is therefore easy to adjust the depth of perforation.

5 - 9 - THE PUNCH SUPPORT GUIDE

It is a brass piece in which will freely slide the punch support rod. This punch guide will be firmly attached to the front of the moving carriage.

It is not an absolute necessity that this piece has exactly the external form we gave it. It could be a stupid parallelepiped, but we like to make chips ...



(Dimensions overall given as a guideline)

The notch made at the base allows to let slide the fixing screw of the punch.

5 - 10 - THE PUNCH

As indicated in the first pages of this document, we opted for a round punch of diameter 3.2 mm

What material for the punch?

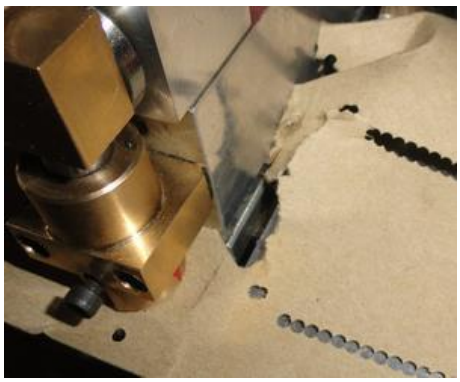
It requires very strong steel type "Hardened". A rod of very good quality can do the trick.

5 - 11 - THE DECHAUSSOIR

The cardboard must always be perfectly pressed against the path of the scroll, and in any case it must not go up at the same time as the punch.

The unhooker allows to press the cardboard against the matrix.

In the opposite case, the cardboard sometimes remains "attached to the punch" and tears when the punch changes position (see opposite)



To press towards the cardboard downwards, we fixed on the trolley an aluminum angle.

Ideally, a spring-loaded system would be required to plate 100% and also take into account its thickness, which can vary depending on the source.

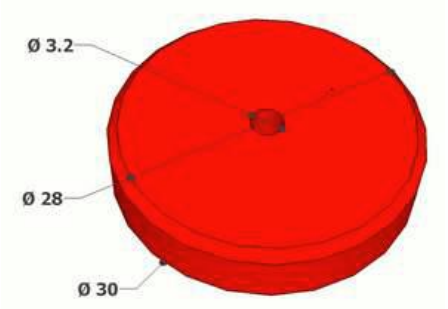
The piece is pierced widely to let the punch. The end cut is there to avoid coming into conflict with the punch locking screw.

All edges that are in contact with the cardboard must be well rounded with the file to avoid picking in it

5 - 12- THE MATRIX

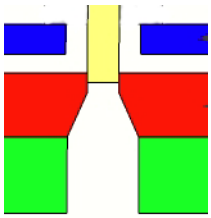
This is the part under the cardboard and in which will come the punch.

- **Steel block**
- **A 3.2 mm round hole**
- **Two M 3 wireed holes for attachment to the matrix support**



(Dimensions overall given as an indication)

To prevent the punch from rubbing over the entire thickness of the piece, the part where it slides has been reduced to 2 millimeters by making a conical hole on its underside.



If we do not take this precaution, the confetti will stack on top of each other, to prevent the descent of the punch

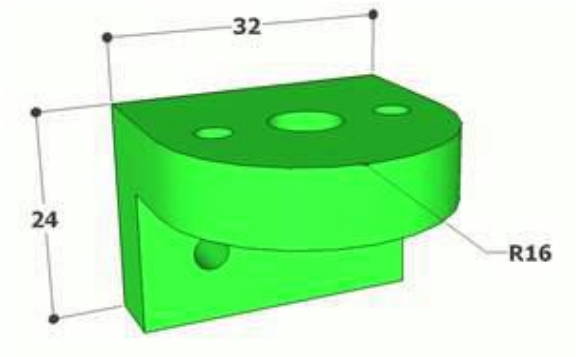
In case of wear it is necessary to pass the top of the matrix to the oil stone to find sharp edges around the hole.

Should there be play between the punch and the matrix? Ideally, the game should be kept to a minimum.

This is the guarantee of a super sharp cut of the confetti. This therefore assumes a precision mechanical realization.

5 - 13 - THE MATRIX SUPPORT

This is the piece of aluminum that will serve to fix the matrix on the mobile carriage.



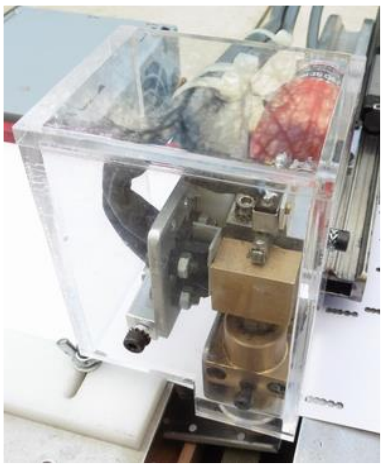
(dimensions overall given as an indication)

The hole in the axis of the punch is of a large diameter to facilitate the evacuation of confetti down.

The die must be in perfect alignment of the punch. This precision is very difficult to achieve. Also, we can circumvent the obstacle by making holes a little larger than the screws that will be used to fix the matrix.

During installation, the punch will be brought manually (with the motor switched off) in the low position, and it is only then that the screws will be tightened to the block.

5 - 14 - THE PROTECTIVE HOOD OF THE PERFORATION HEAD



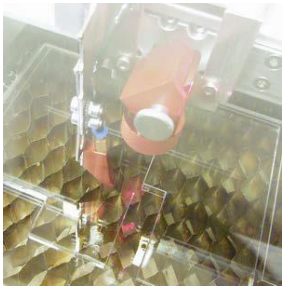
This part is optional and is not necessary for the proper operation of the perfo

In fact, the hood is not made to protect the head that does not fear much, on the other hand it is very useful to avoid approaching the fingers where it hurts.

Although the motor of descent of the punch is relatively weak, by the play of the reducer one obtains at the output a rather important couple, at least enough to shred a fingertip.

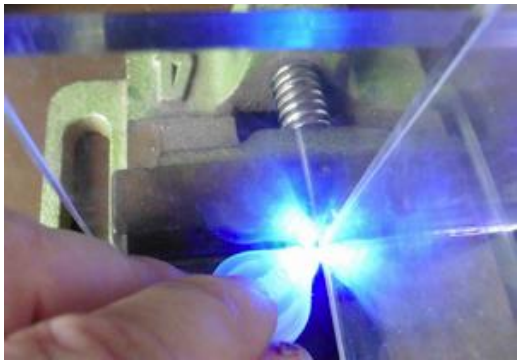
We know what we're talking about ... The risk is not under the punch, but in the control system.

The cover is made with pieces of Plexiglas passed to the laser cutter.



It is unlikely that you have such a tool at home.
So 2 solutions:

- cut the plexiglass with a hacksaw
- join the FABLAB closest to you and benefit from sophisticated tools.



To stick the Plexiglas, we tried several glues without success. Either it does not stick or it leaves white marks.

The best, but still a little weak, is the CYANOLIT "special transparent materials". A mini blue LED can harden the glue.

5 - 15 - MANAGING CONFETTI

To prevent the confetti dispersed throughout the perfo, it must quickly recover.

When they leave the matrix holder, the confetti falls into a toboggan. The vibrations of the machine make them gently go down to a recovery tank.

At the end of the perforation of a cardboard, and before enclosing the perforator in its box, it is necessary to think of emptying the confetti drawer. Otherwise, you spread it everywhere and especially on the rail and inside the straight ball bearing.

6 - THE POSITION CONTROL OF THE HEAD AND THE PUNCH

6 - 1 - WHY WANT TO CHECK POSITIONS?

At any time during the perforation process, the computer program will receive information that will be transmitted to it by position sensors.

Indeed, to precisely define the location where the punch must go down, it is necessary to know very precisely the geographical position of the drilling location (movement X and Y)

It is also necessary to constantly know the high or low position of the punch (movement Z) so that the software sends the drilling orders at the right moment.

In addition, the software must ensure that the punch is in the high position before issuing the cardboard advance or translation commands of the punching head. Otherwise, the cardboard will irretrievably tear.

Optic couplers will therefore be placed at strategic locations which will detect the presence or non-presence of moving mechanical parts, themselves integral with the parts whose position is to be controlled.

An opto-coupler is a component composed of 2 distinct elements that face each other but are separated from each other:

- A light source
- A photocell

The light source is permanent. If no obstacle comes between it and the cell, the cell will send an order to the software through the interface card.

If, on the other hand, a mechanical shutter cuts off the light beam, the cell reacts immediately by sending an order different from the first one.

If you do not see the light emitted by the LED of the opto-coupler, do not deduce that it is dead. To avoid disturbances with an external light source, the LED emits in the spectrum of the infrared.

6 - 2 - CONTROL OF THE CARDBOARD ADVANCING MOTOR

Our assembly includes 4 sensors. Logically, one could think that the first sensor controls the cardboard feed motor, the second sensor controls the carriage translation motor and the last two sensors control the high and low positions of the punch. Well no!

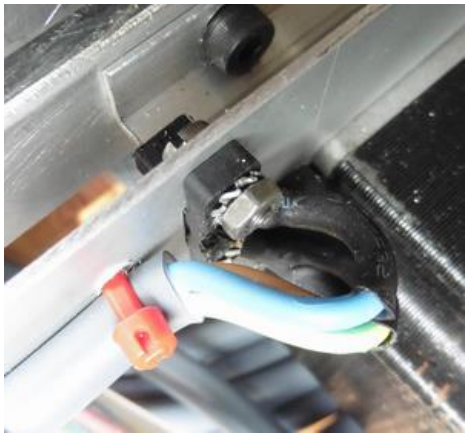
For moving the book, there is no feedback to predict. The card always scrolls in the same direction, and the order sent by the program is ALL or NOTHING.

6 - 3 - CHECKING THE CARRIAGE POSITIONING MOTOR

There, it gets complicated a little bit. The cart comes and goes constantly and we need to know its position very precisely.

To do this, we will use two opto-couplers (available from SELECTRONIC - ref MCT 8 or equivalent)

A first opto-coupler will detect the linear position of the carriage using a rectilinear concealer secured to the carriage.

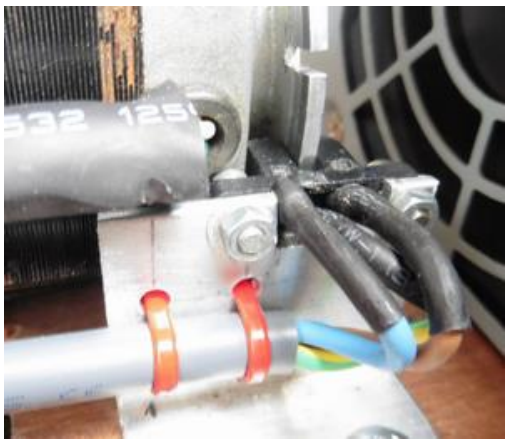


During half of the stroke of the low side head, the opto-coupler is hidden and is unmasked during the other half of the race.

Which means that there is a change of state towards the middle of the race.

For best efficiency, the opto-coupler should be located approximately in the middle of the width of the raceway.

This will be developed later.



A second opto-coupler will be masked and unmasked by a disc placed at the rear of the motor that moves the carriage.

This disc has a slot on its periphery.

The opto-coupler, which is fixed to it, straddles the periphery of the disc to detect the passage of the slot.

At the start of punching a cardboard, the machine goes in search of its original position. In mechanics, this is called P.O.M (machine origin point). In the case of do-it-yourselfers, it is simply called the "point of origin"

The motor will rotate and move the head until it returns to position able to mask the linear opto-coupler.

Then, the motor will continue to rotate in the same direction until the opto-rotary coupler will detect the passage of the slot on the rotating disc integral with the axis of the motor.
Taking into account these two positions (opto-linear coupler masked and opto-rotary coupler unmasked) determines the famous point of origin.

So we have to do a function "AND LOGIC" which corresponds to the essential filling of 2 distinct conditions.

This point of origin is thus located "somewhere" towards the middle of the race of the head. At the initial setting of the machine, it is defined once and for all how many motor steps, this point of origin is located from the edge of the board.

This is a simple operation that is described in the user manual of the software.

Why have you chosen this particular mode of operation?

By setting the point of origin to the middle of the box, we will do a control of the original position each time the head moves in this area, without having to go back to an edge.

This control is therefore completely "free" in terms of time, and no additional movement is created to do it.

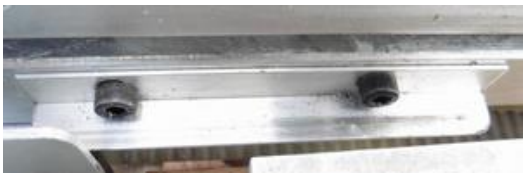
The combination of the 2 linear and rotary opto-couplers can seem quite "far-fetched". In fact, it allows a very precise control, even with low-end opto-couplers, the fineness of the beam can be any.

This is the principle developed by the English Bob ESSEX.

For much more detailed explanations, we refer you to the website of Pierre PENARD where a very complete document has been put online.

Where to place the blackout of the linear position detection of the trolley?

The shade is a simple aluminum "L" angle which is fixed against the flange located opposite the guide rail of the straight ball bearing.



On the subject of its fixation, there are at least two questions to ask:

The first question: How far from the reference edge should the linear opto-coupler ideally be placed?

Answer: The opto-coupler must be changed as often as possible during cardboard perforation. So in theory it should be placed in the middle of the width of the largest cardboard, which in this case, taking into account the maximum capacity of the machine, gives 115 mm (230 mm / 2).

If you start on a hole punch to punch ONLY cardboard 27-29, it is therefore +/- 65 mm (130 mm / 2).

If we consider a machine that can also perforate much larger Cardboards, which is our case, do not put the opto-coupler much further than these 65 mm!

By placing it at 115 mm, it favors the Cardboards of great width, but it penalizes the Cardboards of small width, which are logically more widespread.

Indeed, if we imagine an opto-coupler at 115 mm, and that we perforate a cardboard in 130 mm, if there are no acute notes on a part of the piece, the origin would be never controlled at these places. However, there is always bass, regardless of the width of the book and the piece of music.

Conclusion: it is necessary to place the opto-linear coupler at +/- 65 mm of the reference edge, and it will work well for any type of cardboard.

Before definitively fixing the angle, it is best to fix it temporarily with a piece of double-sided tape. It is only after having validated its good position that the angle will be fixed with 2 small screws on the body of the movable head.

<u>The second question</u>:

In the pair "linear angle / opto-coupler" which element is mobile, and which element is fixed?

- **The angle is movable (integral with the carriage), and the opto-coupler is fixed (secured to the base)**
- **Or the angle is fixed (integral with the base), and the opto-coupler is mobile (secured to the carriage)**
-

In fact, it comes down to the same thing. It's purely mechanical. FYI, we opted for a fixed opto-coupler, which still has the advantage of not moving the connection wires.

6 - 5 - ROTARY DETECTION OF THE CARRIAGE POSITION

To hide and unmask the rotary opto-coupler, we use a simple aluminum disc which is firmly fixed on the axis of the motor ensuring the translation of the movable head.

The radius must be large enough to engage the opto-coupler, but not too much not to rub on the base support. With us, the disc is 60 mm in diameter

At the periphery of this disc, it is necessary to make a small slot so that the light beam of the opto-coupler can illuminate the photocell. The width of the slot is about 3 mm.

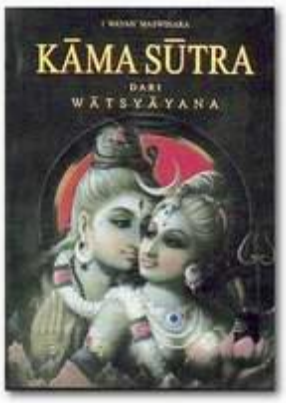
The thickness of the disc is of course not critical, but it must be low enough not to rub against the internal faces of the opto-coupler.

You can indifferently place this disc on one side or the other of the motor.

In our case, we placed it at the rear having first pierced and tapped the axis of the motor (delicate operation)

The disc must be perfectly fixed on the axle to prevent it from turning on itself. If this is not the case, the position control can not reliably be ensured.

6- 6 - DETECTION OF HIGH OR LOW PUNCH POSITION



The punch can have several positions....

The computer program will need to know at all times where the punch is, namely in the high position or low position.

One might ask why the program needs to know where the punch is as it gives him the descent and climb orders.

Logically this should be the case. But it may be that in some extreme situations the punch is stuck in the low position.

It happens after a while when it is not as sharp as in the first hour.

If in this case the software sends an order of advancement of the box, it will very badly withstand the situation and will tear.

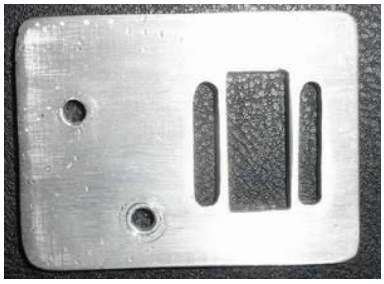
The opposite is also true: the punch can remain blocked at the top, and arriving at the end of the cardboard, one realizes that it lacks full of perforation.

Detections of high and low positions are therefore mandatory.

The duration of the control signal will be set in the soft.

6 - 7 - THE FIXING OF SENSORS OF HIGH OR LOW POSITION AND SWITCH

A strong fixation must be provided to keep opto-couplers in place. A "rickety" fixation will expose you to a bad sliding of the occulteur.



An aluminum support of 3 mm thick guarantees good rigidity.

Lights must be made to allow easy and precise adjustment of the opto-coupler mounting height to ensure that they are hidden and unmasked when necessary.

It must also provide a setting for the switch that will be used to ensure that the punch motor stops at the right time, namely when the punch is raised.

6 - 8 - ADJUSTING THE POSITION OF THE UP AND DOWN OPTO COUPLERS

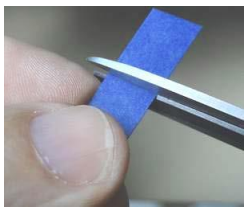
It is obvious that this adjustment phase can only take place once the electronic card has been successfully tested.

The position of the punch has a great impact on the smooth running of the program. The position detection is based on the information that is returned by the 2 opto-couplers (up and down).

The adjustment of the position of the sensors seems at first sight very simple insofar as one tends to think that it is enough to cut out an occluder whose height would correspond more or less to the thickness of the opto-couplers, and that it alternately masks the high beam or the low beam.

Well no, that's not how it works at all!

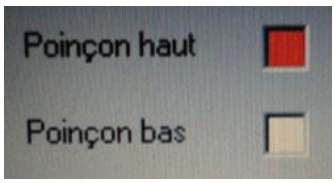
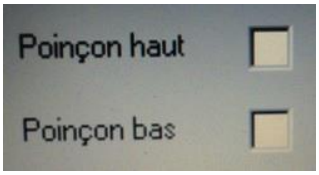
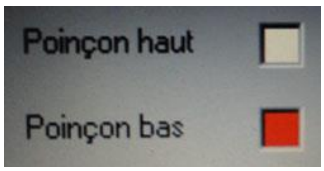
In fact, the height of the occluder must be large enough so that at a given moment it masks both beams. The fact of having used an adjustable support makes it possible to better refine the position of opto-couplers.



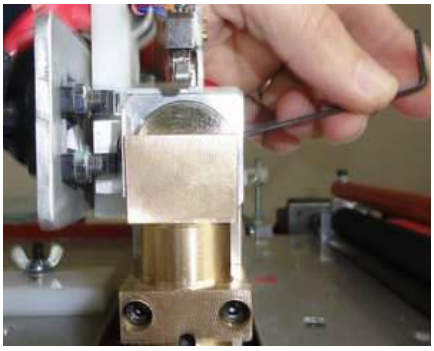
It will then be necessary to act on the height of the occultor which is integral with the rod supporting the punch.

To find the right height of the shade, it is easier to test with a sheet of cardboard. Once the correct size is determined, we can proceed to the manufacture of an aluminum shutter.

In the end, you have to make sure that the position of opto-couplers and the size of the occluder lead you to the following result:

Cycle	Punch position	State of the lights
Phase 1: Hallmark at the top. **It must be sure that in all cases, the punch is cleared when "punch up" lights up.**		
Phase 2: Punch in the middle (transition phase) **None of the 2 LEDs should be lit.** **In fact, LEDs should be considered as end-of-run contacts**		
Phase 3: Punch at the bottom **Only the "Poinçon bas" warning light comes on**		

For a better visualization of the punch, the unhooker has not been put in place on the photos above.



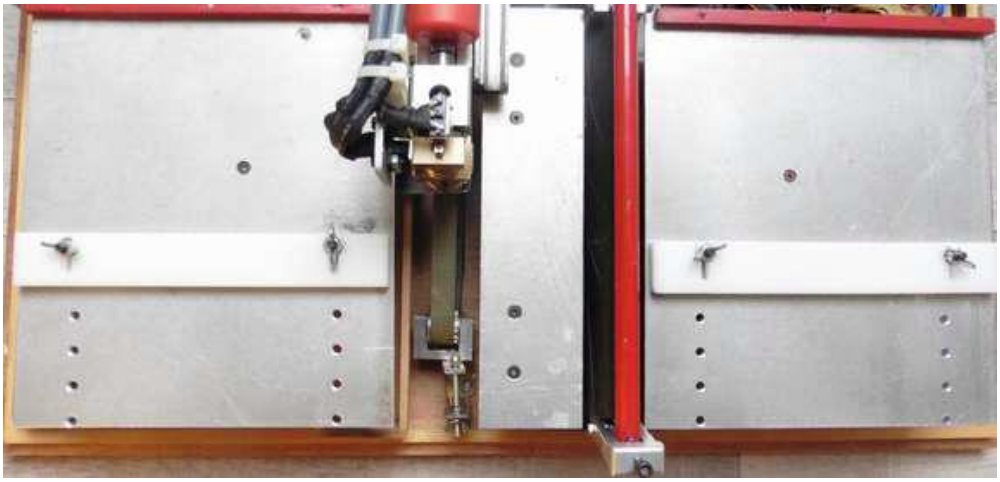
In order to be able to precisely adjust the opto-coupler position and the size of the occluder, it is necessary to switch to "manual" mode.

Namely disconnect the power from the motor and raise and lower the punch by hand by inserting a key awl in the fixing screw on the motor shaft.

7 - THE FLOW PATH OF THE CARDBOARD

It is essential that the cardboard is perfectly guided in width when scrolling. In a vertical plane, it must slide just flush with the matrix that receives the punch and must then engage hair pile between the two coach rollers.

In our performance, the path is divided into three sections:



	Position	Dimensions
1	to the left of the drilling position	Width 215 mm Depth 250 mm
2	between the piercing position and the training rollers	Width 60 mm Depth 250 mm
3	right of the coach rollers	Width 215 mm Depth 250 mm

- Widths are not critical

- The depth is related to the maximum size of the boxes that you plan to pass

The two paths at the ends are equipped with strips to ensure the perfect guidance of the cardboard.

- The strips along the reference edge are of course fixed.

- The bars on the opposite side are made adjustable to fit the width of the cardboard to be passed.

Each section is firmly attached to the support base of the entire drill.

We used Rilsan blocks.

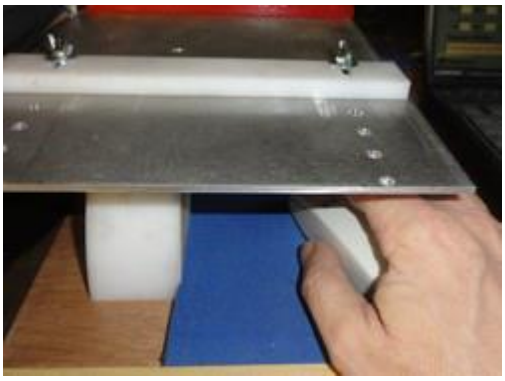
Their particular form is related to what we could recover at a lower cost ...

When fixing, make sure that the edge of travel of the cardboard is perfectly at 90 ° with respect to the travel of the mobile carriage. Otherwise, notes that are supposed to be played at the same time will not be played.

The perfect squareness is verified with a simple square.

All screws must be firmly tightened to avoid vibrations and noise generated by stepper motors.

Depending on the location of the cardboard path holder, you may have room to place a piece of mouse pad.



8 - THE INTERFACE

8 - 1 - RETURN ON THE PREVIOUS VERSION OF THE PERFORATION SOFTWARE

This is not to shame Pierre PENARD, and Jean-Pierre COSSARD to note that the program PERFO version 4 previously used was a little "old."

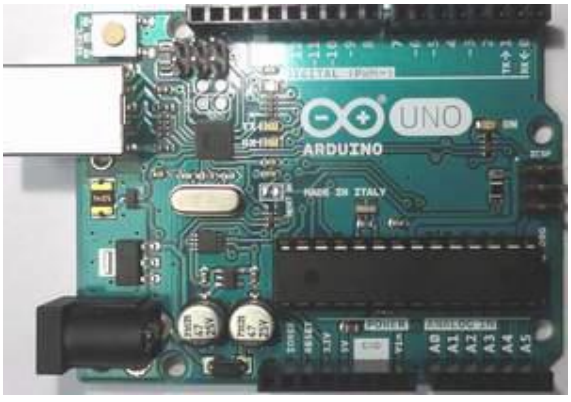
This version was optimized for Windows XP. Although it could turn on more recent versions through the "compatibility" mode, Pierre PENARD still advised to run the program under Windows 95, which in 2016 is still a bit anachronistic.

The orders passed through the parallel port, which is less and less common on recent PCs. This forced to use an old PC.

The PERFO V4 program did not fit well with the multitasking mode of Windows. Also, it had to be run on a specific machine, without anti-virus, screen saver, and without network connection.

During the perforation, it was strongly advised not to touch the risk of having foot losses, or crashes.

With the difficulty of recognizing the USB port on very old PCs, only the transfer by diskette was possible to load the MIDI files. Conversely, recent PCs no longer have a floppy disk drive. So it was a bit of a hassle to go through an intermediate PC with both a USB port and a floppy disk drive.



Do not spit anyway in the soup, because even if the system had some weaknesses, it still works!

Pierre Penard has once again bubbled his neurons by concocting a new interface based on an Arduino board.

The end of the end will have been to develop an interface complementary to the old interface.

It was necessary to take into account the many drills already in service.

So we keep the old interface as is, and we just add an Arduino board. The manipulation is super simple and you will find all the explanations on the site of Pierre.

8 - 2 – OPERATION

Here is very briefly the operation of the interface:

Via a USB cable, information is exchanged between the PC and the Arduino board. Then they transit through the Arduino board connectors for the stepper motor control board.
The card uses mainly two integrated circuits.

- **The first circuit (74 LS 241) receives the signals sent by the Arduino board and formats them to control 8 power transistors, which will in turn control the 2 stepper motors.**
- **The second circuit (74 LS 240) acts in part in the same way to control the motor that actuates the punch, but in addition harvests various information from opto-couplers to send them back to the PC always via the Arduino board.**

This way the PC knows exactly where the mechanical part is.

The main board acts as a power board with buffers (74 LS 241 and 74 LS 240) and Darlington transistors (TIP 122)

Here you know enough! For more complete information, go to Pierre's website.

8 - 3 - THE SCHEME

In the diagram given here, the power supply of the motor X is made in 3.3 Volts and that of the motor Y in 5 Volts. These voltages correspond to that of the recovery motors used by the designer of the card.

If you use the same motors as us, be aware that they are made to be powered by 3 volts. But given the voltage drop in the control transistors (2 volts for a TIP 122), we started with a 5-volt power supply.

Be careful to take into account the fact that the power of the stepper motors is via a dry contact relay R2, which sticks as soon as the interface card sends its first order that can be:

- **The progress of the motor Y (scrolling of the cardboard)**
- **Either forward or reverse of the X motor (carriage movement)**
- **The command of the punch control motor**

From there, and if everything goes well in the process, the relay R2 remains stuck permanently.

On the other hand, if something goes wrong, the relay goes into the rest position, thus cutting power to the stepper motors. It's a security.

The diagram given here is valid for an electric motor punch control. In the case of an electromagnet or solenoid valve actuator for pneumatic cylinder, the final stage of the diagram must be modified. See the information on Pierre PENARD's website

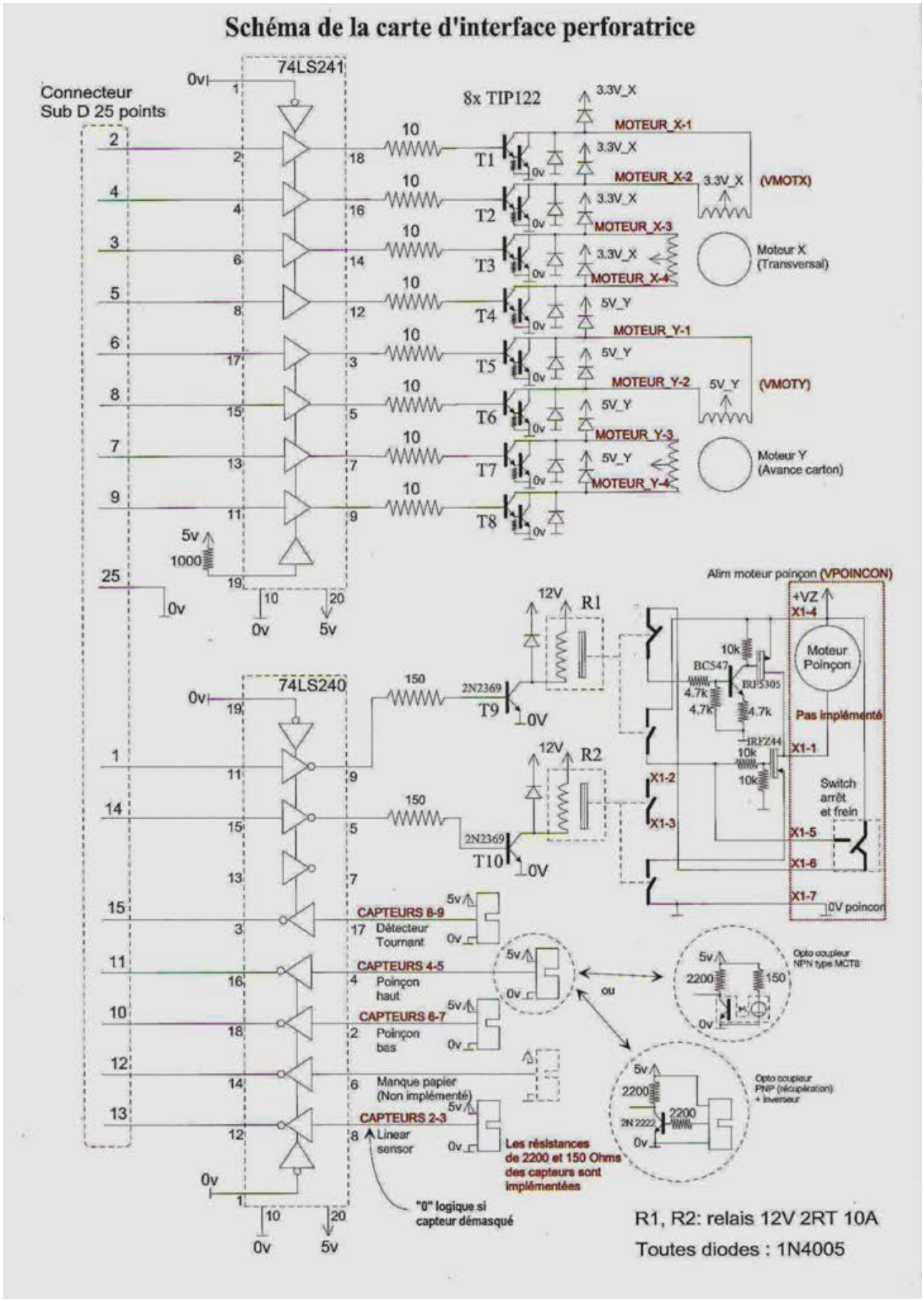


Schéma de la carte d'interface perforatrice
Connecteur
Sub D 25 points
74LS241
74LS240
8x TIP122
MOTEUR_X-1
MOTEUR_X-2
MOTEUR_X-3
MOTEUR_X-4
MOTEUR_Y-1
MOTEUR_Y-2
MOTEUR_Y-3
MOTEUR_Y-4
(VMOTX)
(VMOTY)
Moteur X
(Transversal)
Moteur Y
(Avance carton)
Alim moteur poinçon (VPOINCON)
Moteur
Poinçon
Pas implémenté
Switch
arrêt
et frein
CAPTEURS 8-9
Détecteur
Tournant
CAPTEURS 4-5
Poinçon
haut
CAPTEURS 6-7
Poinçon
bas
Manque papier
(Non implémenté)
CAPTEURS 2-3
Linear
sensor
ou
Opto coupleur
NPN type MCT8
Opto coupleur
PNP (récupération)
+ inverseur
Les résistances
de 2200 et 150 Ohms
des capteurs sont
implémentées
"0" logique si
capteur démasqué
R1, R2: relais 12V 2RT 10A
Toutes diodes : 1N4005

8 - 4 - CONNECTING THE ARDUINO CARD

To connect the ARDUINO board, you have two options, depending on whether you have already built your "old version" interface or if you started from scratch.

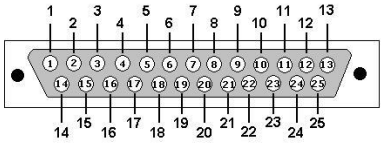
Case # 1 - You already have your interface card with its DB 25 plug.	**Simply solder the Arduino board wires to a female DB25 jack, which will simply plug into the existing jack.**
Case # 2 - You do not have an old card, and you have not planned a DB 25 plug on the new one.	**Solder the Arduino board wires directly to the circuit board.**

Here is the correspondence table according to the 2 possible cases:

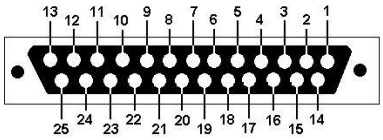
	CASE 1	CASE 2
	Card with DB 25 male 	Direct connection to the circuit board 
Arduino pins	No. of pins DB 25 female	Printed circuit tracks
D 2	2	Pin 2 of the 74LS241 (T1 command)
D 3	3	Pin 6 of the 74LS241 (order T3)
D 4	4	Pin 4 of 74LS241 (T2 command)
D 5	5	Pin 74LS241 (order T4)
D 6	6	Pin 17 of the 74LS241 (T5 command)
D 7	7	Pin 13 of 74LS241 (T7 command)
D 8	8	Pin 15 of 74LS241 (command T6)
D 9	9	Pin 11 of 74LS241 (T8 command)
D 10	10	Pin 18 of the 74LS240 (low punch detection)
D 11	11	Pin 16 of the 74LS240 (high punch detection)
D 12	13	Pin 12 of the 74LS240 (linear detection)
D 13	15	Pin 3 of the 74LS240 (rotary detection)
A 0	1	Pin 11 of the 74LS240 (relay command 1)
A 1	14	Pin 15 of the 74LS240 (relay command 2)
GND	25	To the ground

In either case, the power supply of the Arduino board is via the USB port.

The numbering of the pins is not the same between a DB 25 plug and a DB 25 socket.



View looking into male connector



View looking into female connector

8 - 5 - PUNCH MOTOR CONTROL

To control the motor which sets the punch in motion, two MOSFET power transistors are used. Otherwise, if using conventional relays, the contacts will have a very limited life.

Here is the operating mode of the part "punch motor control"

at the start of the command pulse:

- **The relay R2 contact closes. In the event of a software problem, the contact opens, thus cutting off the power supply to the motor.**
- **The closed contact at rest of relay R1 opens to prevent the BC 547 from controlling the IRF 5305 which is responsible for shorting the motor**
- **The open contact at relay R1 closes, which has the effect of connecting the motor to ground via the IRFZ transistor 44.**
- **The motor starts to turn, and switches the switch, which acts as a self-maintaining contact open rest of the relay R1**

After stopping the command pulse:

- **the motor continues to run until the switch returns to the idle position and supplies the base of the BC 547 via contact R1 is thus closed**
- **The BC 547 powers the gate of the IRF5305 which bypasses the motor to lock it just in the up position**

8 - 6 – MANUFACTURING

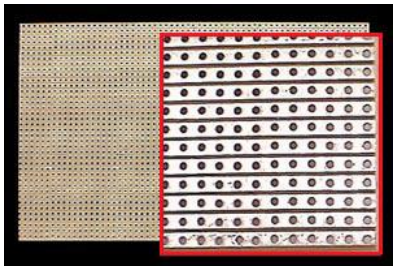
In the previous version of our perfo, we had an electromagnet punch control, so we did not realize the part of the assembly that includes the MOSFET transistors. Switching to the electric motor led us to add an additional circuit board.
You have the choice :

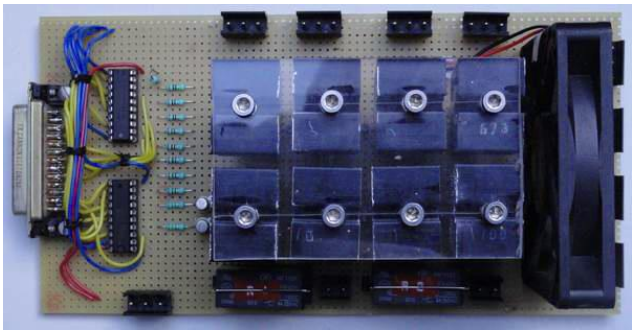
· Either you make a complete circuit for both the power part and the Mosfet part
· Either you realize two separate circuits (this is the solution we chose)

For the PCB (s), you still have a choice to make:

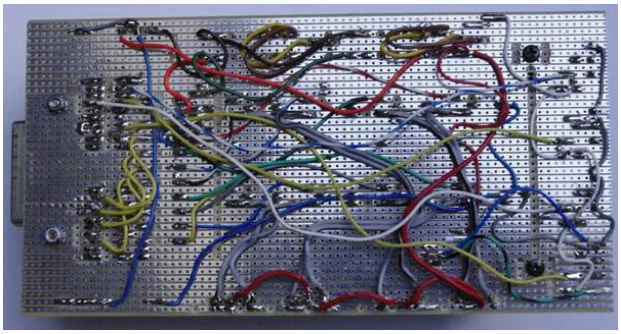
Choice A = Use of tape pads.

This is the solution we chose for the previous version of our perfo.





Component side view (old perfo)



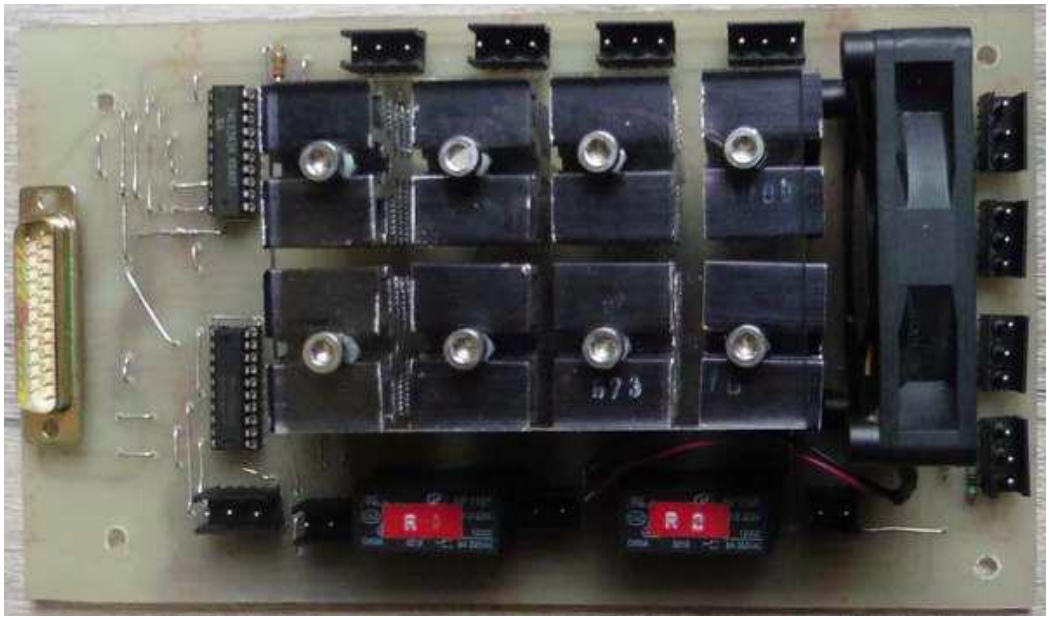
Side view (old perfo)

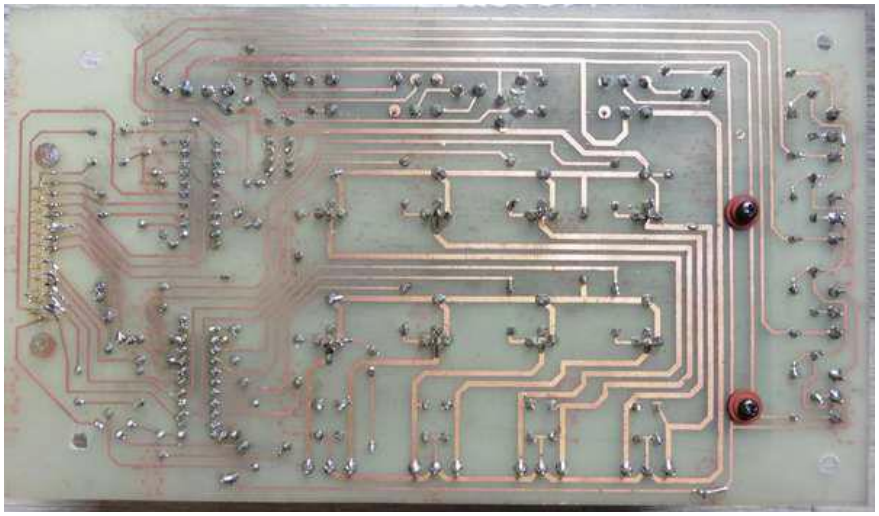
This is not the solution we recommend, and this for the following reasons:

- **Contrary to what one might think, you spend a lot of time designing and producing.**
- **requires extreme attention in the placement of components. Care should be taken to cut the tracks and place the necessary straps in the right places.**
- **Verification and trouble shooting are complicated.**
- **Replacing a component is tricky.**
- **The look is not very professional.**

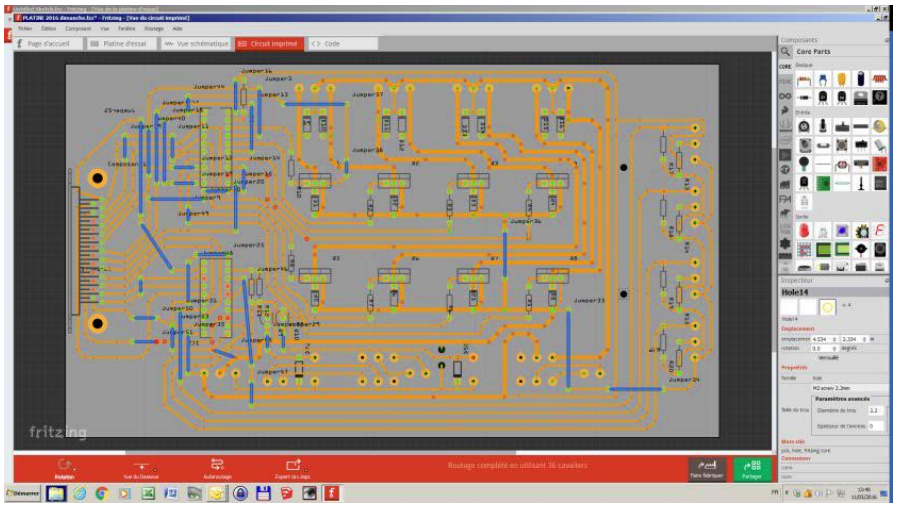
Choice B = Manufacture of a dedicated printed circuit board.

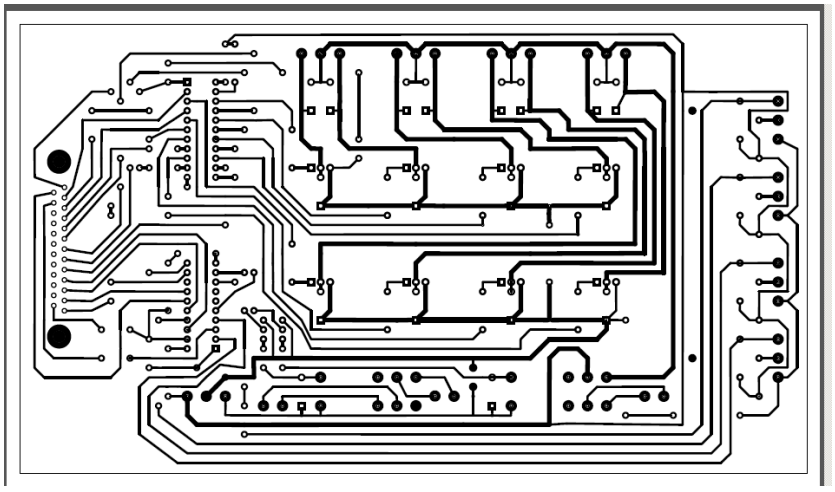
This is by far the solution we advocate. With a dedicated circuit board the risk of error when inserting components is very small (but not inexistent).





You can design your own PCB using the open-source FRITZING software.





Another solution: if you ask us nicely, we will send you the PDF file of the artwork.

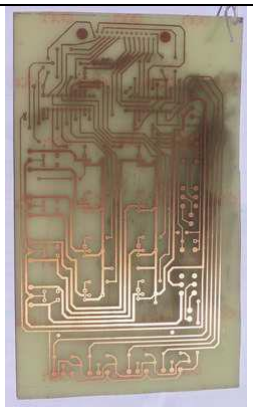
Three remarks on our artwork:

- It is based on the use of a motor for the descent of the punch

- it only takes into account the "power card" part. Due to lack of space, we realized the "MOSFET" part on a very small separate circuit. Given the small number of components, we used this time a wafer with pelletized strips.

- **It is single sided, so easier to do. This explains the presence of some straps.**

For engraving, we abandoned the good old method "UV irradiation and iron perchloride attack" in favor of the technique "toner transfer of a laser printer"

			
Impression of the artwork on a glossy paper (no matter the primary reason ...).	**Toner transfer on the copper side with a hot iron for +/- 2 minutes.**	**Attack of copper by a mixture of hydrochloric acid + hydrogen peroxide + clear water.**	**Take off the paper in water.**

You will have to do some tests on circuit drops before making the big circuit. This will test the quality of the paper on which depends largely the result.

FYI, we used the inside pages of a flyer, on which the ink is fixed well.

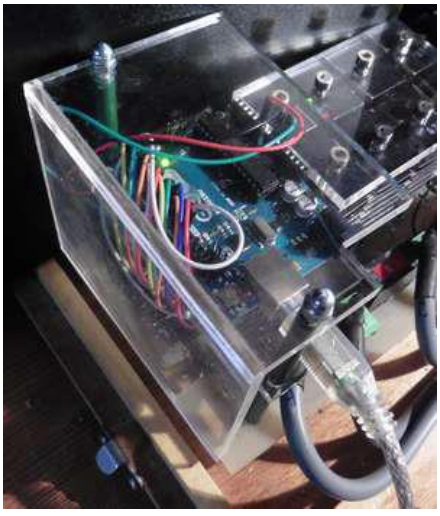
Given the thinness of these pages, it is best to stick them on a white sheet A4 by putting Scotch up and down over the entire width. This will prevent jams in the laser printer. Manipulation does not work with an inkjet printer.

For further information type in your search motor "toner transfer circuit board engraving"

8 - 7 - SETTING THE ARDUINO CARD

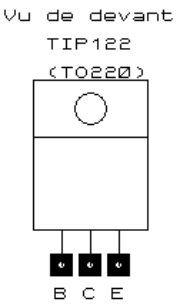
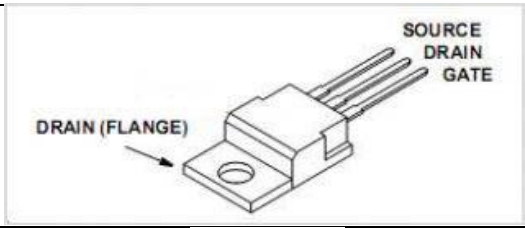
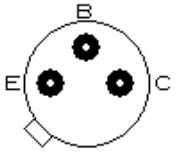
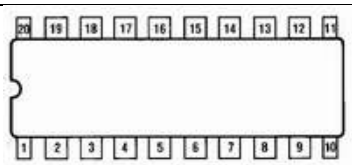
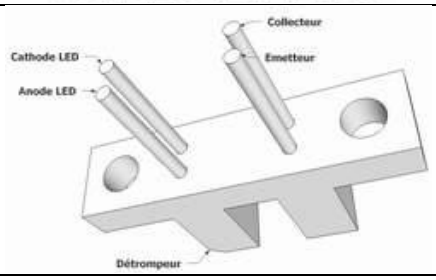
Given the space we had on the existing base, we had no place to put the Arduino card next to the power card.

Also, we realized a small support in plexi to position the Arduino card on the power card, with in addition a cover in the shape of "L" to cover the most exposed parts.



8 - 8 - BROCHING COMPONENTS

Whatever the method of manufacturing the card, the component pinout is the same and is communicated to you here to avoid searching. What does one say ?

For the 8 transistors TIP 122: **Case TO220, pinning given front view, ie with the metal plate (to be pressed against the cooling radiator) located at the back**	
For the 2 MOSFET transistors: **TO220 case,**	
For transistor BC 557: **Broaching seen from below**	
For the 2N2369 transistors: **Broaching seen from below**	
For 74 LS 240 and 74 LS 241 integrated circuits: **Dual-in-line case, pinout view from above**	
For opto-couplers MC T8: **Broaching seen from below.**	

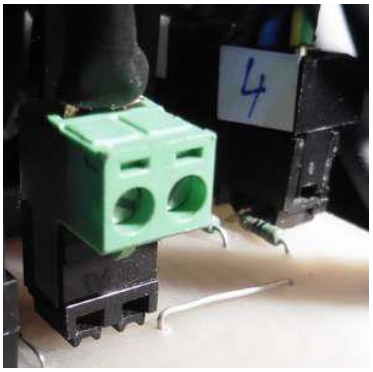
A tip: the price of these active components and relays is very low. Also, if you have a little trouble finding them locally, and you have to order them by mail, take the precaution of taking a few more.

Put them carefully in a small box screwed on the base of the perfo, and you'll be happy one day to have them quickly on hand.

8 - 9 - ASSEMBLY TIPS

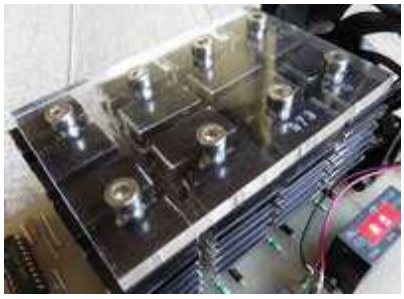
Integrated circuits are mounted on a support.

This prevents their overheating destruction when sold directly, and this also facilitates their replacement. Warning: on our circuit, the 2 ICs are not oriented in the same direction.



All inputs / outputs are on removable connectors (this is convenient for easily reversing the direction of rotation of the motors during the debugging phase).

There are 12 connectors in all, so the need to number them.



For the stepper motor control transistors, the radiators are a bit oversized compared to the transistors. (It's recover ...) Also to prevent them from moving too much, we made them integral by a plate of plexi.

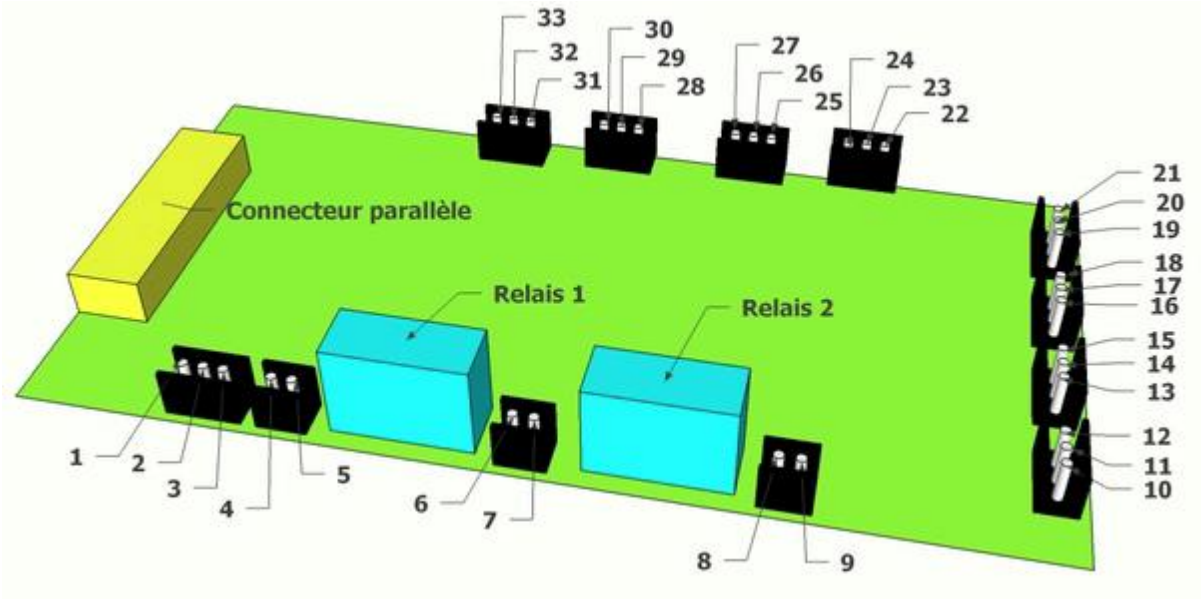
The two relays are also mounted on support to facilitate their replacement

There was still room for a small fan to be retrieved from a PC power supply (this is optional)

8 - 10 - IDENTIFICATION OF THE INPUTS AND OUTPUTS OF THE MAIN CARD

To facilitate the connections and also to avoid inversions, it is strongly recommended to pinpoint the different outputs or inputs on the printed circuits.

The sketch below is just an example and should be adapted to your own editing. Carefully keep this type of information, if one day you need to intervene again for troubleshooting.



CONNECTORS	#	CONNECTIONS ON BOARD	EXTERNAL CONNECTION
Power supply	1	+ 5 volts	Power Supply + 5 volts
	2	Ground	Feed Ground
	3	+ 12 volts	Power Supply + 12 volts
Connection No 1 to the board with MOSFET	4	Dry normally closed contact of relay 1	Resistance 4.7 k of board with MOSFET transistors
	5	Dry normally closed contact of relay 1	+ 12 volt by the motor switch when the punch is in the up position.
Connection No. 2 to the board with MOSFET	6	dry contact of the normally open relay 1	Resistance 10 k of the card with MOSFET transistors, but also on punch motor switch
	7	dry contact of the normally open relay 1	Power supply + 12 volts
Connection No. 3 to the board with MOSFET	8	dry contact of the normally open relay 2	IRFZ44 transistor source
	9	dry contact of the normally open relay 2	ground
Opto-coupler punch low position (see note following this table)	10	Ground	Ground (LED cathode + transistor transmitter)
	11	150 ohm resistor	Anode LED of the opto-coupler
	12	Pin 2 of the 74LS240	Transistor collector of opto-coupler
Opto-coupler punch high position (see note following this table)	13	Ground	Ground (LED cathode + transistor transmitter)
	14	150 ohm resistor	LED Anode of the opto-coupler
	15	Pin 4 of the 74LS240	Transistor collector of opto-coupler
Rotary opto-coupler	16	Ground	Ground (LED cathode + transistor transmitter)
	17	150 ohm resistor	LED Anode of the opto-coupler
	18	Pin 17 of the 74LS240	Transistor collector of opto-coupler

Linear Opto-coupler	19	Ground	Ground (LED cathode + transistor transmitter)
	20	150 ohms resistance	Anode LED of the opto-coupler
	21	Pin 8 of the 74LS240	Transistor collector of opto-coupler
Motor Y advancing Cardboard	22	Transistor collector T8	End 1 winding 1 (green wire)
	23	Power supply + 5 V (via relay)	Midpoint winding 1 (white wire)
	24	Transistor collector T7	End 2 winding 1 (Red wire)
	25	Transistor collector T6	End 1 winding 2 (yellow wire)
	26	Power supply + 5 V (via relay)	Midpoint winding 2 (black wire)
	27	Transistor collector T5	End 2 winding 2 (blue wire)
Motor X displacement of the punch	28	Transistor collector T4	End 1 winding 1 (green wire)
	29	Power supply + 5 V (via relay)	Midpoint winding 1 (white wire)
	30	Transistor collector T3	End 2 winding 1 (Red wire)
	31	T2 transistor collector	End 1 winding 2(yellow wire)
	32	Power supply + 5 V (via relay)	Midpoint winding 2 (black wire)
	33	T1 transistor collector	End 2 winding 2 (blue wire)

Note regarding the connection of opto-couplers up and down:

Contrary to what might seem logical to you, the opto-coupler which is closed when the punch is in the high position is considered to be the low opto-coupler.

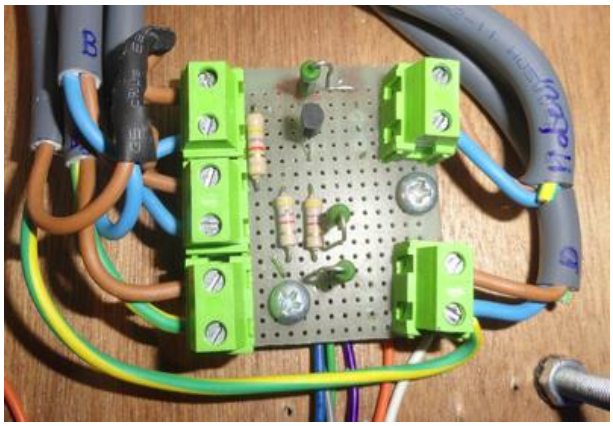
Conversely, the opto-coupler which is closed when the punch is in the down position is considered to be the top opto-coupler.

It's the "end of race" operation that wants that. The opto-coupler is at the top, but it sends its info (it is discovered so), when the punch is down. This must be taken into account when connecting to the interface card.

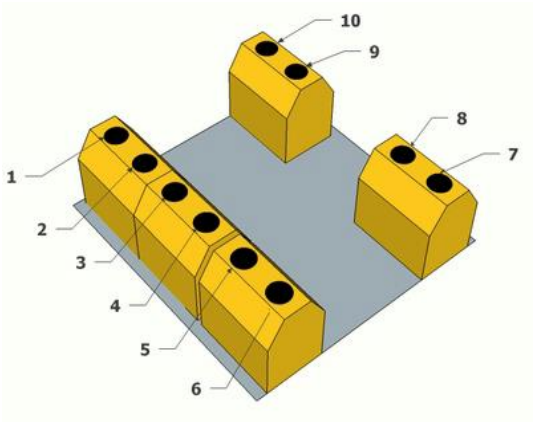
Be aware that there is no risk in reversing both connectors on the board. In one case, or in the other, it must work. If, on the other hand, this is not the case, we must look elsewhere for the cause that can be:

- **A connection error on opto-couplers**
- **A dry solder**
- **A bad connection on the map**
- **A faulty opto-coupler**

8 - 11 - IDENTIFICATION OF THE INPUTS AND OUTPUTS OF THE MOSFET CARD



The additional circuit based on MOSFET transistors



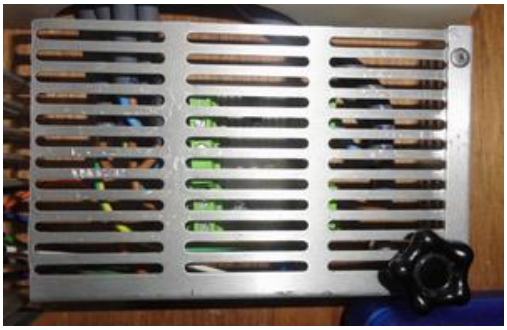
The marking of the output connectors

#	CONNECTIONS ADDITIONAL CIRCUIT	EXTERNAL LINKS
1	Power supply + 12 volts	Power supply + 12 volts
2	Power supply + 12 volts by the motor switch when the punch is high position	Dry contact closed at rest of relay RL 1
3	Resistance 4.7 k	Dry contact closed at rest of relay RL 1
4	Resistance 10 k of the card with MOSFET transistors, but also on punch motor switch	Relay open dry contact of relay RL 1
5	Power supply + 12 volts	Relay open dry contact of relay RL 1
6	Dry contact closed at rest of relay RL 1	Power supply + 12 volts by the motor switch when the punch is high position
7	Ground	RL 2 Relay open dry contact + ground
8	IRFZ44 transistor source	RL 2 Relay open dry contact
9	Drain transistor IRF5305	+ Drain transistor IRFZ44 Motor ground
10	IRF5305 transistor source	+ 12 volts motor

Both MOSFET transistors will heat up. Also, it is essential to mount them on a radiator to dissipate heat.

Caution: The drains of each MOSFET are at the same potential. So we can mount the 2 soles directly on the heatsink without mica sheet, but with a little grease.

In this case, the heatsink will be at the potential of the drains and it will not have to touch another metal part of the drill.



A protective cover covers the MOSFET card. It is made with a perforated sheet metal and recovered from an old device.

8 - 12 - POWER SUPPLY

Unlike the organ, here elbow grease is not enough. To operate, the drill requires several voltages provided by a power supply.

Necessary voltages	To feed
5 volts continuous	• Both stepper motors • Integrated circuits • Opto-couplers
12 volts continuous	• The control relays RL 1 and RL 2 • The punch control motor • The fan on the map (optional)

You have two options for dealing with these needs:

1 - From scratch and manufacture the power completely (transformer + rectification + filtering + regulation)
2 - Recycle a ready-made power supply from an old PC.

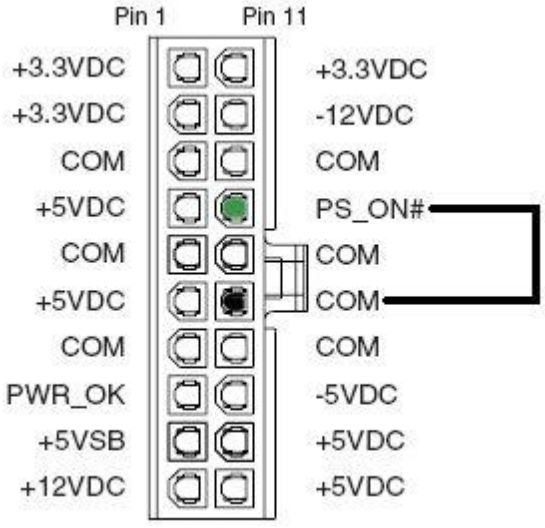
Supporters of the law of least effort, we opted for solution 2.

No, in fact, we thought there was enough work for the whole thing, and we did not want to add a nap.

Do not be surprised if at first, you get no power.

In fact to make it work outside of its normal use to know connected to a PC motherboard, it is necessary to make an electrical bridge between two pins on the power supply:

- **The pin 14 wire - called PS_ON #. This wire is usually green, but sometimes white, and sometimes ...**
- **The pin 16 wire - called COM which is none other than the ground, and which always black (at least to what has been used to date)**



You then have 2 possibilities:

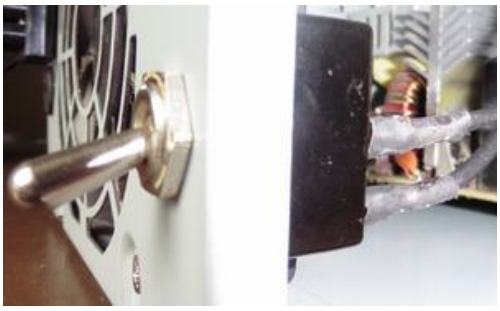
Setting up a strap directly on the connector

Disassembly of the case and welding of the 2 wires

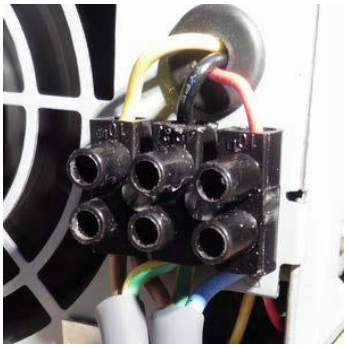
In both cases, the connection must be electrically protected.

It is more convenient to operate a switch than to plug in and unplug the power cord.

The wires are protected by a heat-shrinkable sheath.



The power supply is firmly pressed to the base by aluminum brackets.



- **The + 12 volts (yellow wire)**
- **The + 5 volts (red wire)**
- **The ground (black wire)**

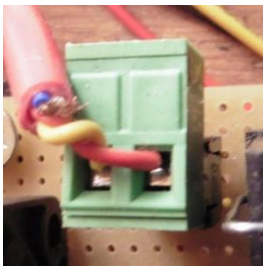
Provide two LEDs for 12 V and 5 V (add resistors to lower tensions)

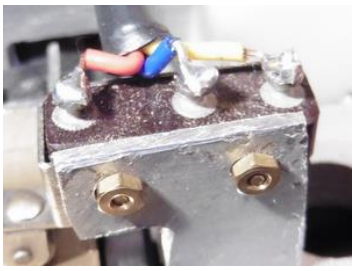
8 - 13 - THE WIRING OF THE ENTIRE

In the version 1 of our perfo, we had all wired with very pretty red telephone wire, because the currents which pass in the sensors are very weak.

It gave the machine a pretty cool look because any production, besides being functional, must also be pretty to look at!

In fact, one should not reason only according to the amperage, but also of term of mechanical resistance. The drill is prone to vibrations and shaking that will eventually break the wires at their connection.

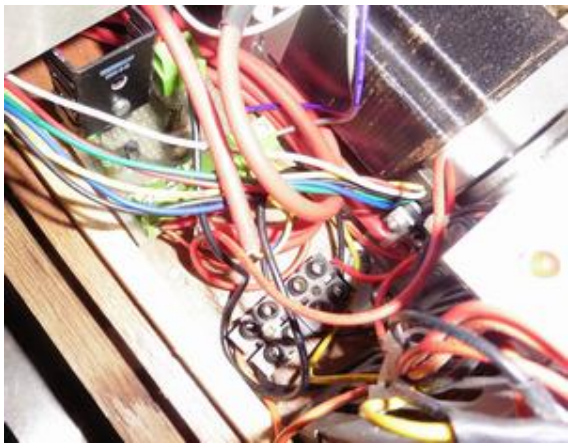




In the version 1 perfo, the binding points above have sometimes given way, with necessarily an interruption in the perforation.

<u>Another point to avoid</u>: the connections "dish of spaghetti". During construction, and sometimes afterwards we sometimes have to change the wiring, either to modify a connection, or to add an element (example of the MOSFET card).

In the end, we can arrive at a functional wiring, but not very readable at the time of the search for failure.



Here are two examples not to follow (version 1 of the perfo)

In addition, with flying yarns, there is also a high risk of tearing when the carriage completely starts in the rear position.

So in this version 2, all the wiring has been completely revised

All the wires are:

- **1.5 mm²** *(15 gauge)* **(1 mm²** *(17 gauge)* **would have been enough)** ***Note: Use 16 gauge wire.***
- **marked with felt pen**
- **terminated by a heat-shrinkable sheath.**

The 6 wires of each step motor are inserted into a transparent plastic pipe.

The cables are pressed against the base with aluminum combs.

The cables must make their way between the different mechanical parts.

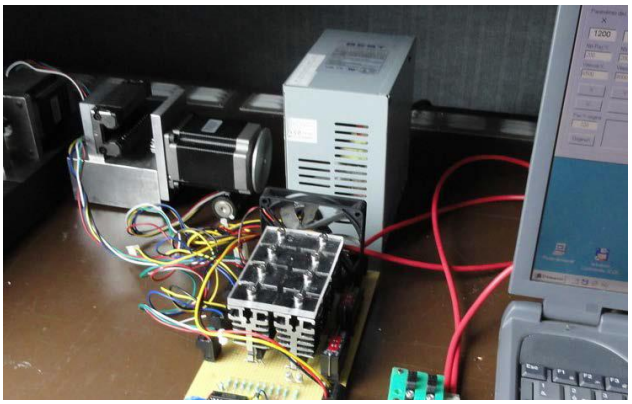
Here they pass under the truck drive motor. The wooden base has been hollowed out.

Be careful not to put too many collars on the cables that are connected to the mobile carriage.

If the cables are too firmly fixed to the base, they will form a coil spring that will have an effect contrary to the translation movement of the carriage. In this case, the motor will move the head in the right place, but the cables will shift a chouïa.

Here, things are back in order by removing the red collar attached to the motor.

8 - 14 - THE TESTS OF THE CARD



In case you have finished the interface card BEFORE you have finished the mechanical part, know that it is possible and even desirable to test it.

Once you are sure you have the right wiring, just run the app.

Then go to the menu "Motors and punch" accessible also by the F2 key.

We can then run the motors, operate the punch, and check in return that the information transmitted by opto-couplers back to the PC by viewing the LEDs.

- **If you click on the X button, the motor moving the head turns in one direction**
- **If you click X- it turns in the other direction**
- **If you click on Y, the paper feed motor starts. One possible meaning in this case. If this direction is not the desired one, simply reverse the 2 connectors on the interface card.**

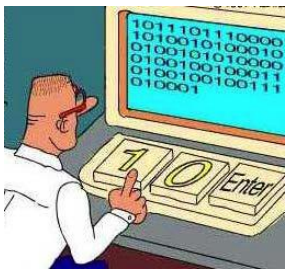
In the box at the top right of the program's F2 screen, there are the various LEDs that reflect the state of the opto-couplers.

When you block the light beam by inserting a piece of opaque plastic, or a piece of cardboard, the corresponding LED goes to WHITE. Conversely, if nothing is inserted, the indicator changes to RED.

This control must of course be done on the 4 opto-couplers (up + down + linear + rotary).

If the tests are conclusive, we can consider that the machine is finished.

9 - THE CONTROL SOFTWARE



Your machine as beautiful as it is is very "stupid". He needs a way to make it work.

To do this, we will call on a very ingenious program developed by Jean-Pierre COSSARD and Pierre PENARD.

Our two friends shared the writing of the program:

- Jean-Pierre COSSARD managed everything related to the exploration of the midi file.
- For his part, Pierre PENARD took care of the control of the mechanical part and also, later, make the operation more reliable, add additional functions such as context backup, step loss controls, and the package of installation, and more recently has made the important changes for taking into account the Arduino board.

What is the function of the program?

Each note of the range is assigned a number defined once and for all by the international standard MIDI (example DO 3 door number 60). The program will manage the notes by their number and not by their name.

In the direction of the width of the Cardboard, each note must be punched at a precise distance from the reference edge of the Cardboard.

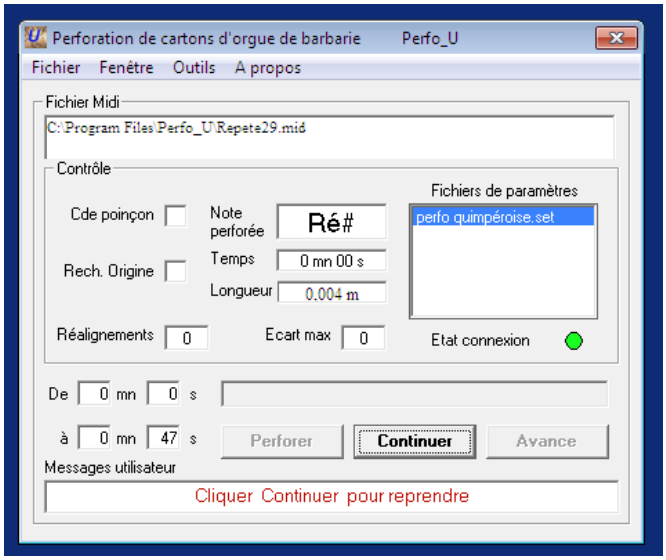
In this way, the hole will be placed in the right place when passing the cardboard on the pan flute. This distance is known to the program (calculation in the parameter screen). The program will calculate the number of steps that the motor must advance to bring the punch to its correct position. (movement X)

The program also calculates the number of steps that the cardboard advance motor must make to respect the gap between the successive notes. (Y movement). Once the punch is at its proper position (X and Y) the program sends a punch order (Z movement), and checks whether the punch goes up well to send new orders for the next note.

The software runs under Windows environment, and is very user friendly. On the site of Pierre PENARD, you will have all the information on how to launch the program.

Note that this software does not perform any processing on the music, and reproduces "as is" on the cardboard, depending on the possibilities of the organ.

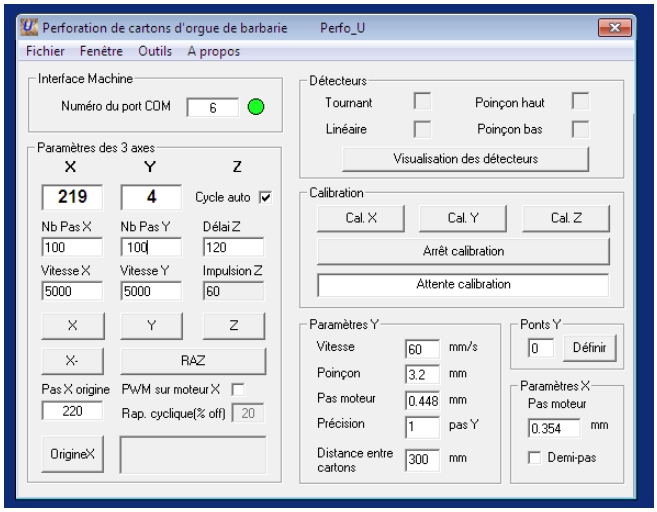
The app is however very well designed, and is very simple in its use.



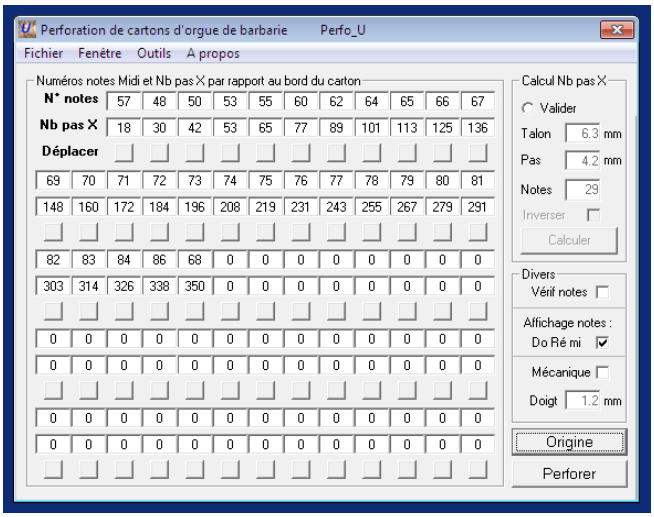
The software is clever enough to draw your attention to the number of notes that may not be played by the organ.

(22 notes are not in the organ's gamma)

A second screen makes it possible to fix the various calibrations necessary for the proper functioning of the motors and the punch, and visually returns the information transmitted by the 4 opto-couplers (after having pressed the button "visualization of the detectors").



A last screen allows you to set up, so to make perfectly compatible your hole punch with your organ.



There is no question here of fully describing how the software works. Pierre PENARD (still him) has pushed the luxury to include in the program a very complete help file (Bill Gates should be inspired ...)

Apart from its perfect operation, the software has two advantages:

- **He is in French**
- **It's free (Many thanks to its developers)**

To download the latest version of the software (and therefore also the doc) go to the website of Pierre PENARD.

10 - OUR EXPERIENCE IN SETTING OUT THE ENSEMBLE

As we are good boys, we will tell you about our modest experience, namely:

- **A few tips**
- **How to solve the small problems that we encountered during the development.**

10 - 1 - FIRST POINT "CAPITAL"

Before starting the various mechanical adjustments (example of the calibration of the point of origin) and the parameterization of the program (example of the motor speeds) one must be sure that all the mechanical part and the electronic part are operational at 300%.

We must hunt for defects:

- **Excessive play**
- **No play**
- **Loose screws**
- **Dry welds**
- **Short circuits**
- **Unstable connections**

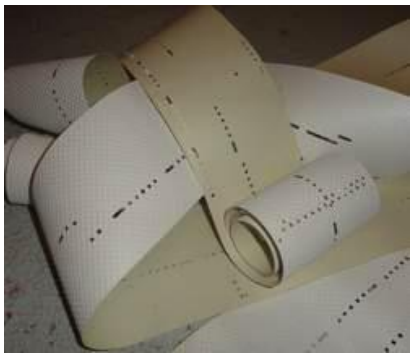
This booklet should avoid you some pitfalls, but unless a great shot, with a machine that works the first time, it is more than likely that the adjustment phase and focus is a bit long. So be patient!

It should also be known that the machine has a stressful power to the extent that it seems to work perfectly, and then suddenly for no apparent reason, it starts spinning.

As long as you use cardboard, the stress is average. When you attack your spool of beautiful cardboard, we go into the red.

10 - 2 - CARDBOARD FOR TESTING

Before punching your spool of good cardboard, make your first perforations on cardboard.
For the very first test, you can use strips of wallpaper.



In any case, the punch calibration operation (function Z) must be done on real cardboard.

If you have free cardboard, you can do the tests directly with. In this case, let us share your good plan ....

If you use cardboard strips of short length, they must be assembled end to end. In this case, do not use an electrician tape for the following two reasons:

- **It's two overthicknesses (1 top + 1 bottom) that goes wrong in the organ's roller box**

- **The cardboard is subject to skating because of the too smooth texture of the scotch**

The best is to use gummed kraft paper. We stick on each side by wetting. This paper is generally used for framing, and is found in DIY stores.

If the fitting should be just at the point of a crease, it should only be on the inside. You can also do many tests without putting cardboard in the machine.

10 - 3 - USE OF 2 PCs

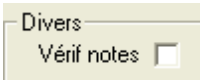
In our case, we used 2 distinct computers:

A first desktop PC connected to the Net, with tools for creating or modifying MIDI files.

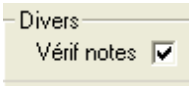
A second older laptop used only for the control of the hole punch.

During the tests, we found that when loading the same MIDI file, the program sends back to us, depending on the PC used, a different information regarding the number of notes not present on the organ.

One said "Ready to punch" while the other said "Attention: xxx notes are not the range of the organ". After working on the subject, we found the cause of the contradiction!



The reason for this is that on the first PC (the one that was ready to punch) the "Check Notes" box on the F3 screen was unchecked.



On the second PC (the one that warned against unplayed notes) the same box was ticked.

Moral: if you use multiple PCs, it is essential that the setting is strictly the same.

10 - 4 - USE OF A BATTERY PORTABLE PC

If you're using a battery-powered laptop, you'll have trouble punching a whole Cardboard.

An average Cardboard can easily require 3 or 4 hours of punching time. If the battery is dry before the end, the PC will stop and the hole will go crazy.

It is therefore imperative to connect the PC to the mains.

10 - 5 - MOTOR DOES NOT RUN AT ALL OR VERY LITTLE

After checking the assembly and connections, the motor will not work.

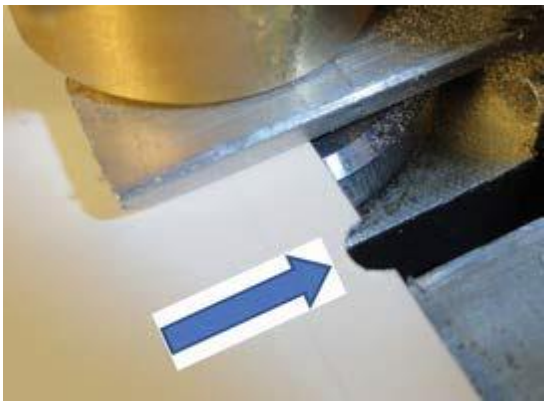
If it does not turn at all, it may be that the value "No. of steps X or Y" is zero. If it makes only small rotations, it may be that the value "No. of steps X or Y" is insignificant.

In both cases, enter a value of 200 and everything will be fine.

10 - 6 - REPERAGE OF THE PUNCH DOWN AXIS

During the adjustment phase of the original position, it is necessary to position the axis of the punch just vertically of the reference edge. Not easy to do precisely because the punch guide does not make it easy to see things.

Here's the tip we found:



• Manually, bring the punch to the place that you think is the edge of the box

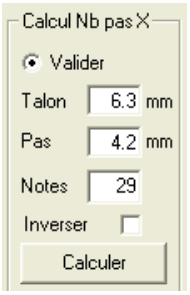
• By clicking on the Z command, make a perforation

• By clicking Card Feed (set to +/- 30 steps), you will see the hole appear.

• If the axis of the hole is not aligned with the edge of the booo, act on Movement X or -X (set to 1 step)

• Repeat the operation until a perfect alignment.

10 - 7 - PERFORATIONS OFFSET IN THE WIDTH



Your perforations are shifted laterally in the X direction.

Solution: It is essential to recalculate the steps in the F3 screen.

The default steps correspond to the exact position of the notes for a given machine, and unless there is a big stroke of the bowl, there is no reason for the head to move for a motor pitch to be the same. one machine to another.

Also check that the axis of the first hole of your pan flute is at 6.3 mm from the reference edge. If not, you must enter the new rib in the "Talon" box.

10 - 8 - STEP LOSS OF THE X MOTOR

Aille go, this is the point that gave us the most trouble in the previous version of our performance that used a rack and pinion gear

Having switched to the version of belt training has been beneficial, but is not the absolute guarantee against the loss of footsteps that may still exist.

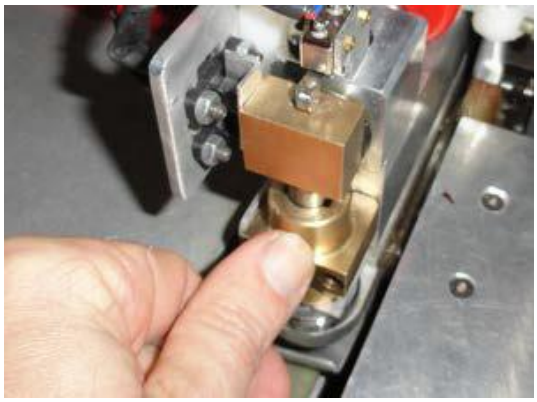
A loss of step results in a small shift on a series of perforations to be on the same line. On several occasions when punching a Cardboard, the software will check if the punch head has not shifted from its normal position.

The software manages the loss of steps and tolerates them in that the fault corresponds to half a distance between tracks. Below it corrects itself. Above, he pauses and it's up to you to find the cause.

In all cases, the software warns you of faults by displaying the number of realignments and the maximum number of steps lost in 1 time.

Our record = 3 realignments
of which one of 36 steps ...

Even if the step losses are few and low values, we should not be content with such an operation. We must almost arrive at ZERO DEFAUIT!



FYI, know that you can cause loss of step by hindering the movement of the perforation head during its translation. Just force on when moving. Be careful where to put your finger!

This manipulation highlights the fact that the loss of steps usually has a mechanical origin.

The causes can be multiple:	And the remedies too:
Carriage too hard	Put a drop of oil on the rail.
Excessive speed of movement of the moving head (speed X)	Gradually reduce the speed. It is far better to wait a little longer than to have a faster Cardboard with offsets. The fact of acting on the control parameters of the punch is a solution having a greater impact than acting on the speed of the drive motor.
Trolley too heavy	It must be lightened by removing matter wherever possible without losing its rigidity
Motor torque a little weak to deal with very slight mechanical blockages	Set up an motor with a larger torque. If the motor in place does not heat too much, we can increase its supply voltage of the order of 20%
Electric wires are a drag on the carriage	Reduce the cable section but not too much. Check that the cables have a large enough travel (so not too much attached to the truck)
Motor pinion turns on itself	Check the tightening of the needle screw
The rotating opto-coupler disc rotates on itself	Block its fixation
The order of translation of the head is launched even before the punch is reassembled	Review the position of opto-couplers.

.

On the old version of the perfo, the causes of loss of step could also be of computer origin. Ancillary elements (antivirus, network connection, screen saver) could interfere with the smooth running of the program.

10 - 9 - STEP LOSS OF MOTOR Y

The Y motor is not subject to a loss of step control by the software. This does not mean that he is not exposed to it. Indeed, in the case of a speed too large, the motor can skip steps randomly, which results in non-identical spacings on two cardboard perforated in the same way.

In this case, it is enough to reduce the speed, by increasing the value Y.

11 - SETTING THE ENTIRE SET

Given the special shape of your drill, and the fragility of its components, it is advisable to build a box that will facilitate both transport and storage.

To avoid the cabinet being too large, it is necessary to predict its size considering that the movable head will be returned to the median position during periods of non-use.

The support base on which the various subassemblies had been placed is bordered by chopsticks at its periphery.

A light allows access to the motor mounting screws managing the movement of the carriage.

Each subset of the drillis securely screwed. Additional holes allow to reach the fixing screws of the bearings of the drive roller.

4 rubber feet avoid the transmission of vibrations

12 - ACCESSORIES

In addition to the hole punch, two complementary and essential accessories must be manufactured:

- **A cardboard reel**
- **A cardboard folder with press system**

12 - 1 - THE CARDBOARD FILLER

A system capable of unrolling the cardboard easily is needed, while keeping it perfectly in the axis of the perforating path of the punch.

The system to be planned depends largely on the characteristics of your coil (outer diameter and weight)

In our case, we bought a coil of +/- 750 meters of Cardboards, enough for 50 to 60 pieces of music.

Such a coil weighs +/- 32 kg, and is 70 cm in diameter.

To facilitate the handling of the cardboard, we considered several tracks:

<u>1 - Cut the length of the piece + a small margin</u>.

The length of the Cardboard is automatically estimated by the software.

(Ready to perforate-Duration: 2mn 39s- cardboard length 9.58m)

This has a drawback: if the margin is too low and a mishap occurs, you are chocolate!

If, on the other hand, the margin is too big, and everything is fine during the perforation, you put the fall in the trash!

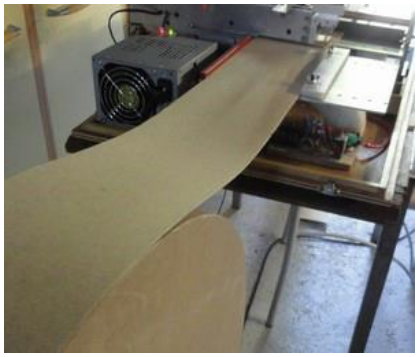
<u>2 - Formatting several small reels from the big</u>.

We take the big coil of 32 kg and we make 4 small 8 kg each.

In addition to the complication of measuring the lengths, there is a disadvantage that the risk of falling at the end of the coil is multiplied by 4.

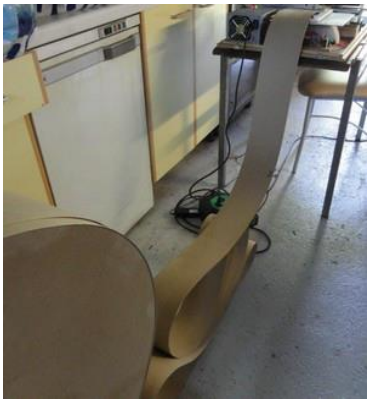
<u>3 - Construction of a strong reel</u>

By placing the reel just upstream of the punch, it is possible that your cardboard drive motor (Y movement) has a little trouble pulling the tape.



If like us you used a 13 kg / cm motor, it does it....

If your motor is a bit righteous, you can place the reel a few meters upstream of the hole punch, and before you start, you unwrap by hand the length of cardboard estimated by the software.



In either case, it is important to position the spool in the axis of the scrolling path to facilitate the passage of the cardboard

Here are some pictures of our reel:

A board on 4 wheels with two arms

Ball bearings at the end of each arm

Two rilsan flanges with a steel axle and a clamping screw

And the result ...

12 - 2 - THE CARDBOARD BENDER

The operation of folding cardboard accordion is very delicate! No, it's not a joke.

To have a card that does not leave in the tower of Pisa, it's really taken of head ...

Going on the Internet, you will find several systems from the simplest to the most elaborate, but each one more ingenious than the other ...

"System D" version

NASA version

It is up to you to make your choice !

Wanting to bring some novelty, we had "invented" a new system that had to be simple, fast, and of course very effective.

Only the first two criteria were met, but not the third, which proves that the subject of folding is very difficult to treat.

So in the immediate future, we have retained Pierre PENARD's system (still him) with his magic box.

See on Pierre's website the explanations for carrying out the folding.

We replaced the stone plywood with plexiglass put to the right dimensions by the laser cutting machine FABLAB Quimper. The three uprights are firmly fixed by aluminum angle.

The marking of the folds must be clear.

A press stay of a few hours will permanently flatten the folds. A vise and two wood chips can do the trick, but nothing beats a good press.

The steering wheel was recovered on a machine tool that was scrapped. If you're not as lucky as us, a simple nut and a pipe wrench will do the trick.

To note the trick given by Pierre PENARD for Cardboards where a short music is supposed to be played very repetitively, for example a Breton dance tune.

Instead of punching a band of ten meters (or more), you can punch just one sentence or two musical phrases to play. It is then enough to assemble in loop the band which will give a small diameter. It then becomes possible to rotate the band until exhaustion of the dancers.

It is certainly less easy to put away, but if you have several, they will never make the same dimension, and they fit together in one another.

Added benefit: you save on cardboard.

If you do not take special precautions, the loop may hang at the point of its connection to the entrance of the roller box. At this time, the Cardboard can bend at 90 °

To avoid this, simply put a cylindrical tube just in the corner.

It can be a piece of broomstick, or a piece of metal pipe.

14 - CONCLUSION

This file does not claim to answer all the questions, but it clears the ground a lot.

Nothing requires you to comply 100% with what is described.
You can also find other ideas to achieve the desired result.

To go even further, both on theory and practice, INTERNET will will certainly bring the little more that you miss.

Jean-Claude and Jean-Marc wish to thank especially the people who made it possible to carry out this beautiful project.	
	**Pierre PENARD** **For very kindly shared his knowledge on the whole of realization.**
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	**René SERPOLLET** **For his advice on the punch motor**
	**Didier DYOLE** **For his advice on the punch.**
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	**Dominique SPINOSI** **For putting your hand on an old Windows 95 CD at our first tests**

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Google SketchUp	**Mr. Google SketchUP** **For putting his 3D drawing software on the net**
 	**Emmanuelle FARAH and Sébastien CORDIER** **For having trained Jean-Claude in the Sketchup software**
	**Vincent GERMAIN** **For the proofreading of this document as "candid"**

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