ROLLER DIE CUTTING MACHINE

Manual Use

Syntactic

Dimensions: 16'' – 17 ¾´´ width
26'' – 29 ¼´´ length
7 ½ - 8 ¾'' height

Weight: 32 lbs

Cost: US$ 395 – US$ 550

Materials: Plastic and steel.

Pragmatic

User - Product

•Turn around the handle.

•It does not require strength. Minimum pressing applied.

Use

1. Set up the dies on the tray. (5 maximum).
2. Set up the paper sheets you desire to cut.
3. Softly turn the handle to allow the tray goes through the rollers once.
4. Take out the shapes of the tray.

Preventive Maintenance

Fast cleaning per use. Deep cleaning to every piece once a month.

Semantic

Context

•It is operated by one person.

•Home – School – Handicraft activities.

Purpose:

•Designed for handicraft work.

•Entertainment –Hobby –Enjoyment –Leisure -Learning.

Design & Emotions :

•Simple design focused on the use rather than the aesthetic features. ''Very industrial design''

•Neutral colors as black and silver.

•Fine textures.

•it is more functional machine than entertained machine.

Advantages

•Easy to use.

•Light design.

•Allows many kind of shapes and figures.

•Cut a lot of sheets of paper in one time.

•Easy to move from one place to another.

•No physical exhaustion.

•Good performance.

•Easy cleaning.

AccuCut

AC5000

AC6000

Disadvantages

•Limited use to compatible dies with the AcceCut machines.

•Too expensive for its use.

•No versatile.

•It does not resist heavy and continuous use.

•It is only for Die Cutting, it can not do embossing.

Daniela Gómez Montoya
Graduation Project – Product Design Engineering - U.EAFIT

DIE CUTTING MACHINE

Manual Use

Syntactic

Dimension: 15 ½ '' width
10'' length
7 '' height

Weight: 16 lbs

Cost: US$ 120

Materials: Plastic and Steel.

Pragmatic

User - Product

•Turn – down movement to the handle.

•It does not require strength. Minimum pressing applied.

Use

1. Set up the die and the paper sheets together.

2. To press the handle down.

4. Take out the cut shapes.

Preventive Maintenance

Cleaning once a month.

Replace the blades once they are useless.

Semantic

Context

•It is operated by one person.

•Home – School – Handicraft activities.

Purpose:

•Designed for handicraft work. .

•Entertainment –Hobby –Enjoyment –Leisure –Learning.

Design & Emotions:

•It evokes and antique designed with a lot of curved shapes and dark colors.

•Sad, passive and heavy perceived design.

•It has a form analogy with a antique car.

Advantages

•Light weight.

•Friendly to be used by kids.

•It cuts variety of thin materials.

•It has guides and marks to make the cuts easier.

•The handle has a lock to avoid undesirable uses.

•Simple and nice design.

Ellison
Leading Expression

A10000

Disadvantages

•It only works with dies specially designed for the machine.

• It does not resist heavy and continuous use.

•It is only for small size cuts.

•It is not versatile.

•Only for Die Cutting.

•It is expensive.

Daniela Gómez Montoya

DIE CUTTING MACHINE

Manual Use

Syntactic

Dimension: 8 '' width

12'' length

7 '' height

Weight: Approximately 16 lbs

Cost: US$ 159.95

Materials: Plastic.

Pragmatic

User - Product

•Press buttons.

•It does not require physical effort or strength.

Use

1. Turn on the machine.

2. To choose the kind of shapes you want to cut.

4. To press the button to star cutting.

5. Take out the cut shapes.

Preventive Maintenance

Periodical cleaning.

Semantic

Context

•It is operated by one person.

•Children environments and graphic decoration.

•It works with batteries.

Purpose:

•Designed for handicraft use.

•Entertainment –Hobby –Enjoyment –Leisure –Learning

Design & Emotions:

•It looks like a toy more than a cutting machine.

•It seems to be for girls use due to the pink and white color combination.

•Compact design that looks like a small box.

personal cutting system

Advantages

•Light weight.

•Friendly to use by kids

Ideal to use for adhesive works.

•Variety of small size shapes.

•Small Design.

Disadvantages

•It only works with dies specially designed for the machine.

• It does not resist heavy and continuous use.

•It does not do medium and big size cuts.

•It is not versatile.

•It is only for die cutting.

•Expensive.

Daniela Gómez Montoya

DIE CUTTING MACHINE

Manual & Industrial Use

Syntactic

Sizes: 12 '' Weight 100 Kg

15'' Weight 150 Kg

18 '' Weight 300 Kg

Dimension: 2' x 3'

Cost: US$ 600 - 800 Approximately.

Materials: Steel.

Pragmatic

User - Product

•Movements of handles.

•It require a little physical effort or strength.

Use

1. Set up the machine for paper size and the dies.
2. Set up the paper sheets.
4. To press the handle.
5. Take out the cut shapes.

Preventive Maintenance

Periodical cleaning, specially after use.

Semantic

Context

•It is operated by one person.

•Graphic and printing industries.

•Human force.

Purpose:

•Designed for Industrial use.

•Industrial performance.

•Efficiency, fast and quality result.

Design & Emotions:

•It looks unfriendly and difficult to use.

•It seems heavy and not trustable.

•Due to the colors and forms it looks sad and boring.

Advantages

•For heavy use.

•Ideal to use in big quantities request.

•It cuts variety of paper materials.

•It has guides and marks to make the cuts easier.

•The handle has a lock to avoid undesirable uses.

Disadvantages

•It is not nice looking.

•It is not versatile.

•It is only for die cutting.

•Expensive.

•It is not easy to load.

Daniela Gómez Montoya

Graduation Project – Product Design Engineering - U.EAFIT

DIE CUTTING & EMBOSSING MACHINE

Manual Use

Syntactic

Dimension: 7 '' – 15'' width
16'' – 21'' length
5'' - 7 '' height

Weight: 17 - 53 lbs

Cost: US$ 40.00 – US$ 595

Materials: Plastic and Steel.

Pragmatic

User - Product

•Movement of handle.

•It does not require physical effort or strength.

Use

1. Set up the dies on the tray.
2. Accommodate the paper sheets on the tray.
4. To press the handle down to cut the paper.
5. Take out the cut shapes.

Preventive Maintenance

Periodical cleaning.

Semantic

Context

•It is operated by one person.

•School classroom & handicraft activities.

Purpose:

•Designed for handicraft use.

•Entertainment –Hobby –Enjoyment –Leisure –Learning

Design & Emotions:

•Functional and practical design.

•Simple design focused on the use rather than the aesthetic features. ''very industrial design''

•Use of neutral colors.

•Fine textures.

Advantages

•Light weight.

•Friendly and easy to use.

•Comfortable.

•Variety of small size shapes.

•Small Design.

•Faster cutting and embossing.

•Lifetime warranty.

Ellison
Leading Expression

19101

38-0605

Disadvantages

•It only works with dies specially designed for the machine.

• It does not resist heavy and continuous use.

•Some of the models are expensive.

Daniela Gómez Montoya
Graduation Project – Product Design Engineering - U.EAFIT

DIE CUTTING & EMBOSSING MACHINE

Manual Use

Syntactic

Dimension: 7 '' width
16'' length
5'' height

Weight: 17 lbs

Cost: US$ 40.00 – US$ 60

Materials: Plastic and Steel.

Pragmatic

User - Product

•Movement of handle.

•It does not require physical effort or strength.

Use

1. Set up the dies on the tray.
2. Accommodate the paper sheets on the tray.
4. To press the handle down to cut the paper.
5. Take out the cut shapes.

Preventive Maintenance

Periodical cleaning.

Semantic

Context

•It is operated by one person.

•School classroom & handicraft activities.

Purpose:

•Designed for handicraft use.

•Entertainment –Hobby –Enjoyment –Leisure –Learning

Design & Emotions:

•Functional and practical design.

•Simple design focused on the use rather than the aesthetic features. ''very industrial design''

•Fine textures.

•It looks weak and destroyable.

Advantages

•Light weight.

•Friendly and easy to use.

•Small Design.

•Faster cutting and embossing.

wizard embossing & die cutting system

Disadvantages

•It only works with Spellbinders Embossing and Cutting Dies

•It does not resist heavy and continuous use.

•Some of the models are expensive.

•It cuts only very small size shapes.

Daniela Gómez Montoya
Graduation Project – Product Design Engineering - U.EAFIT

MOLDS INVENTORY MR PRINT

These are some of the molds available in MR PRINT. They are classified in some categories according to the end use.

MR PRINT SND BHD

Labels

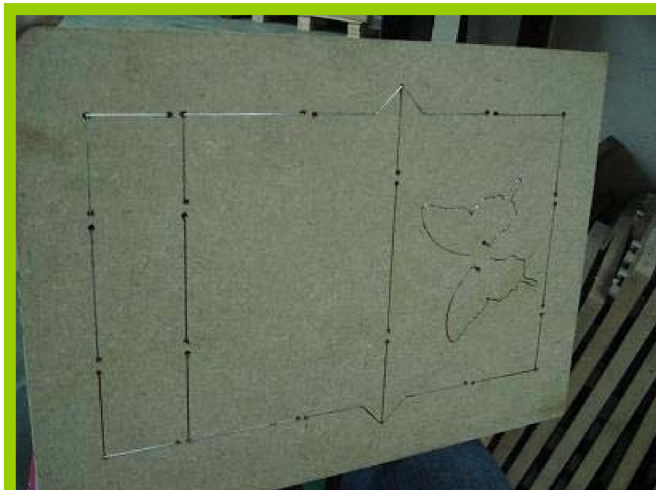
The white sponges help to expulse the paper once the cutting is done.

MR PRINT SND BHD

Envelopes

The white sponges help to expulse the paper once the cutting is done.

MOLDS INVENTORY MR PRINT



Daniela Gómez Montoya
Graduation Project – Product Design Engineering - U.EAFIT

MR PRINT SND BHD

Dividers

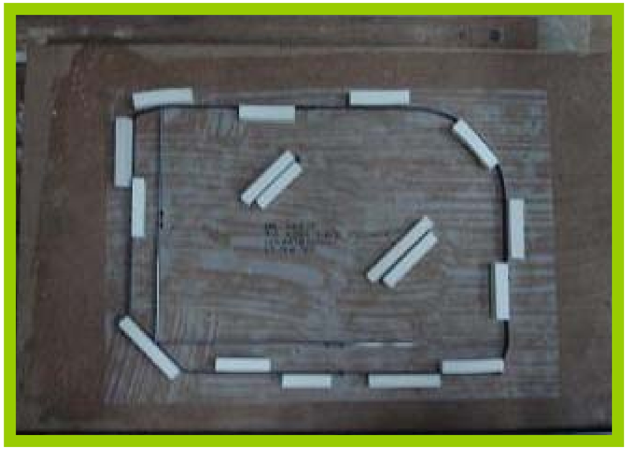
The white sponges help to expulse the paper once the cutting is done.

Daniela Gómez Montoya

MR PRINT SND BHD

Pockets

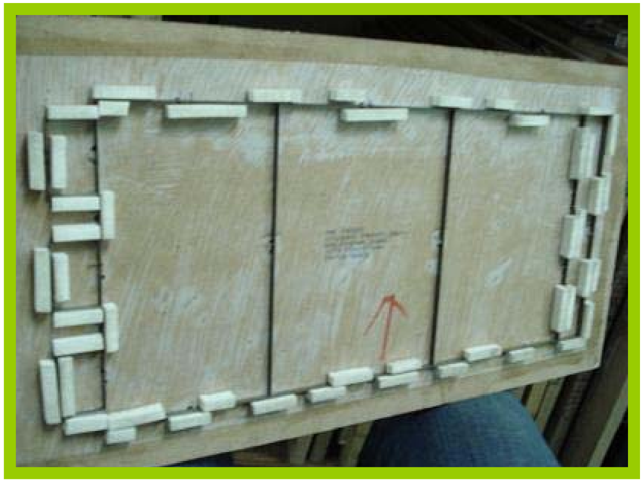
The white sponges help to expulse the paper once the cutting is done.



MR PRINT SND BHD

Boxes

The white sponges help to expulse the paper once the cutting is done.



MR PRINT SND BHD

Embossing

The white sponges help to expulse the paper once the cutting is done.

MALE

FEMALE

PRODUCT DESIGN SPECIFICATIONS- DIE CUTTING AND EMBOSSING MACHINE FOR MR PRINT SDN BHD
GRADUATION PROJECT - DANIELA GÓMEZ MONTOYA

ELEMENT	DEMAND / WISH	INTERPRETATION	REQUIREMENT					
			D	W	Unit	Value	Condition	Import
Security	It doesn't cut or hurt the operators.	Without edges. With rounded borders.			R. (mm)	3	Minimum.	**5**
	It doesn't cause accidents.	Safe operation. Cutting hand prevention system.			Handles, visibility, covered blades .		Minimum.	**5**
		The tools and components need to be safety assembled.			Use of security threads and join systems.			**5**
		Indication to dangerous parts or procedures.			Use signals or symbols in yellow or red color on the product if is required.			**4**
	it has clear indications for its use.	Operation and safety handbook.			# pag.	15	Maximum.	**5**
Aesthethic and shape	It is beautiful.	Simple and nice design.			Geometric simple shapes. Proportional design.			**4**
					Colors related with the function and the context.			**3**
		It has physic and aesthethic stability .			Use of materials like steel and plastics.			**4**
		Its shape and formal design has a reason.			Use of the methodology learned of Fhape Theory, assigment of EAFIT University.			**5**
Maintenance	It is easy to clean.	Minimun time of preventive maitenance.			Time (min)	20	Maximum.	**3**
		Without deep slots.			Depth (cm)	1	Maximum.	**3**
		The operator should do the preventive maintenance.			Quant times/month	2	Minimum.	**4**
	It has good quality.	It will require a minimum of corrective maintenance.			Quant times/month	When it is needed.	Maximum.	**4**
	Simple tools to do the maintenance.	Simple tools to do the maintenance.			To use standard tools available on the market to to the maintenance activities.			**4**
Ergonomy and user	It is comfortable.	Ergonomic handles.			Diameter (cm)	4	Maximum.	**4**
		Anthropometric and biomechanic considerations.			Human Factors Design Guide. Office of chief scientific and technical advisor for Human Factors. US department of transportation.			**4**
		Easy operation.			Movements.	Class 1 y 2.	Maximum.	**4**
					Activities to operate	5	Maximum.	**4**
		Minimum effort.			Lever, geargs, and trasmissions to have mechanical advantage.			**4**
	It is easy to understand.	Shapes and colors related with the functions of the product.			Shapes and colors to differenciate the functions of the product.			**3**
		Operation easy to understand.			To design a user manual.			**4**
		The operator should be capable to operate the product.			To provide capacitations and instruction about the product to the operator by the design and manufacture team.			**5**
Materials	It is light in weight.	Light materials as much as possible.			Aluminum, Steel and Plastics.			**4**
	They are easy to get in the market.	Made in Malaysia. Materials get locally.			Kuala Lumpur - Malasia.		Maximum.	**4**
	They are nice to touch.	Soft manipulation surfaces for easy job.			Plastics, resines and elastomeric materials.			**3**
	They are in accordance with their use.	Use plastic, steel, aluminum, etc in the product.			%	30	Minimum.	**4**
	They are nice.	Materials with good aesthetic finishes.			Plan and fine finished surfaces. Minimum Roughness.			**3**
	The materials are appropiate to the function.	Structural Steel for elements such as bars, angles, beams, washers, pins, nuts, etc.			ASTM A 6, ASTM A 325, ASTM A36, etc.			
	Easy to clean.	To allow easy preventive maintenance.			Aluminum, Steel and Plastics.			**3**

Standar parts	The parts are easy to get in the market.	Easy to get in the local market.	%	40	Minimum.	**4**
			Holding and join systems with standard parts.			**4**
		The most vulnerable parts should be standard.	Joint and assembly systems, structural tubes, etc.			**4**
	No commercial parts should be easy to get.	Not standard parts are easy to fabricate and replace.	Simple Procees like: Drilling, Milling, rolling, welding, cutting, etc.			
Instalation	It is easy to install.	Short time of instalation.	Time (min)	25	Maximum.	**3**
	It is easy to move from one place to another.	Easy to adapt to different places and surfaces of work.	Easy to adapt to different places and surfaces of work.			**4**
Quality, Reliability and life in service	It is lasting in time.	Long life cycle.	Years	5	Minimum.	**4**
		To design use tests.	Operation of the product.			**5**
	It has reliable mechanisims.	Good and checked assemblies.	Make sure the assemblies are perfectly done and orientated.			**4**
Performance	It cuts paper.	Paper of specified thickness.	GSM	60 to 300	Minimum - Maximum.	**5**
	It cuts a big area	Mold biggest area.	Width x Length (cm)	40 x 50	Maximum.	**5**
	It is easy to use.	Low complexity in its operation.	Simple movements grade 1, 2 o 3 to operate the machine.		Maximum.	**4**
	It is efficient.	Low time periods of work than made by hand, for 200 units.	Tiempo (horas)	2	Maximum.	**5**
	It is versatile.	Irregular and regular shapes.	Area. (cm)	30 x 40	Maximum.	**5**
		System that allows to use die cutting and embossing molds.	Using the same working principle.			
	It works properly for low quantity requests.	Perfect die cutting and embossing for low quatity resquests.	Units	200	Maximum.	**5**
			# Sheets to be cut.	1 at the time.	Maximum.	**5**
	The cutting knives are durable.	The cutting knives should resist industrial use time (continuosly).	Material	Cold Rolled Steel	Minimum.	**4**
	The molds can be change easily.	Cutting and embossing molds of easy exchange.	Seconds	240	Maximum.	**4**
	It could be manual machine	Manual or simple mechanisms to get an improvement in the current process.	It uses simple engineering mechanisms systems.			**5**

	The cutting and embossing should be perfect.	The pressure or force applied should be adequated.			KN	17	Maximum.	**5**
Cost	It is reasonable in cost.	The parts for replacing shouldn't be expensive.			%	30	Total product cost.	
		The total cost of the machine should be not expensive.			**RM** Ringgits Malaysia	2000 - 6000	Minimum - Maximum.	**5**
Size and weight	It is not too heavy.	The assembled system should have a reasonable weight according with its purpose.			Kg	100	Maximum.	**5**
	It is not too big.				Width x Heigth x Length (cm)	80 x 80 x 50	Maximum.	**5**
		The maximum area of the die shouldn't be too big.			Width x Length (cm)	40 x 50	Maximum.	**5**
Manufacture processes and facilities	Prototype easy to produce.	The partial prototype most prove the overall function principle.			Quantity	1	Maximum.	**5**
		Minimum parts of special fabrication.			%	40	Maximum.	**4**
		Special fabrication parts should have simple procceses.			Simple Procees like: Drilling, Milling, rolling, welding, cutting, etc.			**4**
	Final Product easy to produce.	The Final product will be given to the company as a definitve drawings.			Quantity	3	Maximum.	**5**
	It is economic to produce.	Minimum costs of production.			The costs should be according to the company budget: RM6000			**4**
Evironment & wastes	It is friendly with the environment.	There are no wasted products affecting the environment.			Quantity of toxic wastes.	0	Maximum.	**4**
		It minimises the actual wasted paper.			Perfect cutting, reducing to a minimum level the error limits and decreasing the current quantity of wasted paper: approximately 3 Kg daily.			**4**
	It uses friendly materials.	The materials should be 100% recyclables and not toxics.			Use of Thermoplastics polymers like ABS, PC, PP, etc; and metals like steel and aluminum.			**4**
		The waste of the material for the prototype should be minimum.			The % of the wasted material should not be more than 30%. Old pieces and parts can be wasted material once they are replaced, but they can be recycled after their use.			**4**
Test		To design and apply test for the use related with engineering.			Engineering, performance, cutting and embossing, resistance.			**5**
Company limitations	It requires a minimun maintenance.				Maintenance is and outsorcing service. It is an additional cost for the company.			**3**
Time	The project should be developed as fast as possible.	The project should follow EAFIT University rules in time of submission, according to the schedulle planned.			Semesters	2	Maximum.	**5**
	Report progres to University authorities.	Present Inform progresses constantly.			Informs	10	Maximum.	**5**
Context	It should respect the company environment.	It should has low noisy levels.			Decibels	40 - 80	Maximum.	**4**
	The environment shouldn't be too hot.	The context should not rise high temperatures.			Celsius Degress	10 to 35	Maximum.	**4**

	It sholdn't has a short life.	Minimum Wear			The product should be used under roof.			**4**
Quantity	To check the product in a physical way	To build a funcional partial prototype to test the die cutting and embossig activities.			Units	1	Maximum.	**5**
	The product will have not so many parts.	The number of parts of the product are minimum.			Parts	300	Maximum.	**4**

ANNEX No. 4 SYSTEMS REQUIRED FOR THE DEVELOPMENT OF THE PROJECT

Morphologic Matrix

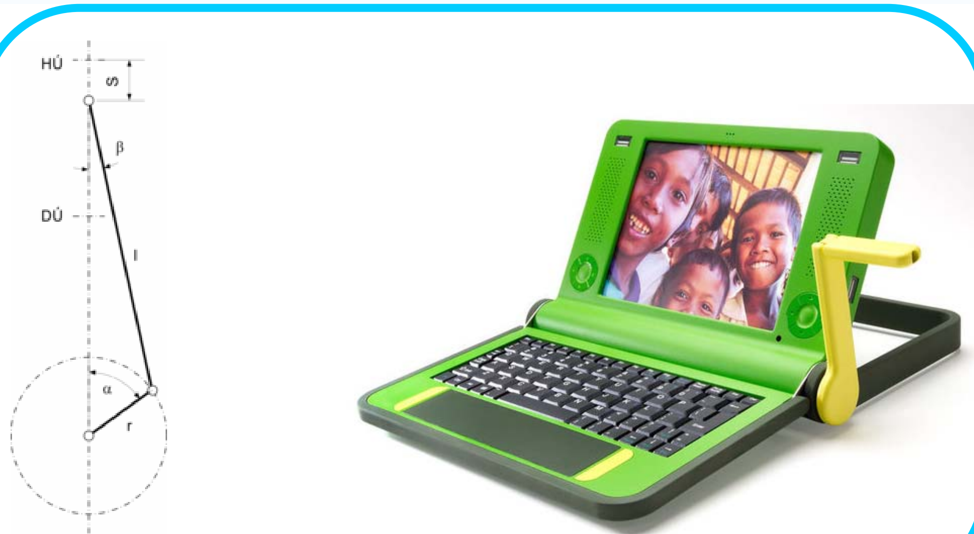
1. OPERATION OF THE PRODUCT

1.1. Crank Mechanism (WIKIPEDIA-Crank@2007)

A **crank** is an arm at right angles to an axle or spindle, by which motion is imparted to or received from the shaft; also used to change circular into reciprocating motion, or reciprocating into circular motion. The arm may be a bent portion of the shaft, or a separate arm keyed to it.

One application is human-powered turning of the axle. Often there is a bar perpendicular to the other end of the arm, often with a freely rotatable handle on it to hold in the hand, or in the case of operation by a foot (usually with a second arm for the other foot), with a freely rotatable pedal.

Figure 1: Crank System



Own Elaboration

Using a hand

- Manual pencil sharpener
- Fishing reel and other reels for cables, wires, ropes, etc.
- Train window
- Manually operated car window

Using feet

- The crankset that drives a bicycle via the pedals.
- Treadle sewing machine

1.2 Pedal Mechanism (WIKIPEDIA-Pedal@2007)

The word **pedal** comes from the Latin (**pes**, **pedis**) and relates to the foot. It is a leverlike part worked by the foot to supply power in various mechanisms.

Sometimes, depends of the kind of work, it is much easier to use the foot to make the force and one of the advantages is to have hands free to make more efficient the activity.

Figure 2: Pedal System

Own Elaboration

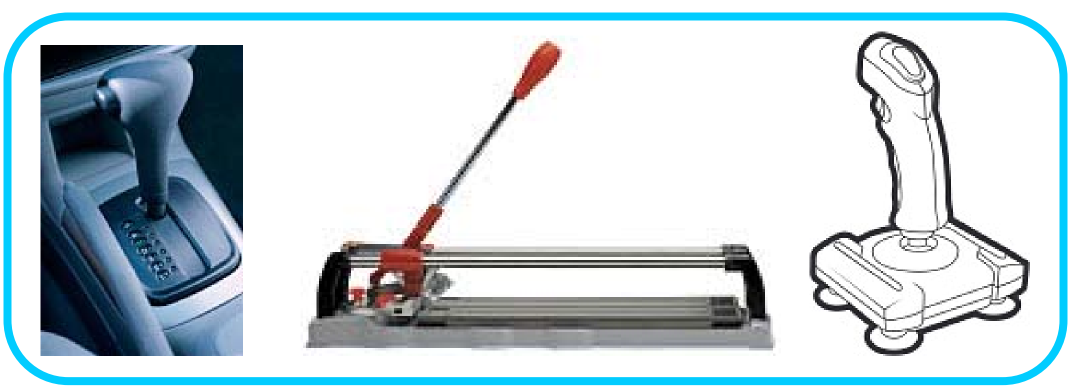
1.3 Lever Mechanism (WIKIPEDIA-Lever@2007)

In physics, a **lever** (from French *lever*, "to raise", c.f. a *levant*) is a rigid object that is used with an appropriate fulcrum or pivot point to multiply the mechanical force that can be applied to another object. This is also termed mechanical advantage, and is one example of the principle of moments. A lever is one of the six simple machines.

The principle of leverage can be derived using Newton's laws of motion, and modern statics. It is important to note that the amount of work done is given by force times distance. For instance, to use a lever to lift a certain unit of weight with a force of half a unit, the distance from the fulcrum of the spot where force is applied must be twice the distance between the weight and the fulcrum. The amount of work done is always the same and independent of the dimensions of the lever (in an ideal lever). The lever only allows to trade force for distance.

The point where you apply the force is called the effort. The effect of applying this force is called the load. The load arm and the effort arm are the names given to the distances from the fulcrum to the load and effort, respectively.

Figure 3: Lever System

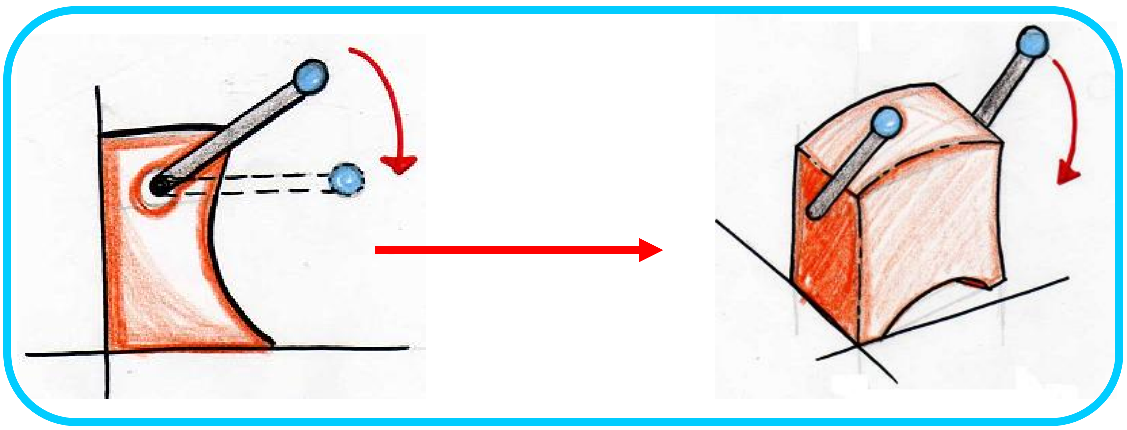


Own Elaboration

1.4 Double Lever Mechanism

As a proposed mechanism, it could exist the possibility of a lever in both sides of the product. This is thinking, since an ergonomic perspective, about the operator, to give him an option of the use of both hands.

Figure 4: Lever System



Own Elaboration

1.5 Switch Mechanism

A **switch** is a mechanical device used to connect and disconnect a circuit. Switches cover a wide range of types, from subminiature up to industrial plant switching megawatts of power on high voltage distribution lines.

In applications where multiple switching options are required (e.g., a telephone service), mechanical switches have long been replaced by electronic switching devices which can be automated and intelligently controlled.

The prototypical model is perhaps a mechanical device (for example a railroad switch) which can be disconnected from one course and connected to another.

The switch is referred to as a "gate" when abstracted to mathematical form. In the philosophy of logic, operational arguments are represented as logic gates. The use of electronic *gates* to function as a system of logical gates is the fundamental basis for the computer—i.e. a computer is a system of electronic switches which function as logical gates.

Figure 5: Lever System

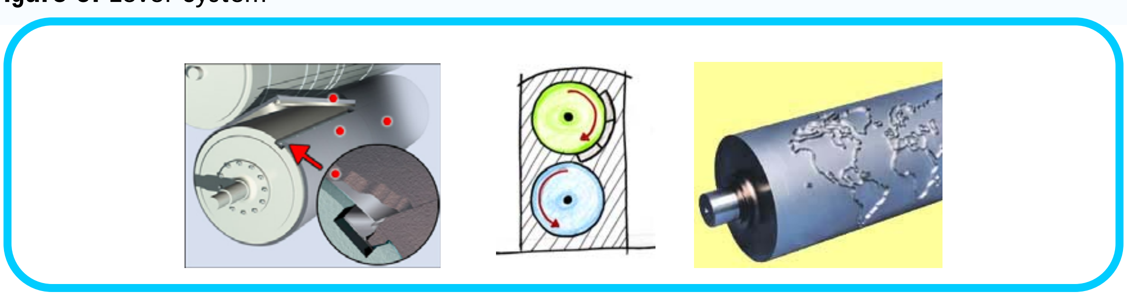
Own Elaboration

2. TO CONVERT: DIE CUTTING AND EMBOSSING PRINCIPLE

2.1. Rotary System with a curved die (PAK-LITE@2007)

Rotary die cutting involves cutting materials including foam, foam rubber, foils and non-wovens between the blades on a cylindrical die and an anvil which is a smooth hard cylinder. Though sheets of material can be fed through a rotary die, it is more common to cut material including foam parts in continuous roll form (defined in the industry as a web).The capacity of a rotary die process is defined as the widest possible part that can be cut on the equipment. For example, our 13" (330mm) can be utilized in die cutting foam, foils, rubber materials for gasketing, cushioning, vibration control, stabilization and medical applications.

Figure 6: Lever System



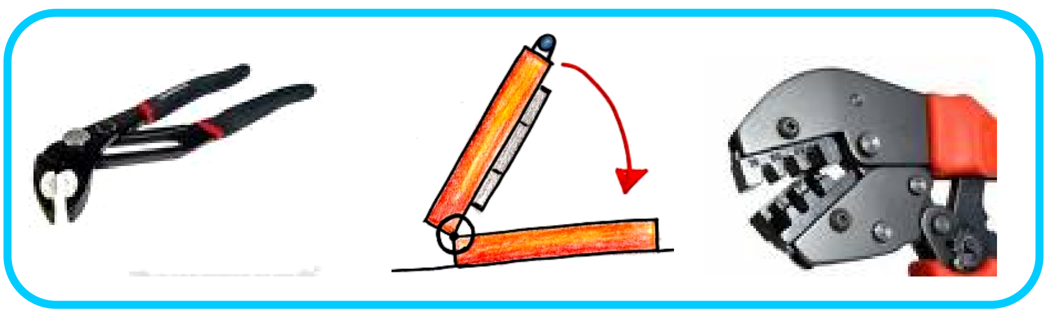
Own Elaboration

2.2. Jaw System

Based on the human and animal anatomy, the jaw system principle is an useful solution for many products because of its mechanical advantage. "The **jaw** is either of the two opposable structures forming, or near the entrance to, the mouth. The term *jaws* is also broadly applied to the whole of the structures constituting the vault of the mouth and serving to open and close it and is part of the body plan of most animals. In most vertebrates, the jaws are bony or cartilaginous and oppose vertically, comprising an *upper jaw* and a *lower jaw*" (WIKIPEDIA-Jaw@2007).

As a machinery definition a Jaw is one of two or more parts that grasp or hold something. (DICTIONARY-Jaw@2007)

Figure 7: Jaw System



Own Elaboration

2.3. Press System

A mechanical press is a machine that accumulates energy through a flywheel and transmits either mechanically or pneumatically to an element through a system of crank-handle.

The force generated by the press varies along its route depending on the angle of application of force. The nearest point of this application to the PMI (Point

Lower Dead) greater strength, it is being at this point (PMI) theoretically infinite. These presses are used for cutting, stamping, bending, etc.

"Machine presses can be hazardous, so safety measures must always be taken. Injuries in a press may be permanent, since there can be over 100 tons of pressure coming down on a limb caught in the machine. Bimanual controls (controls the use of which requires both hands to be on the buttons to operate) are a very good way to prevent accidents, as are light sensors that keep the machine from working if the operator is in range of the die"[1].

Figure 8: Press System

Own Elaboration

2.4. Rotary System with a Flat bed die

It uses the same working principle but in this case the die is on a flat bed. There are some handicraft manual machines developed by ACCUCUT, but they only can work with special ACCUCUT dies and are not suitable for industrial heavy work.

The advantage of this kind of mechanism is that the cutting is only happening in the area in contact between the roller and the die (cutting knives). So it is much easier to guarantee a better cut.

[1] WIKIPEDIA. Press Machine. [Internet Article]. http://en.wikipedia.org/wiki/Machine_press [December 30th 2007]

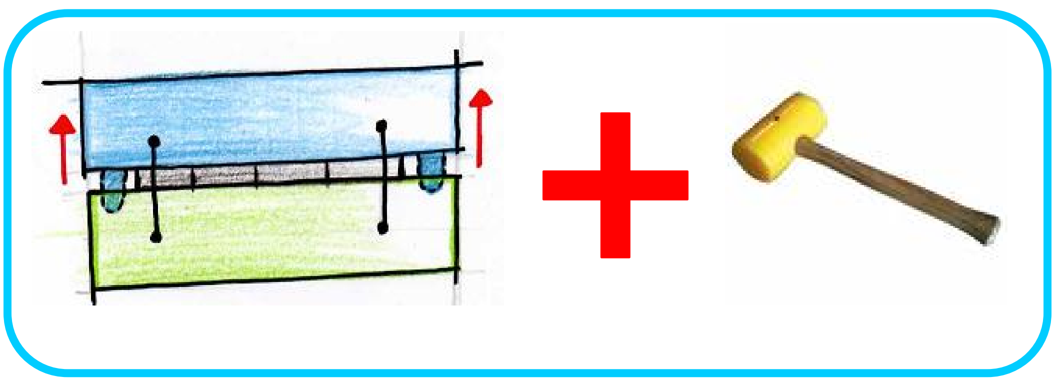
Figure 9: Rotary System – Flat bed Die

Own Elaboration

2.5. Mallet Handle System

The mallet handle die was the first kind of die created. They were originally fashioned by a blacksmith to the desired configuration of the product to be produced. After the cutting edges were hand-sharpened and heat treated, a handle was attached to the back of the die which could be struck with a mallet to force the die through the material to be cut.

Figure 10: Mallet Handle System



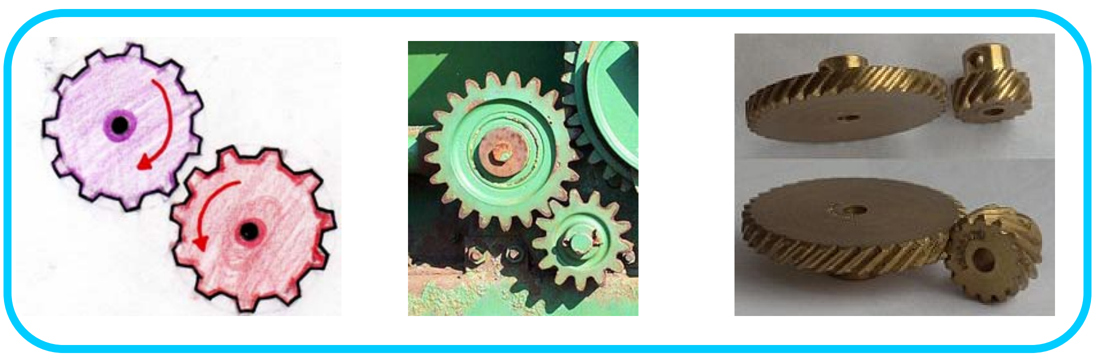
Own Elaboration

3. TO MOVE THE MECHANISM

3.1. Gear (WIKIPEDIA-Gear@2007)

A gear is a component within a transmission device that transmits rotational force to another gear or device. A gear is different from a pulley in that a gear is a round wheel which has linkages ("teeth" or "cogs") that mesh with other gear teeth, allowing force to be fully transferred without slippage. Depending on their construction and arrangement, geared devices can transmit forces at different speeds, torques, or in a different direction, from the power source. Gears are a very useful simple machine. The most common situation is for a gear to mesh with another gear, but a gear can mesh with any device having compatible teeth, such as other rotational gears, or linear moving racks. A gear's most important feature is that gears of unequal sizes (diameters) can be combined to produce a mechanical advantage, so that the rotational speed and torque of the second gear are different from that of the first. In the context of a particular machine, the term "gear" also refers to one particular arrangement of gears among other arrangements (such as "first gear"). Such arrangements are often given as a ratio, using the number of teeth or gear diameter as units.

Figure 11: Gear System

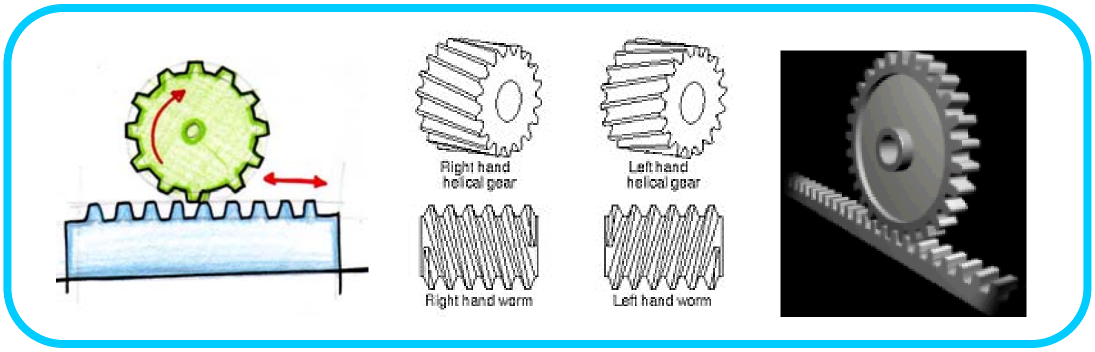


Own Elaboration

3.2. Rack and Pinion (WIKIPEDIA-Rack@2007)

A rack is a toothed bar or rod that can be thought of as a sector gear with an infinitely large radius of curvature. Torque can be converted to linear force by meshing a rack with a pinion: the pinion turns; the rack moves in a straight line. Such a mechanism is used in automobiles to convert the rotation of the steering wheel into the left-to-right motion of the tie rod(s). Racks also feature in the theory of gear geometry, where, for instance, the tooth shape of an interchangeable set of gears may be specified for the rack (infinite radius), and the tooth shapes for gears of particular actual radii then derived from that.

Figure 12: Gear System



Own Elaboration

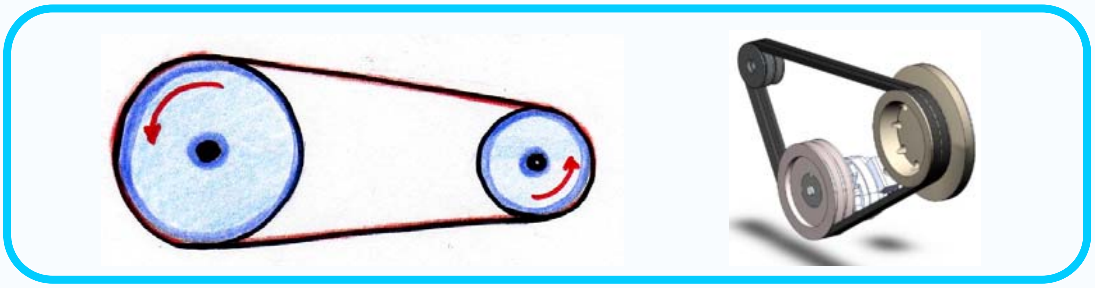
3.3. Belt and Pulley System (WIKIPEDIA-Belt@2007)

A belt and pulley system is characterized by two or more pulleys in common to a belt. This allows for mechanical power, torque, and speed to be transmitted across axes and, if the pulleys are of differing diameters, a mechanical advantage to be realized.

A belt drive is analogous to that of a chain drive, however a belt sheave may be smooth (devoid of discrete interlocking members as would be found on a chain sprocket, spur gear, or timing belt) so that the mechanical advantage is given by the ratio of the pitch diameter of the sheaves only (one is not able to count 'teeth' to determine gear ratio).

Belt and pulley systems are systems that can be very efficient, with stated efficiencies up to 98%.

Figure 13: Belt and Pulley System

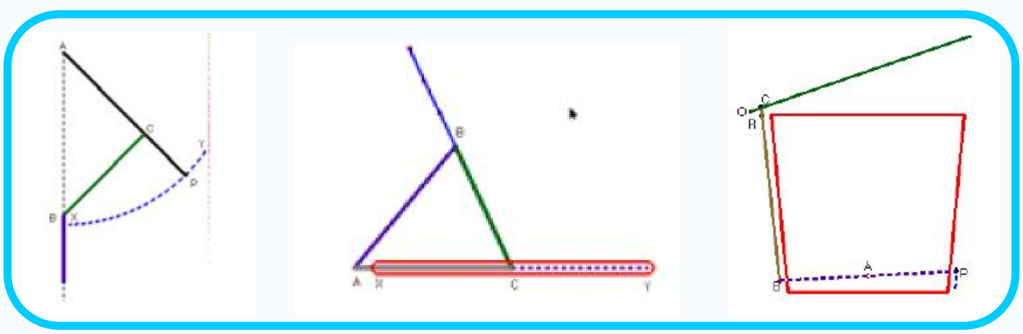


Own Elaboration

3.4. Bars System

Using bars and different junctions to create movement is one of the options to produce mechanical advantage. Lineal and rotary movements could be the result of this kind of mechanism.

Figure 14: Bar System



Own Elaboration

3.5. Electric Motor (WIKIPEDIA-Electric@2007)

An **electric motor** uses electrical energy to produce mechanical energy. The reverse process of using mechanical energy to produce electrical energy is accomplished by a generator or dynamo. Traction motors used on locomotives often perform both tasks if the locomotive is equipped with dynamic brakes. Electric motors are found in household appliances such as fans, refrigerators, washing machines, pool pumps, floor vacuums, and fan-forced ovens.

Most electric motors work by electromagnetism, but motors can be based on other electromechanical phenomena, such as those used in an electrostatic motor, piezoelectric motor, ultrasonic motor or ball bearing motor (i.e., thermal motor). The fundamental principle upon which electromagnetic motors are based is that there is a mechanical force on any current-carrying wire contained within a magnetic field. The force is described by the Lorentz force law and is perpendicular to both the wire and the magnetic field. Most magnetic motors are rotary, but linear motors also exist. In a rotary motor, the rotating part (usually on the inside) is called the rotor, and the stationary part is called the stator. The rotor rotates because the wires and magnetic field are arranged so that a torque is developed about the rotor's axis. The motor contains electromagnets that are wound on a frame. Though this frame it is often called the armature, that term is often erroneously applied. Correctly, the armature is that part of the motor across which the input voltage is supplied. Depending upon the design of the machine, either the rotor or the stator can serve as the armature.

Figure 15: Motor System

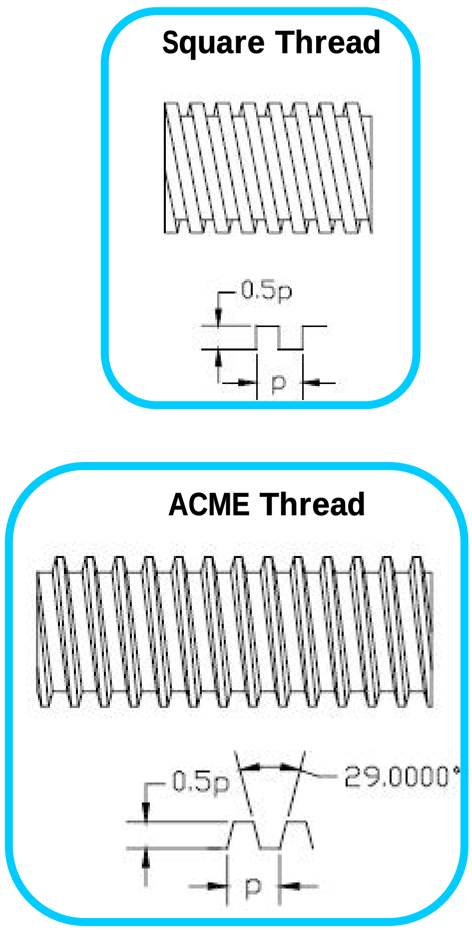
WIKIPEDIA-Electric@2007

3.6. Power Screw System

Power screws are designed to convert rotary motion to linear motion and to exert the necessary force required to move a machine element along a desired path.

"Power Screws are classified by their threads" (University-Tenesee@2007).

Figure 16: Threads of Power Screws



University-Tenesee@2007

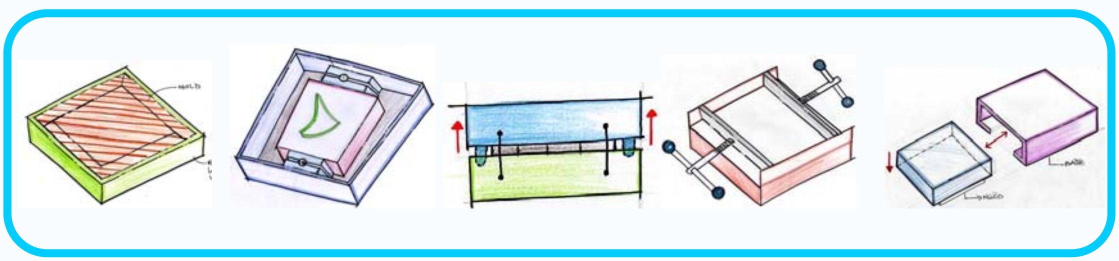
"Ball screws are a type of power screw. Efficiencies of between 30% and 70% are obtained with conventional power screws. Ball screws have efficiencies of above 90%. Power Screws are used for the following three reasons"[2]:

- To obtain high mechanical advantage in order to move large loads with minimum effort. e.g Screw Jack.
- To generate large forces e.g A compactor press.
- To obtain precise axial movements e.g. A machine tool lead screw.

4. TO SET UP THE MOLD (TO HOLD)

The mold holding mechanism system is a simple function. Some of the solutions proposed on the morphologic matrix are not exactly documented on technical literature; they are just the result of ideas and possibilities from the mind of the designer. For this reason, this time the options of systems are not explained.

Figure 17: Set Up of the Mold System



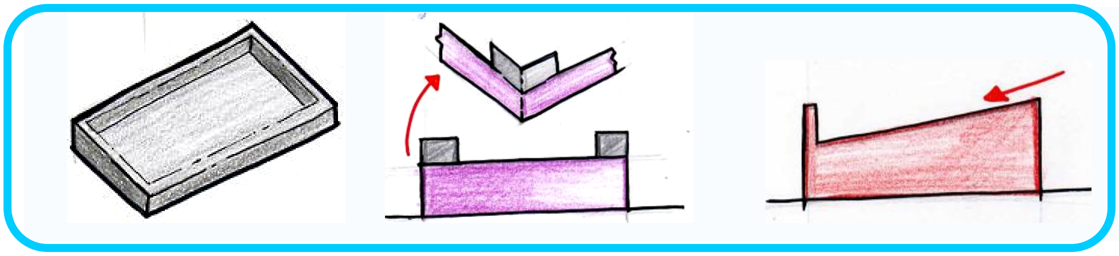
Own Elaboration

5. TO CONTAIN THE PAPER

As the case explained above, this is also a very simple function, result of the solutions ideas from the designer's mind. The different options are not easily found on technical documents, reason why it won't be specified in this document.

[2] POWER SCREWS @. [Internet Article] http://www.roymech.co.uk/Useful_Tables/Cams_Springs/Power_Screws.html. [December 30th 2007]

Figure 18: To Contain the paper



Own Elaboration

ANNEX NO. 5 Compression Test
Sponge/Cork used to eject the paper from the mold

Detailed process

Test Identification	Compression test for the mold's cork
Type of test	Strength to compress the cork
Element to be tested	Cork or sponge used to eject the paper from the mold once the cut is done.
Date of elaboration	23rd January 2008
Responsible	Daniela Gomez Montoya
Test Objective	To compress the cork 6 mm to determine how much force needs to be applied for that purpose.

It is very important to now how much pressure we need to apply to compress the cork 6 mm (this is the normal compression in the current process at the company), but MR PRINT does not have any information about the mechanical properties of the material and its behavior.

By the other hand, there is not any technical information about the "shear strength of the paper". Different books, internet and experts[1] were used to look for this special property, but there is no any data or information. The closest property found is "Tear Strength" but this one is not the exactly one needed to guarantee the engineering calculation of the forces during the cutting and embossing process. That is the reason why this test needs to be done.

Description of the test:

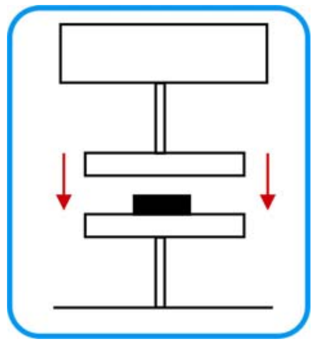
The test is made using the UNIVERSAL MACHINE, in the Materials Laboratory of EAFIT University.

The cork is located in between 2 steel plates that will compress the material 6 mm. The machine is controlled through a computer. The operator will introduce the initial parameters like cork's measures, the desired speed for the

[1] Francisco Gonzalez PROPAL; Nelson Londoño, Lecturer of UNIVERSIDAD DE ANTIOQUIA; SATAS D, Web processing and converting Technology; www.matweb.com; etc.

machine and the compression length needed. At the end the machine will give the exactly force and a graphic of Strength-Deformation.

Figure 1: Diagram of the test



Own Elaboration

Place of the test: EAFIT University, Materials Laboratory.

Time of duration: 30 minutes.

Cork's measures:

Area: The shape of the cork is an ellipse. So the **$A = \pi \times a \times b$**
Where "a" is the biggest radius and "b" the smallest radius.

A Cork= 1169 mm²

Thickness: 9.75 mm

Elements:

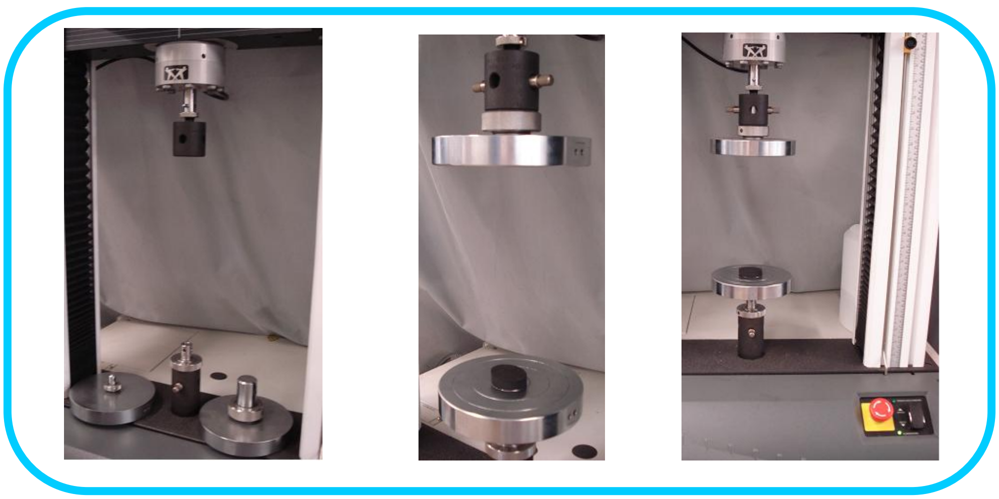
Figure 2: Elements of the test

Own Elaboration

Procedure:

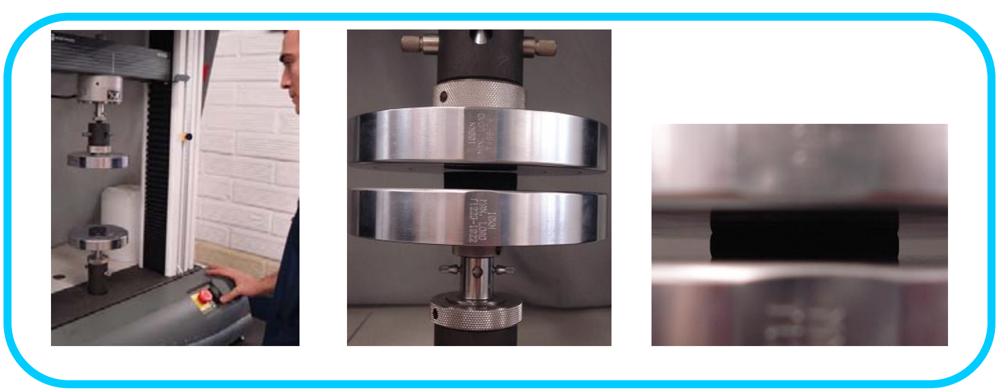
STEP	DESCRIPTION	RESPONSIBLE	OBSERVATIONS
1	Machine Assembly	Juan Carlos Duque	
2	Measure of the material	Daniela Gomez	
3	To give parameters to the Machine	Juan Carlos Duque	Speed, Measures, Distance.
4	Start the test, run the machine.	Juan Carlos Duque	The process is very slow. 1mm/minute
5	Get the results and the graphic.	Juan Carlos Duque Daniela Gomez	

Figure 3: Procedure 1



Own Elaboration

Figure 4: Procedure 2

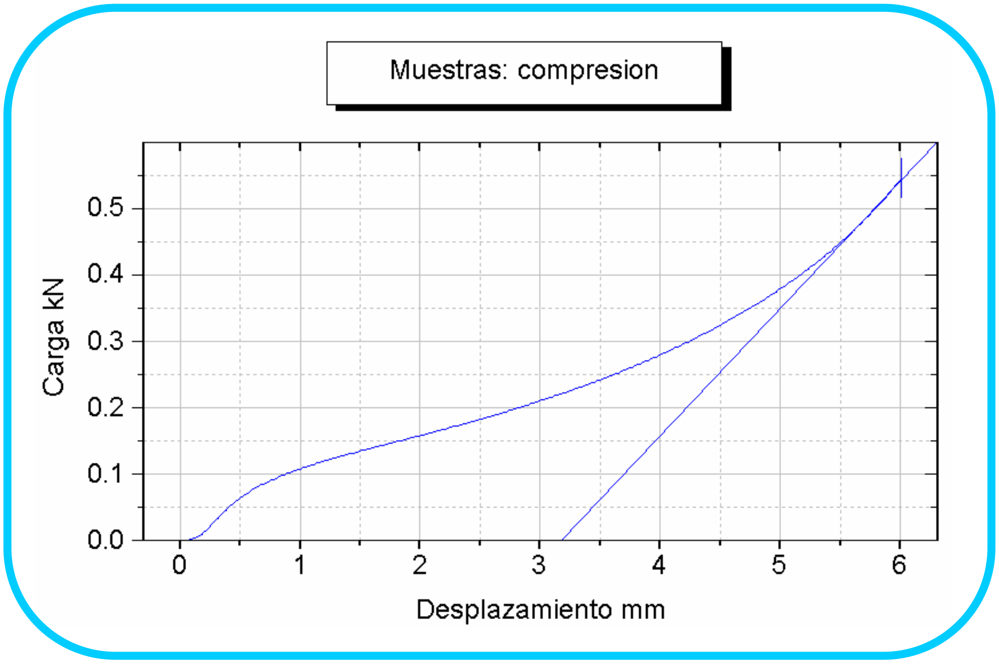


Own Elaboration

Conclusion

To compress the cork of (1169 mm²) area, **<u>6mm</u>** it is necessary to apply a force of **0.545 KN (545 Newton)**. The following figure shows the graphic of Strength – Deformation.

Figure 5: Graphic of Strength - Deformation



Materiasl Laboratory – EAFIT University

Daniela Gomez Montoya

ANNEX No. 6 Paper Compression - Cutting Force Test
Shear Strength of Paper

Detailed process

Test Identification	Shear strength of paper - Test
Type of test	Force to cut 3 different kind of papers.
Element to be tested	3 different GSM papers: BOND, CARDBOARD thin and thick.
Date of elaboration	29th January 2008.
Responsible	Daniela Gomez Montoya
Test Objective	To compress the mold against the paper, to know the exactly force needed to cut it.

It is very important to now how much pressure we need to apply to cut the most common papers used at the company, but MR PRINT does not have the specific information, as they are not interested in those variables.

By the other hand, there is not any technical information about the “shear strength of the paper”. Different books, internet and experts[1] were used to look for this special property, but there is no any data or information. The closest property found is “Tear Strength” but this one is not the exactly one needed to guarantee the engineering calculation of the forces during the cutting and embossing process. That is the reason why this test needs to be done.

Description of the test:

The test is made using two kinds of UNIVERSAL MACHINES, in the “Materials Laboratory” of EAFIT University: one is digital (only can apply 10KN) and the other one is manual (it can apply more charge).

[1] Francisco Gonzalez PROPAL; Nelson Londoño, Lecturer of UNIVERSIDAD DE ANTIOQUIA; SATAS D, Web processing and converting Technology; www.matweb.com; etc.

The paper is located in between the die-mold and the polyethylene cutting board (to protect the cutting knives) and this system as well is located between 2 steel plates that will do compression. The digital machine is controlled through a computer and the manual machine by a watch and the operator.

Before the test start each piece of paper need to be measure with a micrometer in 10 different points and then calculate the media to assure a closest result.

Place of the test: EAFIT University, Materials Laboratory.

Time of duration: 2 hours.

Paper's thickness measures:

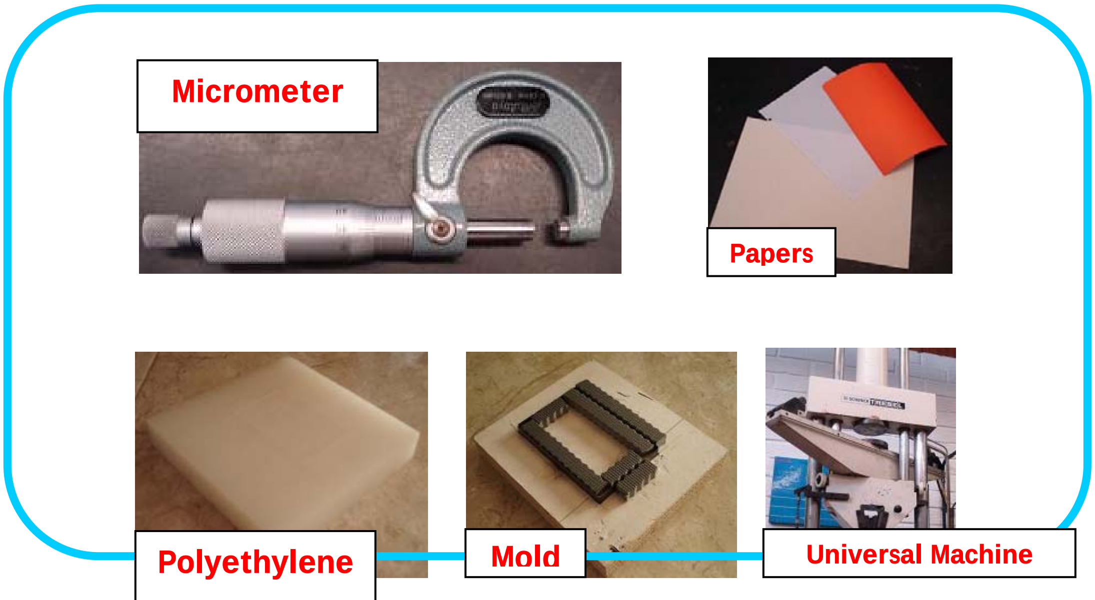
Table **1**: Paper Thickness – Cutting Test

PAPER THICKNESS (mm) SHEAR STRENGTH TEST			
Measure	**BOND**	**CARDBOARD 1**	**CARDBOARD 2**
1	0,088	0,218	1,053
2	0,087	0,217	1,100
3	0,088	0,228	1,030
4	0,084	0,207	1,105
5	0,084	0,222	1,015
6	0,088	0,223	1,010
7	0,096	0,208	1,044
8	0,097	0,216	1,030
9	0,09	0,218	1,044
10	0,095	0,220	1,034
MEDIA	**0,090**	**0,218**	**1,047**

Own Elaboration

Elements:

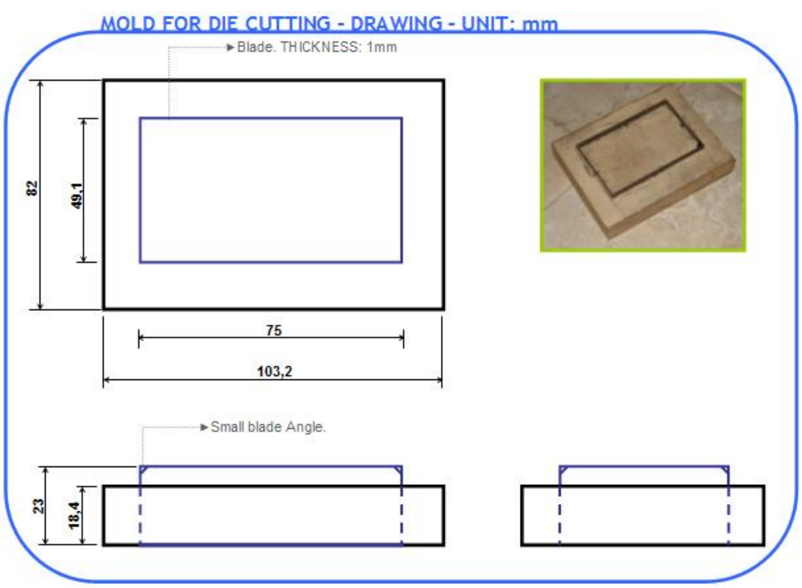
Figure 1: Elements of the test



Own Elaboration

Mold's dimensions:

Figure 2: Mold's Dimensions



Own Elaboration

Procedure:

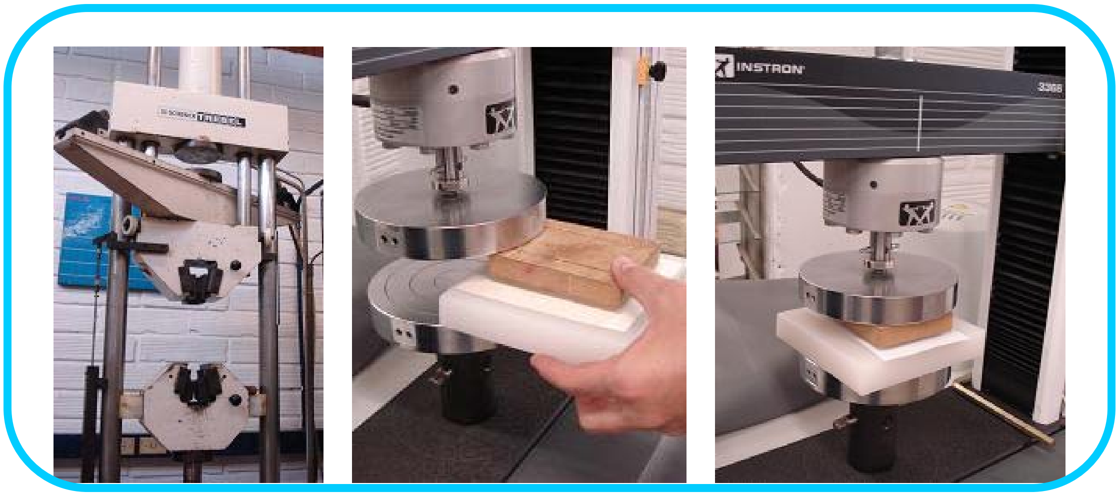
Table **2**: Procedure

STEP	DESCRIPTION	RESPONSIBLE	OBSERVATIONS
1	Machine Assembly	Juan Carlos Duque	
2	Measure of the material in 10 different points.	Daniela Gomez	The paper thickness is not constant for the whole surface.
3	Calculate the media of step 2.	Daniela Gomez	
4	Locate the paper, mold and polyethylene.	Juan Carlos Duque Daniela Gomez	Center
5	Start the test, run the machine.	Juan Carlos Duque	The process speed is 2 MPa/s
6	Get the results.	Juan Carlos Duque Daniela Gomez	
7	Repeat steps 4, 5 and 6 with each paper.	Juan Carlos Duque and Daniela Gomez	
8	Conclusions	Juan Carlos Duque Daniela Gomez	

Own Elaboration

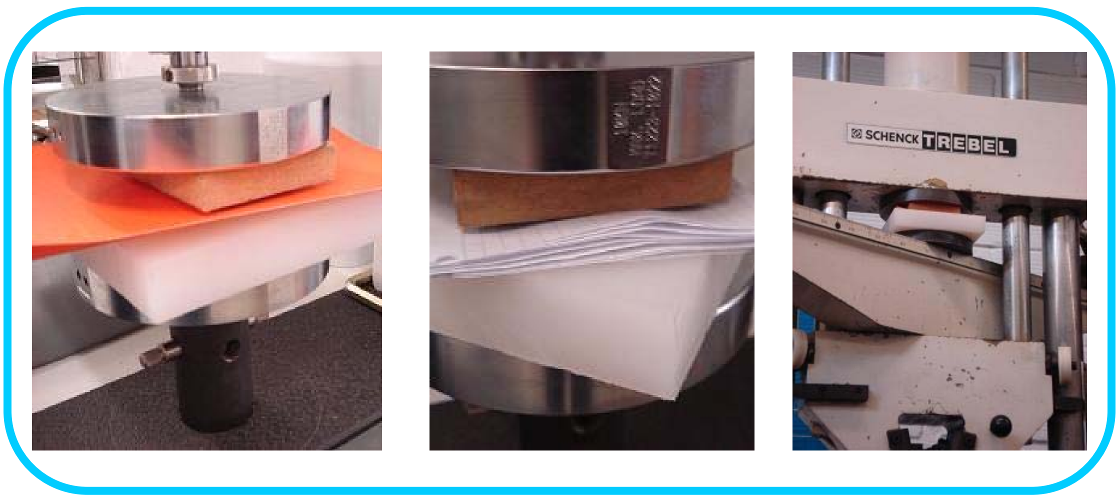
The function of the press board of polyethylene is to protect the cutting knives when the mold is pressed against the paper. It makes the cutting easier as well.

Figure 3: Procedure 1



Own Elaboration

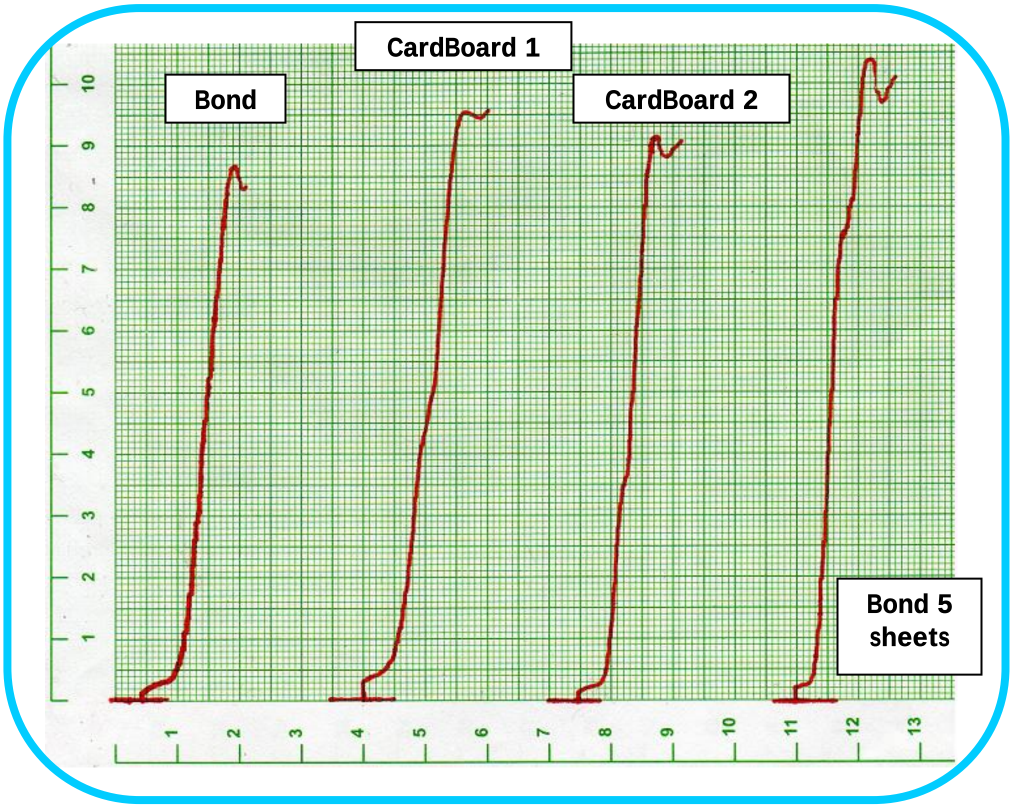
Figure 4: Procedure 2

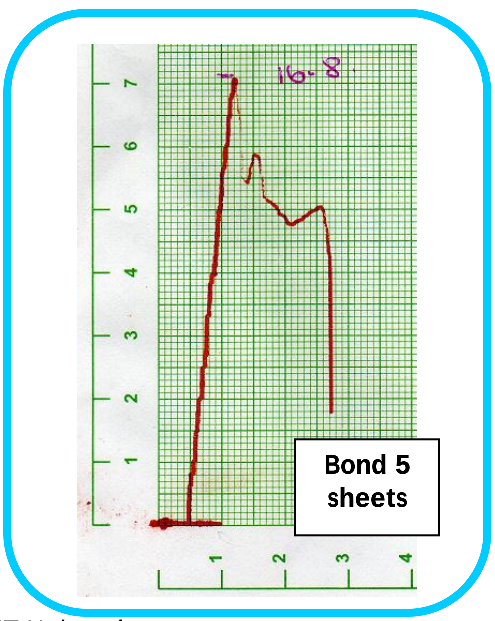


Own Elaboration

Conclusion

Figure 5: Graphics





Laboratory Materials – EAFIT University

Table 3: Results

PAPER	FORCE	PICTURE
Bond (75 GSM)	8,35 KN	
CardBoard 1 (180 GSM)	8,80 KN	
CardBoard 2 (340 GSM)	9,20 KN	
Bond (5 sheets of paper)	10 KN	
Bond (10 sheets of paper)	16,8 KN	MAXIMUM

Own Elaboration

Daniela Gomez Montoya

ANNEX No. 7 Paper Compression - Embossing Force Test

Detailed process

Table 1: Preliminary Considerations

Test Identification	Strength of paper for Embossing - Test
Type of test	Force to emboss 1 and 2 sheets of bond paper.
Element to be tested	BOND 75 GSM.
Date of elaboration	30th January 2008
Responsible	Daniela Gomez Montoya
Test Objective	To compress the Female – Male mold against the paper, to know the exactly force needed to emboss it.

Own Elaboration

Once the paper shear strength test has been done, giving us as a result a maximum force of 16,8 KN; this test of embossing is done, using only the paper that required more force (BOND paper), in order to confirm if it is necessary a higher force to embosses the paper.

Description of the test:

The test is made using the UNIVERSAL MACHINE, in the "Materials Laboratory" of EAFIT University. It is a static and compression test.

The paper is located in between the embossing mold (Matrix of male-female), this system as well is located between 2 steel plates that will do compression.

As in this case is not so easy to find out, in one try, the required force to emboss the paper correctly, the test is done increasing the load in terms of 500 N in order to define the final force.

Before the test start each piece of paper need to be measure with a micrometer in 10 different points and then calculate the media to assure a closest result.

Place of the test: EAFIT University, Materials Laboratory.
Time of duration: 2 hours.
Paper's thickness measures:

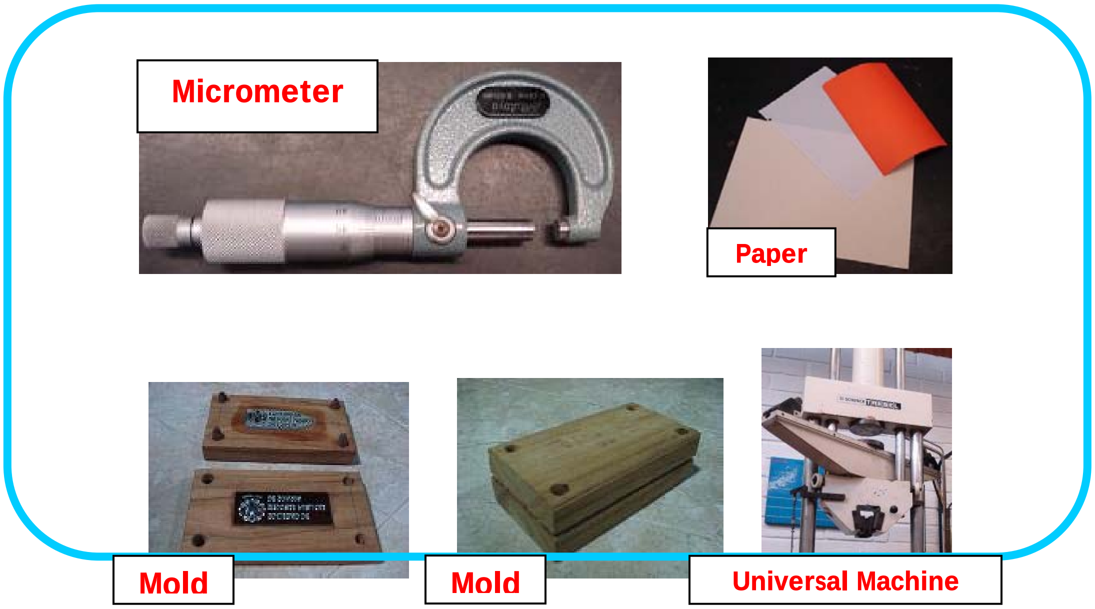
Table 2: Paper Thickness – Embossing Test

PAPER THICKNESS (mm)	
Measure	**BOND**
1	0.086
2	0.089
3	0.087
4	0.084
5	0.085
6	0.086
7	0.091
8	0.09
9	0.09
10	0.089
MEDIA	**0.088**

Own Elaboration

Elements:

Figure 1: Elements of the test



Own Elaboration

Procedure:

Table 3: Procedure

STEP	DESCRIPTION	RESPONSIBLE	OBSERVATIONS
1	Machine Assembly	Juan Carlos Duque	
2	Measure of the material in 10 different points.	Daniela Gomez	The paper thickness is not constant for the whole surface.
3	Calculate the media of step 2.	Daniela Gomez	
4	Locate the paper and mold.	Juan Carlos Duque Daniela Gomez	Center

5	Start the test, run the machine.	Juan Carlos Duque	The process speed is 2 MPa/s
6	Get the results.	Juan Carlos Duque Daniela Gomez	
7	Repeat steps 4, 5 and 6 with each paper.	Juan Carlos Duque and Daniela Gomez	
8	Conclusions	Juan Carlos Duque Daniela Gomez	

Own Elaboration

Conclusion

Table 4: Graphics 2

DESCRIPTION	FORCE	CONCLUSION
Bond (75 GSM) 1 Sheet	500 N	No Emboss
Bond (75 GSM) 1 Sheet	1 KN	Emboss very smooth, not so clear.
Bond (75 GSM) 1 Sheet	1,5 KN	Emboss smooth, still not so clear.
Bond (75 GSM) 1 Sheet	2 KN	Emboss correctly!
Bond (75 GSM) 2 Sheet	2 KN	No Emboss
Bond (75 GSM) 2 Sheet	3 KN	Emboss smooth, not so clear.
Bond (75 GSM) 2 Sheet	4 KN	Emboss correctly!

Own Elaboration

Figure 1: Embossing Results

Own Elaboration

Daniela Gomez Montoya

ANNEX No. 8 User and Ergonomic Analysis

The design of an industrial product involves some issues related with the person who is going to do the operation and manipulation of such a product. In our case, one of the main objectives is to improve the current process of the company as this process is not only being inefficient (time, quality, material)[1], but also very unsafe and uncomfortable for the operator.

In order to apply ergonomic methodologies and principles, it is necessary to have a clear idea and analyse the current process and procedures inside the company.

The ergonomic aspects of the product are the most important in this phase in order to give facilities to the operator and make him feel comfortable. For that reason the following aspects are going o be studied (Spanish@2008):

- **Biometric Ergonomy:** To analyse the biomechanics and the types of movements of the body involved.

- **Corrective Ergonomy:** Evaluation and analysis of the current process and some existing examples with other kind of products.

- **Preventive Ergonomy:** To minimize the risk and injuries, ergonomic design of the product.

[1] Situation explained in detail in chapter 5.

1. Analysis of the user during the current process at the company

Figure 1: Board Of the current Die-Cutting process

Own Elaboration

The **Figure 1** represents the positions and postures that the operators are using when they need to cut different shapes by hand. The red circles are showing wrong postures that are not only uncomfortable, but also not recommended for the health in a medium and long future.

Figure 2: Board of Operation of different products.

Own Elaboration

The Board showed on the **Figure 2** is useful to consider and analyse many aspects related with the operator in an industrial environment. As it was concluded on the previous section the comfort, safety, clarity of vision, easy operation, etc; are the inherent requirements to involve to the product.

- The most important part of the body to take care and prevent for injuries in the Vertebral Column. The product should guarantee the right position, relating the visual angle, the height from the floor to the crank, and the distance facilitate the set up of the matrix with the mold and the paper.

- The blades and knives should not be exposed without protection as the operator could be in risk of cutting himself in a wrong movement.

- The operator should have the possibility to work either sitting down or on his foot, this could make him feel comfortable and change position every time he needs it.

- As the cutting and embossing activities can be done by women or men with different body complexions (height, weight, etc) the product should be able to be graduated in height. This allows to everybody the use of the machine without any problem.

In this case only the Die-cutting process is analysed as it is sometimes done by hand. For the embossing an automatic machine is done, as it is required a higher force to do the job. As an added value our product will not only do die-cutting, but also embossing for paper in different thickness.

2. Anthropometry and biomechanics

The **“Human Factors Design Guide”** (WAGNER@1996) was used as a reference for the human factors analysis.

Designers and human factors specialists incorporate scientific data on human physical capabilities into the design of systems and equipment. Human physical characteristics, unlike those of machines, cannot be designed. However, design oversight can place unnecessary demands and restrictions upon user personnel.

3.1 Anthropometry

It is the scientific measurement and collection of data about human physical characteristics and the application (engineering anthropometry) of these data in the design and evaluation of systems, equipment, manufactured products, humanmade environments, and facilities.

3.2 Biomechanics

It describes the mechanical characteristics of biological systems, in this case the human body, in terms of physical measures and mechanical models. This field is interdisciplinary (mainly anthropometry, mechanics, physiology, and engineering). Its applications address mechanical structure, strength, and mobility of humans for engineering purposes.

Anthropometric and biomechanics data shall be used in the design of systems, equipment (including personal protection equipment), clothing, workplaces, passageways, controls, access openings, and tools.

3.3 Selecting the correct percentile statistic

Design criteria for a human physical integration problem shall be based upon the range of the population to be accommodated. Designers and human factors specialists shall determine the appropriate statistical points, usually percentile statistics, to accommodate an appropriate range of the population distribution for the specific design problem.

The **percentile statistic** is determined by ranking all data values (using the applicable measurement values related to the selected human physical characteristic) in the sample and determining the percentage of data that fall at or below a specific datum value. This percentage is known as the **percentile value** (or point) of the selected datum.

Usually, for design purposes, it is impractical to accommodate the extremes of the distribution because there is so much variability at the extremes and so few cases. Often, persons who are extreme in dimensional measurement values (in the lowest or highest one percent) know it, and they behave so as to compensate for the designed portions of their environments.

Designers select the most applicable **statistical point(s)** from the appropriate distribution to accommodate the portion of the population that is appropriate to the design problem. The design limits approach involves selecting the appropriate **percentile statistic(s).** It was previously noted that different kinds of design problems (clearance, reach, adjustment, and sizing) call for different strategies and result in the selection of different percentile statistics.

3.3.1 Clearance dimension at the 99th percentile

If a certain clearance design dimension is critical to the activities of the entire population or could be life threatening to likely users who are at the larger extremes of the distribution, then a human measurement value that is at least the 99th percentile male shall be used as the criterion design dimension.

Discussion: Whole body clearance dimensions for frequently used passageways and dimensions for critical escape hatches need to be based on the 99th percentile statistic. This practice ensures 99 percent of the user population who are smaller than this measurement value will have proper clearance.

3.3.2 Limiting dimension at the 5th percentile

Limiting design dimensions, such as reach distances, control movements, display and control locations, test point locations, and handrail positions, those restricts or are limited by body or body part size, shall be based upon the 5th percentile of female data for applicable body dimensions.

Discussion: For example, the maximum height from floor level to an accessible part of any piece of equipment needs to be within reach of the 5th percentile female maintainer, which will ensure that at least 95 percent of the user population can access this part of the equipment.

3.3.3 Limiting dimension at the 1st percentile

If certain limiting designs dimensions are critical to the activities of the entire population or could be life threatening to likely users who are at the smaller extremes of the applicable distribution, then the 1st percentile of the female distribution shall be used as the basis for the criterion dimension.

Discussion: Dimensions for reaching emergency or lifesaving equipment are examples where access cannot be denied to the smaller extremes of the population. There are several common errors to be avoided by designers when they apply anthropometric data to design. These are: (1) designing to the midpoint (50th percentile) or average, (2) the misperception of the typical sized person, (3) generalizing across human characteristics, and (4) summing of measurement values for like percentile points across adjacent body parts.

Misuse of the 50th percentile or of the average: The 50th percentile or mean shall not be used as design criteria as it accommodates only half of the users.

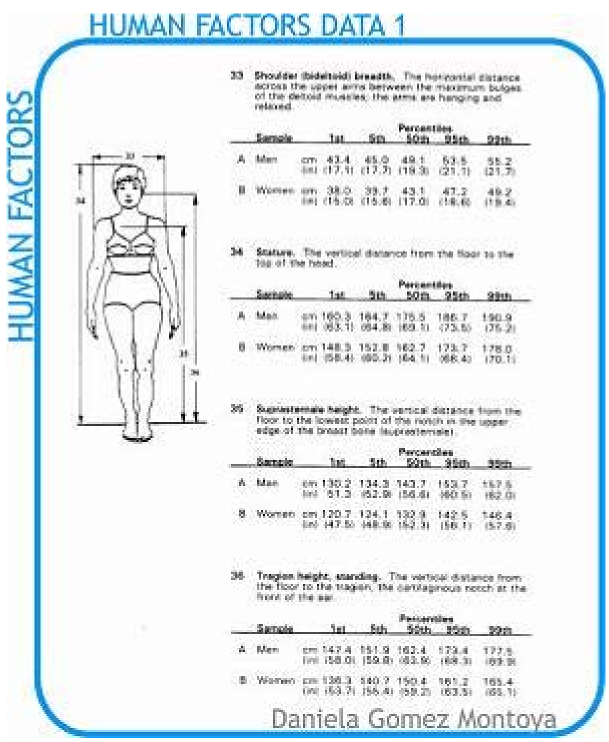
Misperception of the typically sized person: Designers or human factors specialists shall not use the concept of a typically sized person where the same percentiles values are expected across many dimensions. A person at the 95 percentile in height is unlikely to measure at the 95th percentile in reach or other dimensions. A percentile value and its measurement value that pertains to a particular body part shall be used exclusively for functions that relate to that body part.**Summation of segment dimensions.** Summation of like percentile values for body components shall not be used to represent any human physical characteristic that appears to be a composite of component characteristics.

3.4 Anthropometric and biomechanics data

During this section is presented the most relevant data useful for the project. Based on this information and according to the right percentile choice, the product's dimensions are defined. To have a width detail about the process, please refers to (WAGNER@1996).

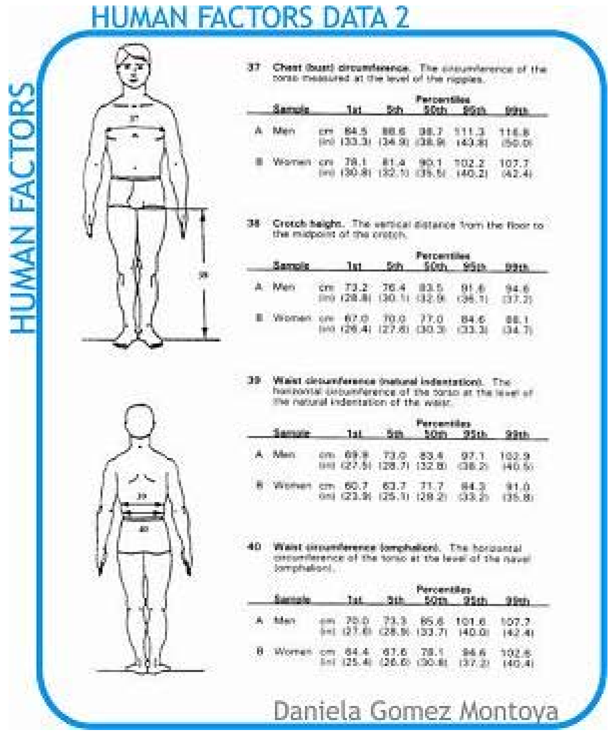
3.4.1 Static body characteristics

Figure 3: Human Factors data 1



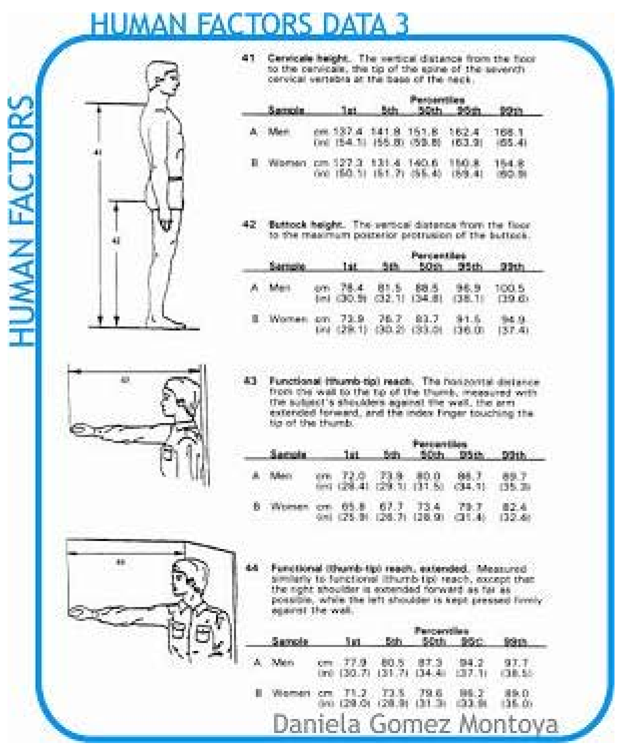
WAGNER@1996

Figure 4: Human Factors data 2



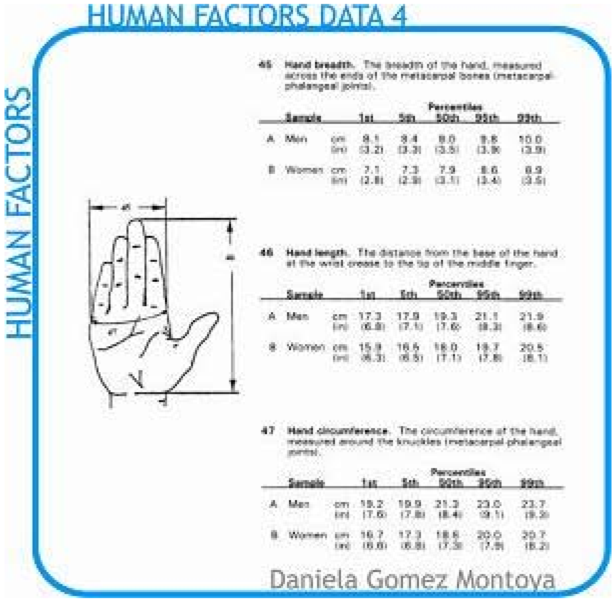
WAGNER@1996

Figure 5: Human Factors data 3



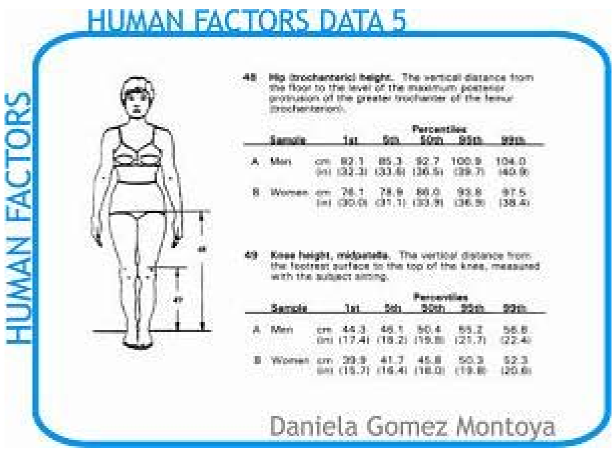
WAGNER@1996

Figure 6: Human Factors data 4



WAGNER@1996

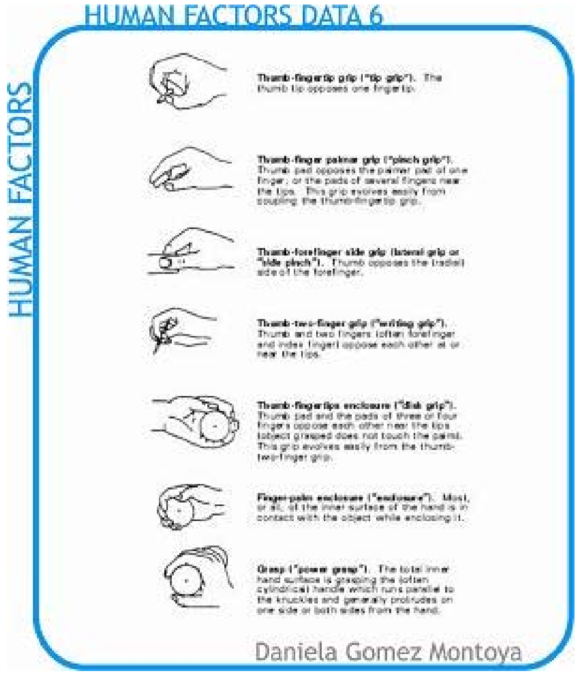
Figure 7: Human Factors data 5



WAGNER@1996

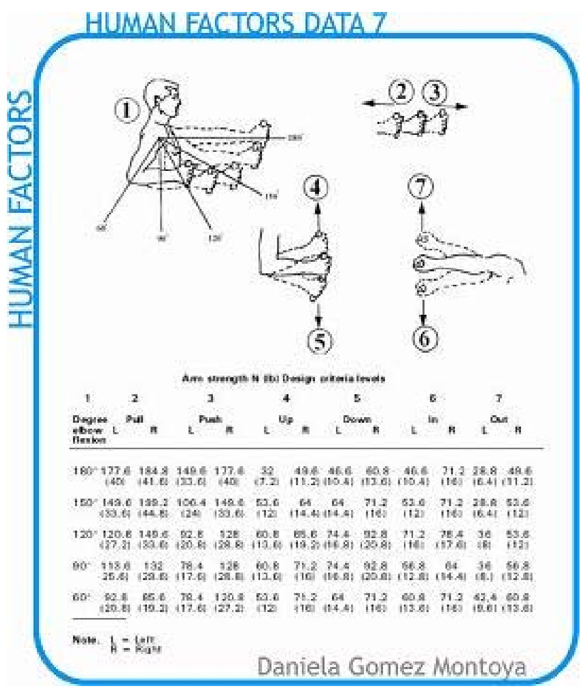
3.4.2 Dynamic (mobile) body characteristics

Figure 8: Human Factors data 6 – Arm Reach



WAGNER@1996

Figure 9: Human Factors data 7 – Strength of the arm



WAGNER@1996

3.5 Handle characteristics

3.5.1 Handle comfort

Handles shall be comfortable and easy to grasp; they shall not cut into the hand or cause undue pressure on the fingers.

3.5.2 Handle surface

The surface of handles shall be sufficiently hard that grit and grime do not become embedded during normal use.

3.5.3 Handle conductivity

The handle material that comes into contact with a maintainer's hand shall not conduct heat or electricity.

3.5.4 Handle attachment

Handles shall be permanently attached to the unit of equipment.

3.5.5 Recessed, hinged, and folding handles

Recessed, hinged, or folding handles may be used to conserve space or to achieve a smooth surface; when they are used, they shall be accessible without the use of tools, and they shall remain securely folded when not in use.

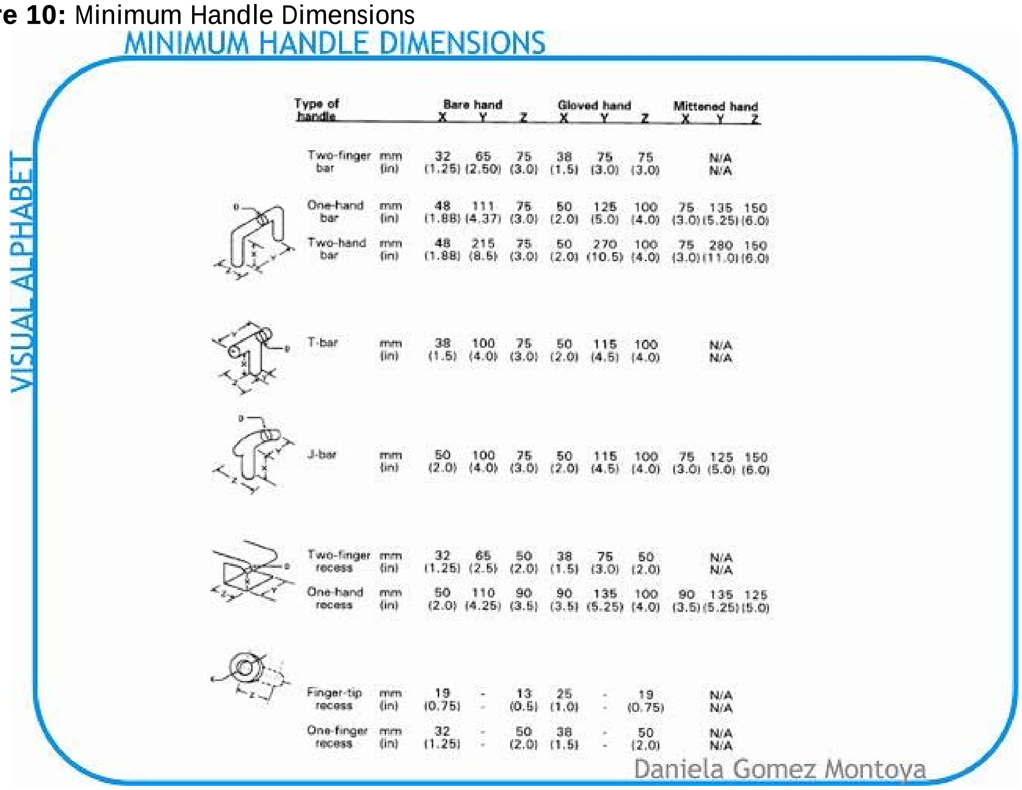
3.5.6 Stops for hinged or folding handles

Hinged or folding handles shall have a stop that holds them perpendicular to the surface on which they are mounted when they are moved into carrying position. It shall require only one hand to move them into this position.

3.5.7 Handle Dimensions

The dimensions of handles depend primarily upon the type of handle, the weight of the unit of equipment, and the type of hand covering the maintainer wears (none, gloves, or mittens). Other factors affecting handle dimensions include the normal operating position of the unit, the frequency and distance it is lifted or carried, and whether or not the handle has an additional purpose, such as protecting the front of the equipment or serving as a stand when the equipment is in its maintenance position.

Figure 10: Minimum Handle Dimensions



Type of handle		Bare hand X	Bare hand Y	Bare hand Z	Gloved hand X	Gloved hand Y	Gloved hand Z	Mittened hand X	Mittened hand Y	Mittened hand Z
Two-finger bar	mm	32	65	75	38	75	75		N/A	
	(in)	(1.25)	(2.50)	(3.0)	(1.5)	(3.0)	(3.0)		N/A	
One-hand bar	mm	48	111	75	50	125	100	75	135	150
	(in)	(1.88)	(4.37)	(3.0)	(2.0)	(5.0)	(4.0)	(3.0)	(5.25)	(6.0)
Two-hand bar	mm	48	215	75	50	270	100	75	280	150
	(in)	(1.88)	(8.5)	(3.0)	(2.0)	(10.5)	(4.0)	(3.0)	(11.0)	(6.0)
T-bar	mm	38	100	75	50	115	100		N/A	
	(in)	(1.5)	(4.0)	(3.0)	(2.0)	(4.5)	(4.0)		N/A	
J-bar	mm	50	100	75	50	115	100	75	125	150
	(in)	(2.0)	(4.0)	(3.0)	(2.0)	(4.5)	(4.0)	(3.0)	(5.0)	(6.0)
Two-finger recess	mm	32	65	50	38	75	50		N/A	
	(in)	(1.25)	(2.5)	(2.0)	(1.5)	(3.0)	(2.0)		N/A	
One-hand recess	mm	50	110	90	90	135	100	90	135	125
	(in)	(2.0)	(4.25)	(3.5)	(3.5)	(5.25)	(4.0)	(3.5)	(5.25)	(5.0)
Finger-tip recess	mm	19	-	13	25	-	19		N/A	
	(in)	(0.75)	-	(0.5)	(1.0)	-	(0.75)		N/A	
One-finger recess	mm	32	-	50	38	-	50		N/A	
	(in)	(1.25)	-	(2.0)	(1.5)	-	(2.0)		N/A	

WAGNER@1996

This is table resuming the most common control characteristics for continuous adjustment:

For the product the best option is using a crank for the operation. This is due to the size of the machine, the transmission system for the movement of the rollers, etc. It is used when multiple rotations are required; fast; can handle high forces, with proper gearing can be use for either gross or fine positioning over a wide range of adjustments.

The crank also offers the possibility to use any of both hands, at any of both sides of the machine depends of the person who is operating.

Table 1: Characteristics of common controls for continuous operation

CHARACTERISTICS OF COMMON CONTROLS OF OPERATION		
CONTROL	**ADVANTAGE**	**DISADVANTAGE**
Crank	Large forces can be developed.	No effectiveness as a part of a combine control.
	Desirable limits to control movements.	No effectiveness of operating controls simultaneously with like controls in an array.
	No likelihood of accidental activaction.	Space requirements for location and operation of control.
	Minimum effort fo the operator.	
Pedal	Large forces can be developed.	No effectiveness as a part of a combine control.
	Minimum effort fo the operator.	No effectiveness of operating controls simultaneously with like controls in an array.
		Space requirements for location and operation of control.
		Likelyhood of accidental activaction.
Lever	Large forces can be developed.	Space requirements for location and operation of control.
	Effectiveness of visually identifying control position.	Likelyhood of accidental activaction.
	Effectiveness od coding.	
Hand Wheel	Large forces can be developed.	No effectiveness of operating controls simultaneously with like controls in an array.
		Space requirements for location and operation of control.
		Likelyhood of accidental activaction.
		No effectiveness of operating controls simultaneously with like controls in an array.
Knob	Desirable limits to control movements.	No large forces can be developed.
	Effectiveness of visually identifying control position.	Likelyhood of accidental activaction.
		Space requirements for location and operation of control.

Own Elaboration

3.5.8 Cranks

3.5.8.1 Crank specifications

The dimensions, resistance, and separation of adjacent circular swept areas of cranks shall not exceed the maximum and minimum values given in the **Figure 11.**

3.5.8.2 When to use

Cranks should be used for any task that requires many rotations of a control, particularly if high rates or large forces are involved. For tasks that involve large slewing movements as well as small, fine adjustments, a crank handle may be mounted on a knob or handwheel. The crank would then be used for slewing and the knob or handwheel, for the fine adjustment. If a crank is used for tuning or another process involving numerical selection, each rotation of the crank should correspond to a multiple of 1, 10, 100, or other appropriate value. If extreme precision is required in an X-Y control, for example, in setting crosshairs or reticles in reading a map, a simultaneously-operated pair of handcranks should be used in preference to other two-axis controllers. The gear ratios and dynamic characteristics of such cranks should permit precise placement of the followers without over- or undershooting and successive corrective movements.

3.5.8.3 Grip handle

The handle of a handcrank shall turn freely around its shaft.

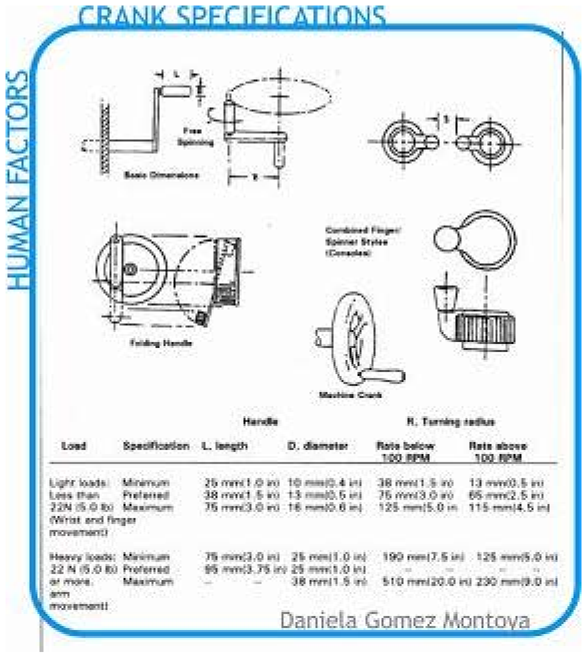
3.5.8.4 Folding handles

If a crank handle might be a hazard to persons passing by, or if it is critical that the handle not be moved inadvertently, a folding handle should be used. If a folding handle is used, it should be stable in both the extended and folded positions.

3.5.8.5 Crank balance

In applications in which resistance is low, the crank shall be balanced so that the weight of the handle does not move the crank from its last setting.

Figure 11: Crank Specifications



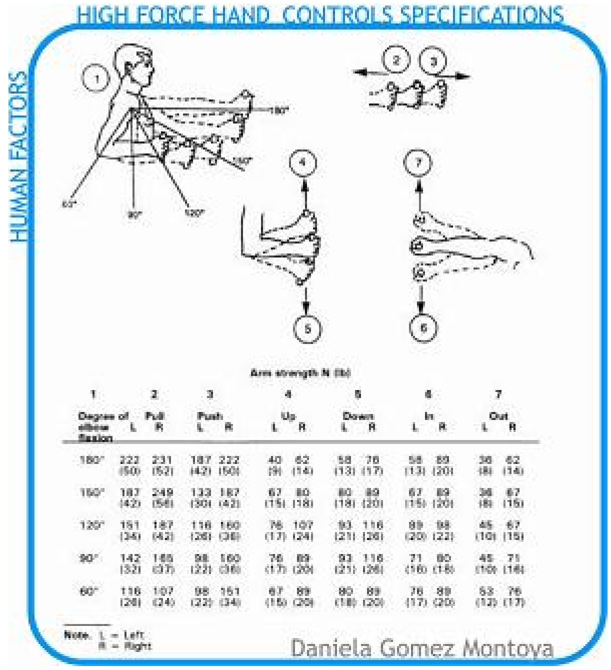
		Handle		R. Turning radius	
Load	Specification	L. length	D. diameter	Rate below 100 RPM	Rate above 100 RPM
Light loads: Less than 22N (5.0 lb) (Wrist and finger movement)	Minimum	25 mm(1.0 in)	10 mm(0.4 in)	38 mm(1.5 in)	13 mm(0.5 in)
	Preferred	38 mm(1.5 in)	13 mm(0.5 in)	75 mm(3.0 in)	65 mm(2.5 in)
	Maximum	75 mm(3.0 in)	16 mm(0.6 in)	125 mm(5.0 in)	115 mm(4.5 in)
Heavy loads: 22 N (5.0 lb) or more. (arm movement)	Minimum	75 mm(3.0 in)	25 mm(1.0 in)	190 mm(7.5 in)	125 mm(5.0 in)
	Preferred	95 mm(3.75 in)	25 mm(1.0 in)	—	—
	Maximum	—	38 mm(1.5 in)	510 mm(20.0 in)	230 mm(9.0 in)

WAGNER@1996

NOTE: Units of equipment weighing more than 18 kg

Units of equipment weighing more than 18 kg (40 lb) shall have handles that provide easy handling of the unit by two or more people. If the unit is very large, it shall have lifting eyes.

Figure 12: High Force Hand control specifications



Arm strength N (lb)

1	2		3		4		5		6		7	
Degree of elbow flexion	Pull		Push		Up		Down		In		Out	
	L	R	L	R	L	R	L	R	L	R	L	R
180°	222 (50)	231 (52)	187 (42)	222 (50)	40 (9)	62 (14)	58 (13)	76 (17)	58 (13)	89 (20)	36 (8)	62 (14)
150°	187 (42)	249 (56)	133 (30)	187 (42)	67 (15)	80 (18)	80 (18)	89 (20)	67 (15)	89 (20)	36 (8)	67 (15)
120°	151 (34)	187 (42)	116 (26)	160 (36)	76 (17)	107 (24)	93 (21)	116 (26)	89 (20)	98 (22)	45 (10)	67 (15)
90°	142 (32)	165 (37)	98 (22)	160 (36)	76 (17)	89 (20)	93 (21)	116 (26)	71 (16)	80 (18)	45 (10)	71 (16)
60°	116 (26)	107 (24)	98 (22)	151 (34)	67 (15)	89 (20)	80 (18)	89 (20)	76 (17)	89 (20)	53 (12)	76 (17)

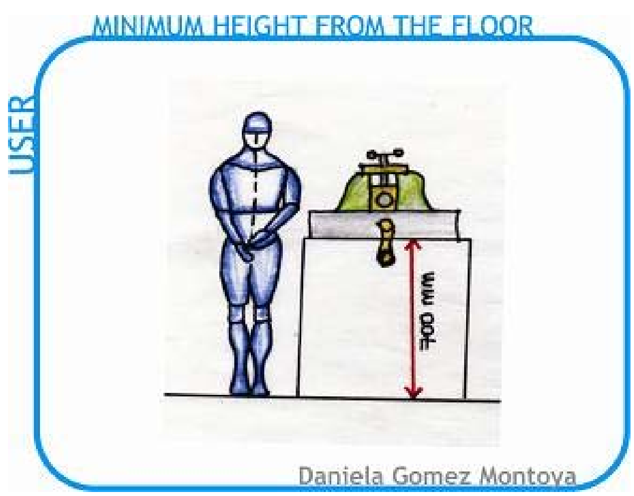
Note. L = Left
R = Right

WAGNER@1996

3.5.9 Design Considerations

According to the previous information, extracted from the "HUMAN FACTORS DESIGN GUIDE", the following analysis is presented, considering all the important aspects for the product design and dimensions:

Figure 13: Minimum Height from the Floor



Own Elaboration

The **Figure 13** represents the minimum height considered from the floor to the base of the machine. This is based on the 5^{th} Percentile for women, as it has to be in a reachable distance for at least the 95% of the population.

Figure 14: Operation Position Stand Up

Own Elaboration

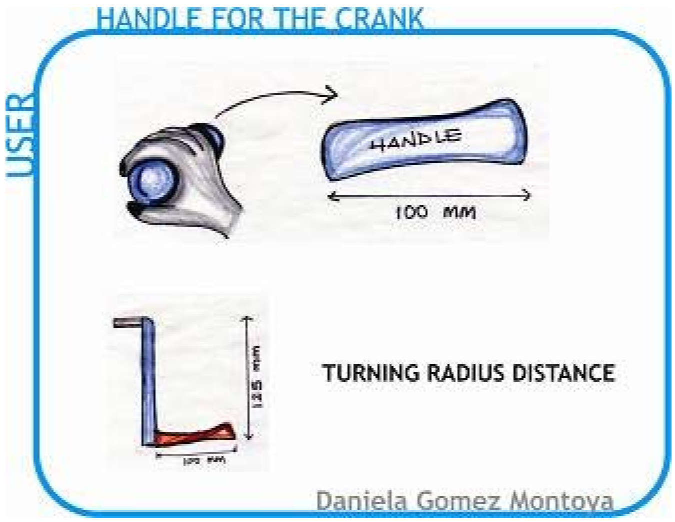
The **Figures 14** is representing the correct body position during the operation of the product standing up. This position is the most appropriate for the activities as it is less riskily in terms of illnesses, it is more effective as the gravity has a big influence on the operation and the visual angle of the product is better from the top view.

Figure 15: Hand’s reach distance

Own Elaboration

The **Figure 15** is showing the distance of the reach of the hand. This value is considering the minimum value for the 5th Percentile in women. That is the maximum point from the body to the crank mid point position. It is important to consider as well, that the body can be inclined a little (15 degrees) to help to the arm's movement.

Figure 16: Handle of the Crank



Own Elaboration

The **Figure 16** is illustrating the dimensions for the handle of the crank as so it is for the Turning Radius. The handle dimension is based on the 99th Percentile for men, as it needs to ensure that most of the population is going to have enough space to hold the crank and operate it. The Turning Radius is based on the crank's specifications of the HUMAN FACTORS DESIGN GUIDE.

ANNEX No. 9 Shape synthesis - Product Styling

This phase of the product design describes the formal development of the process. This phase is the meaning of the figures, shapes, colours of some of the elements of the product.

If it is true that some of the components of the product should have an specified shape or characteristic due to it functional performance, there are others than can be interfere and designed using some of the methodologies learned during the "*Formalization Emphasis line*", specially those ones that are related with the user-product interaction. This phase is related with the semantic of the product.

The methodology used, according to assignments *"Teoría de la Forma, Proyecto 6 y Taller de Diseño"* [1], involves a "*VISUAL ALPHABET*"[2]. This part consists of choosing a formal referent from the nature or artificial and, through a research work, to obtain as much information as possible about: shapes, colours, textures typographies, visual image, etc. The idea is to go beyond the literal elements and does an exploration work, to have a complete and original development of the design process of the project.

1. Boards[3]

The visual languages of the process design are the Boards. Moreover they are a compilation of images and pictures to explain issues as the user, the context in which the project is focused to start the creation on design concepts.

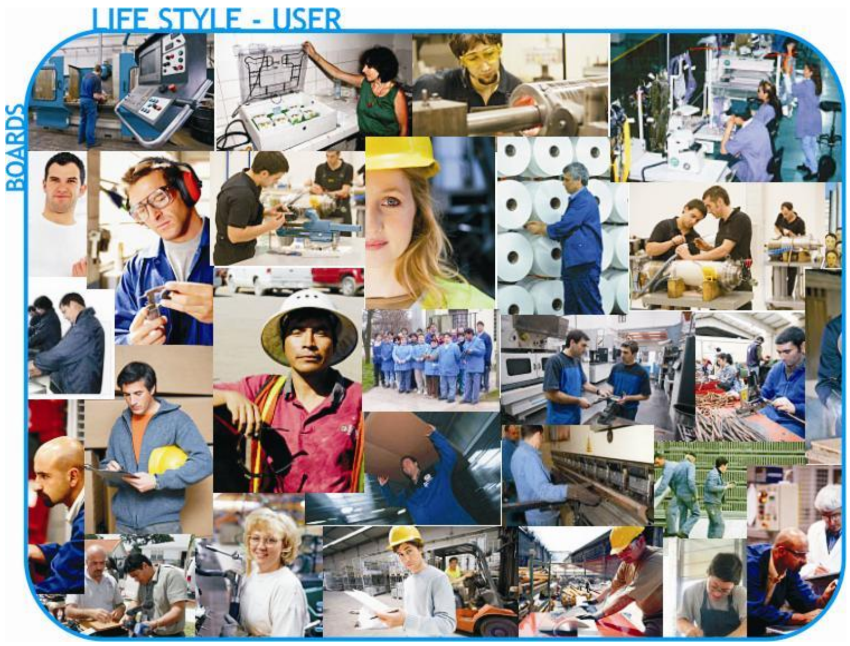
[1] Spanish name of some of the assignments attended during the studies of product Design Engineering at EAFIT UNIVERSITY.
[2] Element or component of the Design Methodology, in Spanish "ALFABETO VISUAL".
[3] BAXTER, Mike. Product Desing. Boards. June 1999.

It is a useful tool to define the product styling, the product's message, trying to find coherence with its environment.

1.1 Life Style Board

This first Board describes the user and its activities, as it shown in the next figure:

Figure 1: Board Life Style - User

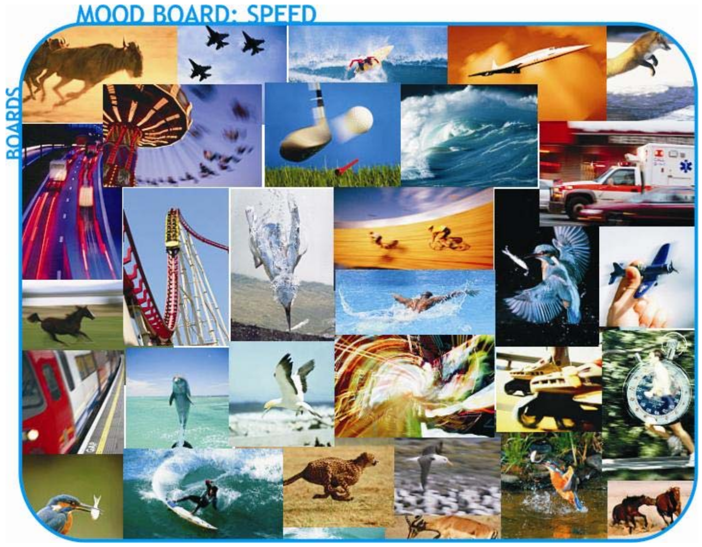


Own Elaboration

1.2 Mood Board

This Board evidences an attribute that the product wants to represent. It talks about the emotion when the user uses the product. The emotion chosen is **SPEED.** The current activities at the company of die cutting and embossing, when the volumes of production are not big enough, are very slow because they are made in a handicraft way. It is very important to improve the times and get the activities done in a faster way. That is the reason why "*Speed*" is the emotion that the product wants to represent.

Figure 2: Mood Board



Own Elaboration

1.3 Context Board

The context Board shows in a very general way the places where the user will be operating the product and the most significant elements and other products around. In our case it is clear: the product is developed for a Graphic, Printing and Delivering Company, MR PRINT SDN BHD.

Figure 3: Context Board

Own Elaboration

1.4 Visual Theme Board

This board is a collection of images and pictures of other products used by the target group represented at the Life Style Board. These can be from different market sectors and with different functions. Products related with the user and the context.

Figure 4: Visual Theme Board

Own Elaboration

2. Visual Alphabet

The visual alphabet is a very useful tool used for the generation of ideas and alternatives of design. It uses a formal referent taken from the nature or the artificial world and elements like colours, textures, shapes, principles, etc; can be very useful for the creation process. The main objective of this phase is to complete the design of handles, shells and some other elements where the shape does not affect the functionality.

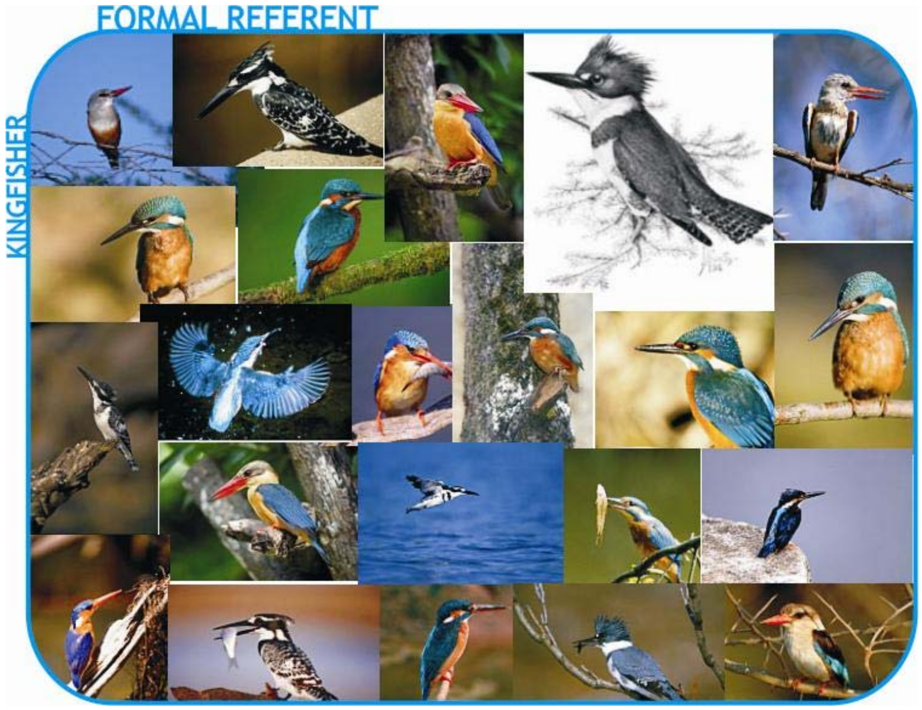
2.2 Formal Referent

As Malaysia is the context where the company, MR PRINT SDN BHD, is located, the referent is a beautiful and particular specie of bird typical from that region: THE KINGFISHER. Even though, the Kingfishers are found now days throughout many places around the world. Kingfishers are birds of the three families Alcedinidae (river kingfishers), Halcyonidae (tree kingfishers), and Cerylidae (water kingfishers). There are about 90 species of kingfisher. All have large heads, long, sharp, pointed bills, short legs, and stubby tails. Kingfishers live in both woodland and wetland habitats. Kingfishers that live near water hunt small fish by diving. They also eat crayfish, frogs, and insects. Wood kingfishers eat reptiles. Kingfishers of all three families beat their prey to death, either by whipping it against a tree or by dropping it on a stone. They are able to see well both in air and under water. To do this, their eyes have evolved an egg-shaped lens able to focus in the two different environments.(WIKIPEDIA-Kingfisher@2007)

Figure 5: Formal Referent 1

Own Elaboration

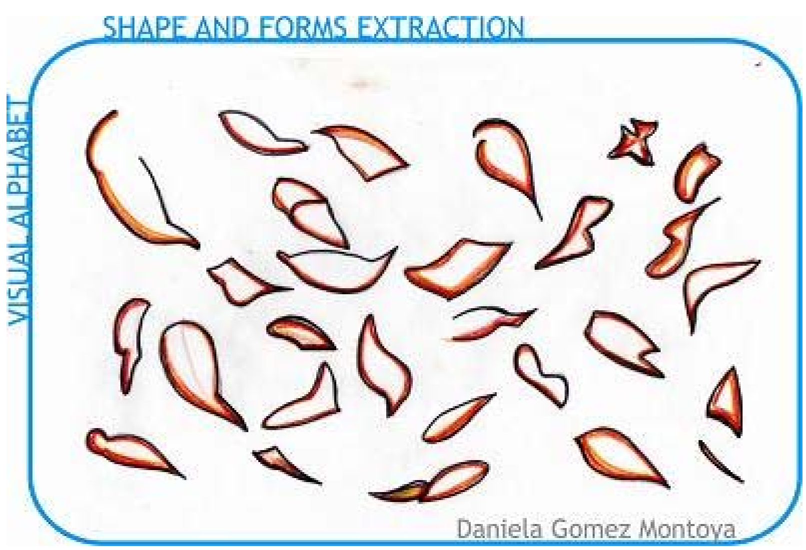
Figure 6: Formal Referent 1



Own Elaboration

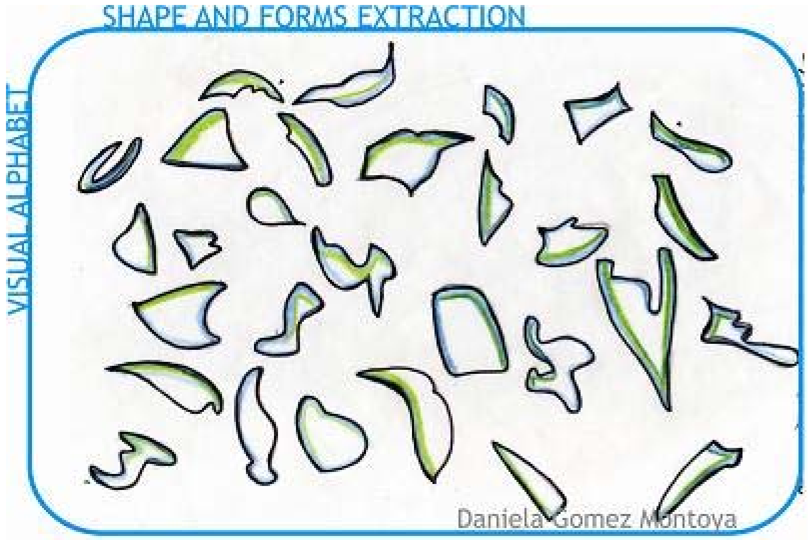
3.2 Shapes and forms extraction

Figure 7: Shape and Forms extraction 1



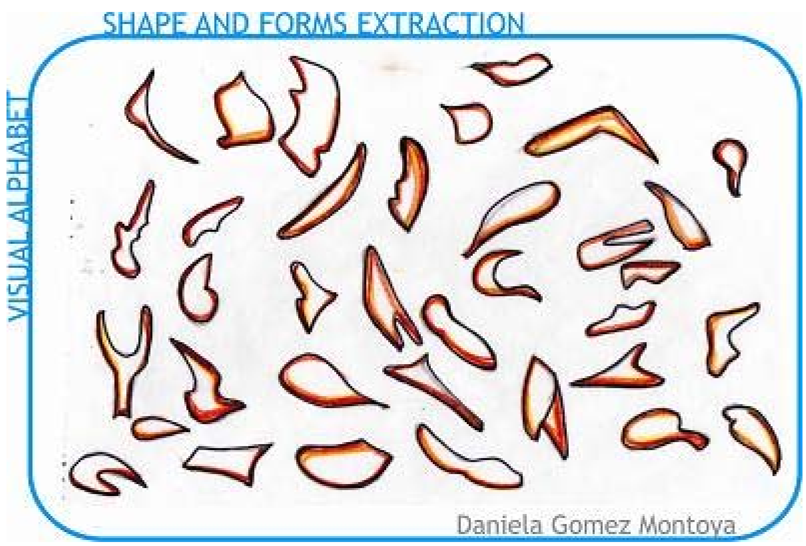
Own Elaboration

Figure 8: Shape and Forms extraction 2



Own Elaboration

Figure 9: Shape and Forms extraction 3



Own Elaboration

4.2 Colours and Textures extraction

There is a range of colours and textures than can be extracted from the design referent and are useful for the development of the design process. The following figure shows a synthesis of this analysis.

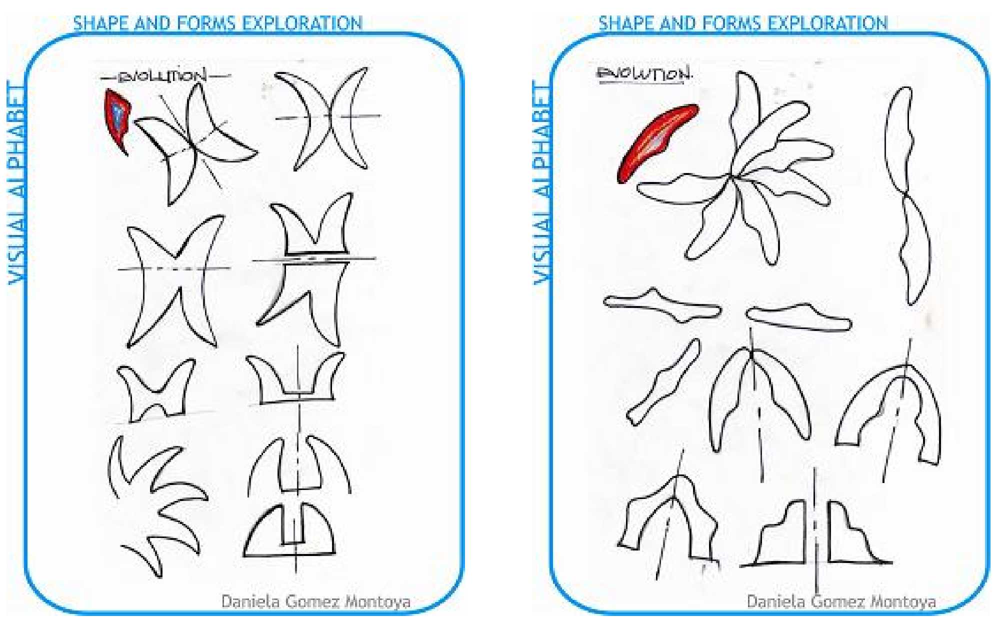
Figure 10: Colours and Texture extraction

Own Elaboration

5.2 Shapes and forms exploration

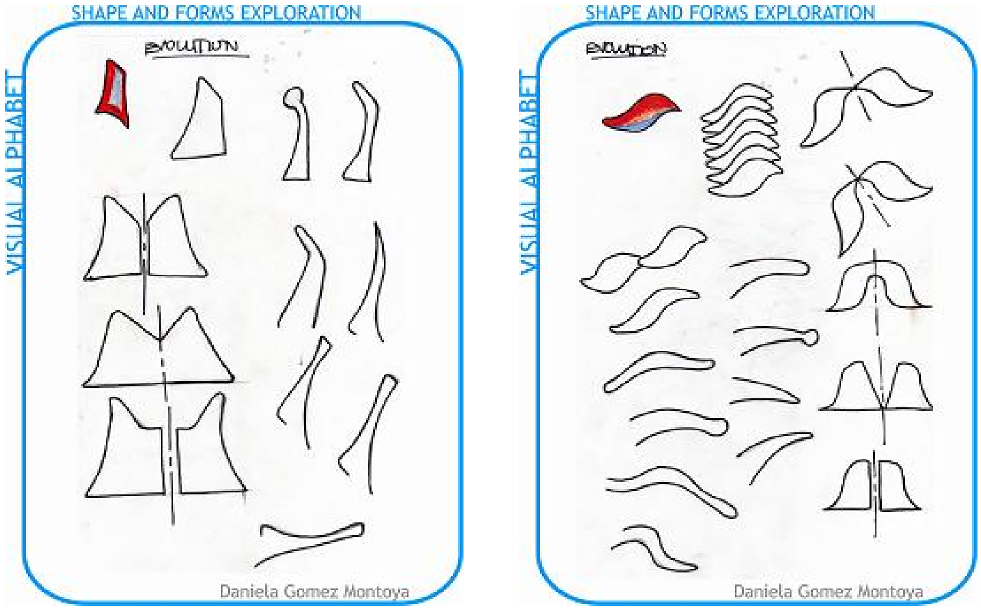
Once the extraction of shapes, colours and textures is done, the next phase is to do an exploration modifying parts from the shapes extracted for the design process. The creativity of the designer is important to make variations and changes to the first extractions from the original referent in order to create different alternatives and ideas for the design purposes.

Figure 11: Shape and Forms exploration 1



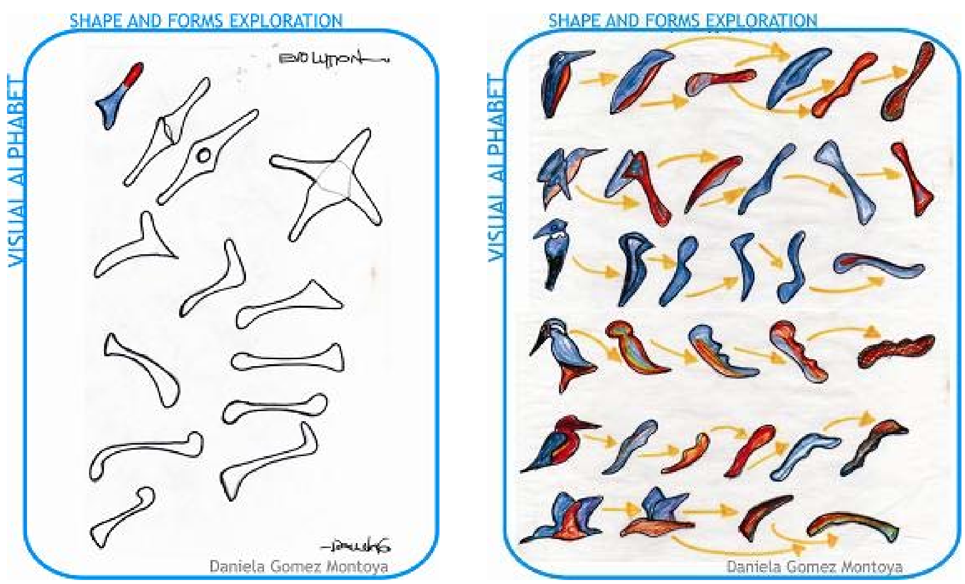
Own Elaboration

Figure 12: Shape and Forms exploration 2



Own Elaboration

Figure 13: Shape and Forms exploration 5



Own Elaboration

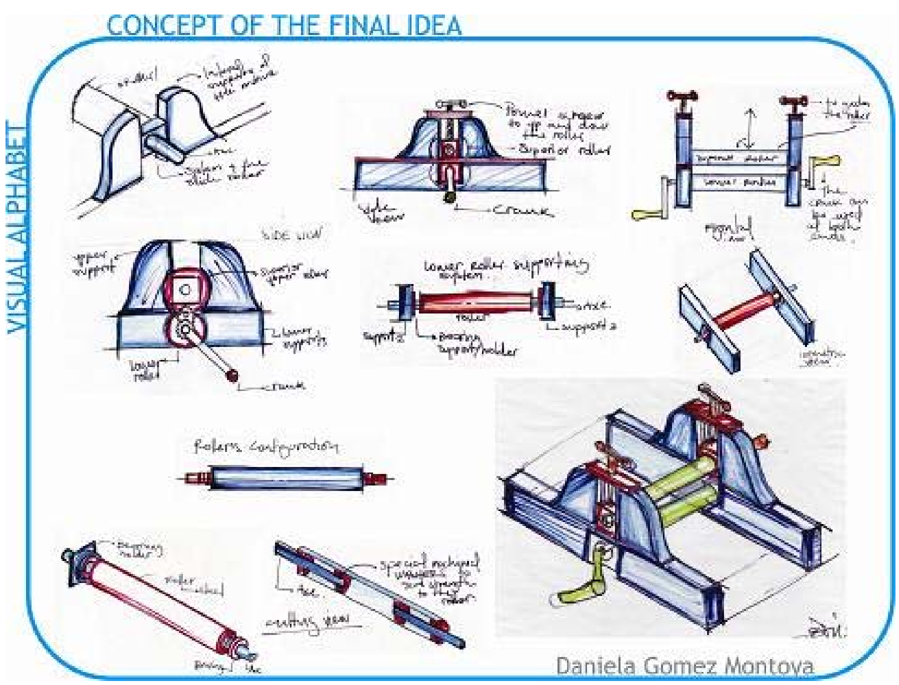
6.2 Concept of the Final Idea

Based on the visual alphabet and considering the working structure selected on the *Chapter 3*, the final and definitive idea starts to take form. During this section is presented a compilation of the most representative process made to give place to the final modelation and detailed design. This step pretends to be fast and is not taking care of single details, as the CAD 3D modelation will show in a most comprehensible way how the product is solve.

It is important to say that, for the project, design + production principles were combined. That means that the production facilities, machine processes and options of fabrication were highly considered when the shape was defined.

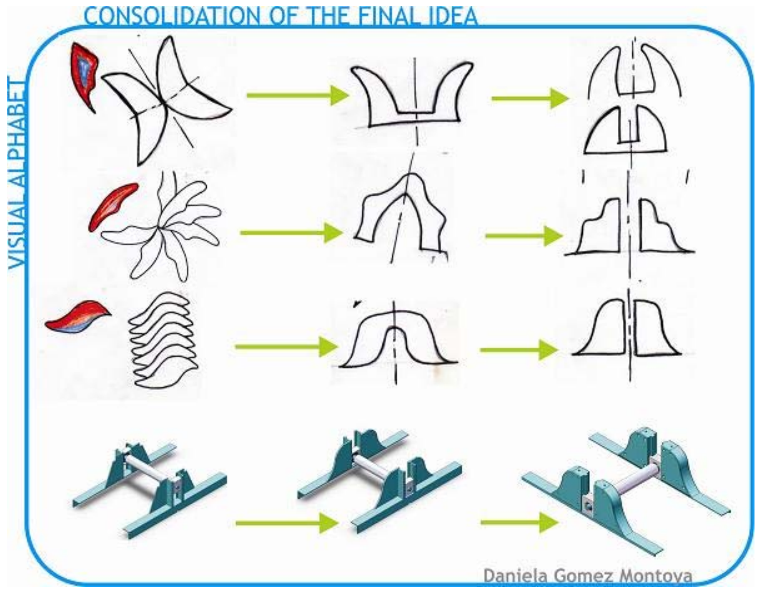
After this phase, during the detail design, more refinements were done, in order to improve the final idea. Those details are clearly showed on the A**nnex No. 11: Product CAD Modelation.**

Figure 14: Concept of the Final Idea



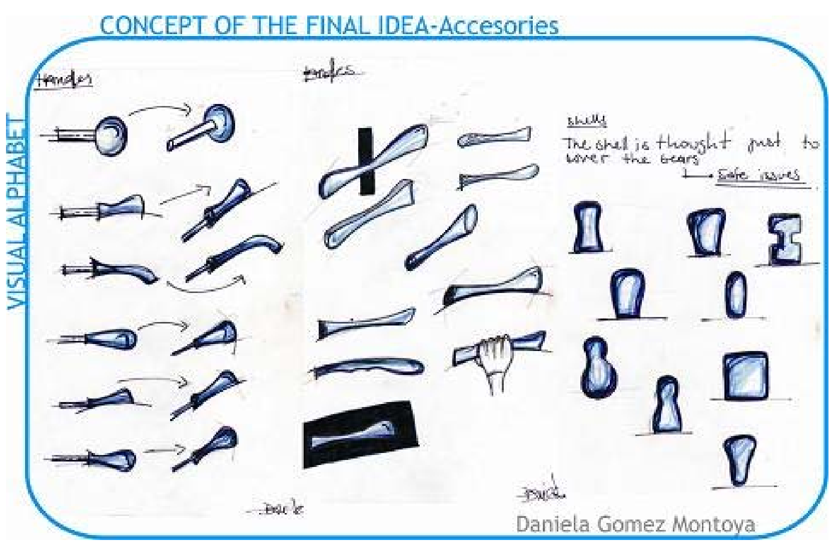
Own Elaboration

Figure 15: Lateral Supports



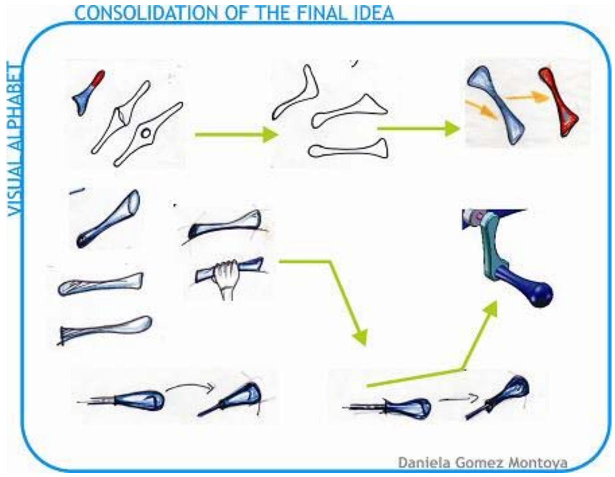
Own Elaboration

Figure 16: Concept of the Final Idea –Handles



Own Elaboration

Figure 17: Crank's Handle

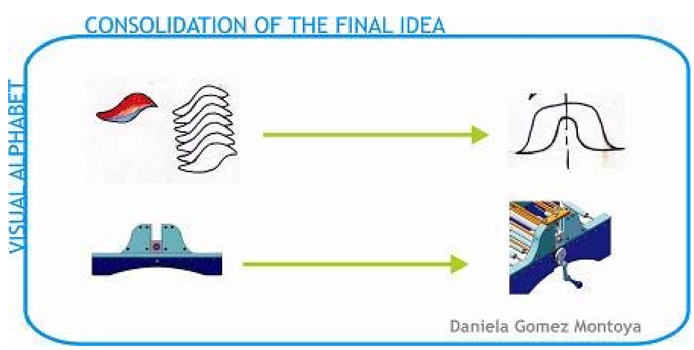


Own Elaboration

Figure 18: Connection Rod

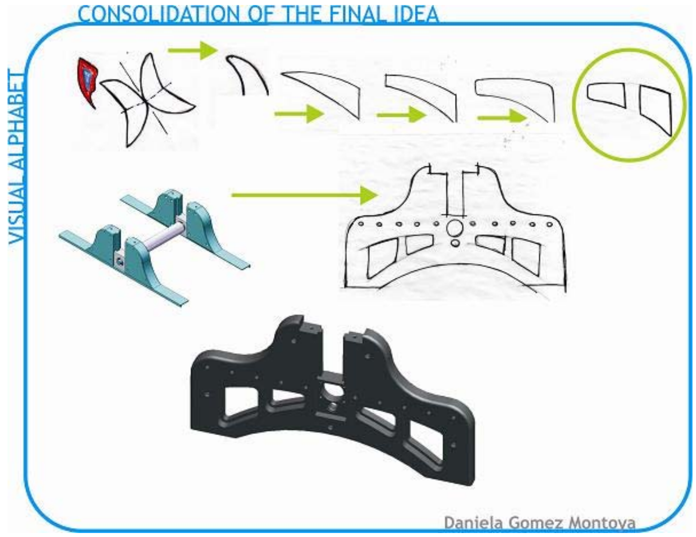
Own Elaboration

Figure 19: Inferior Supports



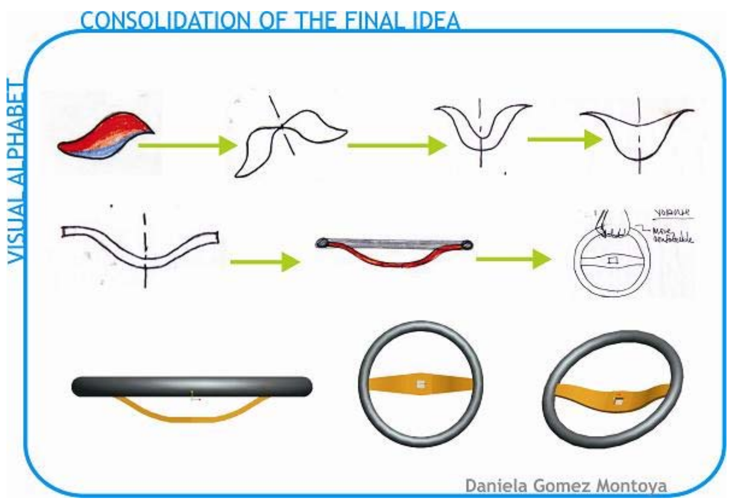
Own Elaboration

Figure 20: Final Lateral Supports



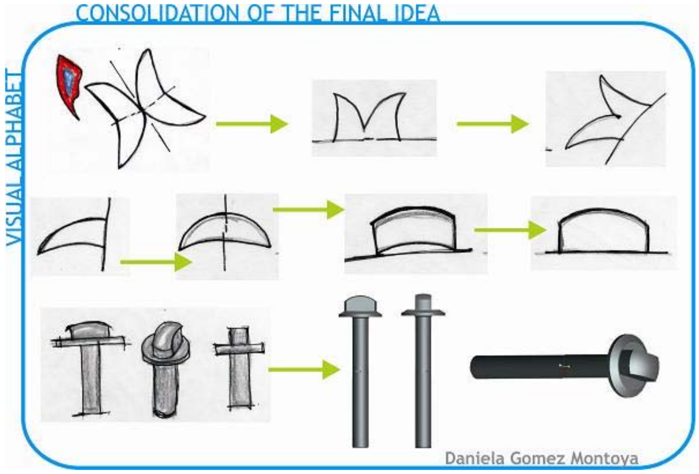
Own Elaboration

Figure 21: Lever of the Power Screw



Own Elaboration

Figure 22: Screw for the springs of the plate – Special fabrication part



Own Elaboration

The **Annex No. 10** will show in detail the Engineering calculations considered to guarantee the function of the product. These results are next showed on the **Annex No.11** where the detail of the 3D modelation process using PRO - ENGINEER as a design Software, is presented.

ANNEX No. 10 Engineering Considerations and Calculations

1. Engineering considerations and calculations

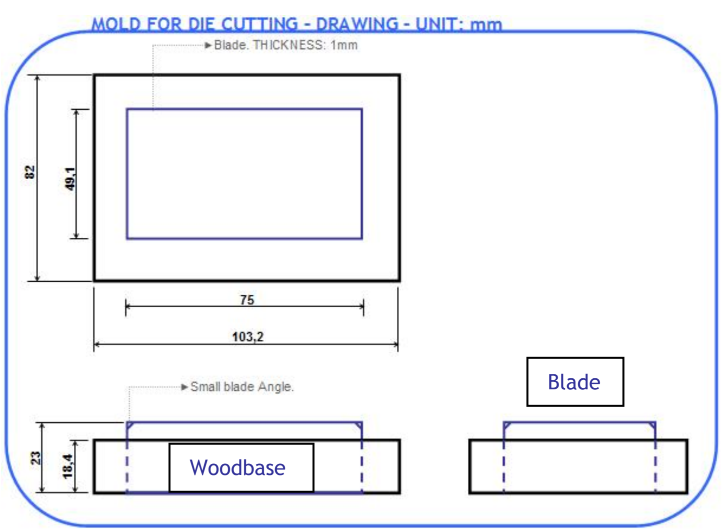
1.1 Design Considerations

This section contains all the preliminary considerations to start the engineering calculations.

It is very important to understand that the calculations are based on the tests elaborated previously (*see Annexes 4, 5 and 6*) considering the most critical and difficult scenarios in order to ensure an excellent performance:

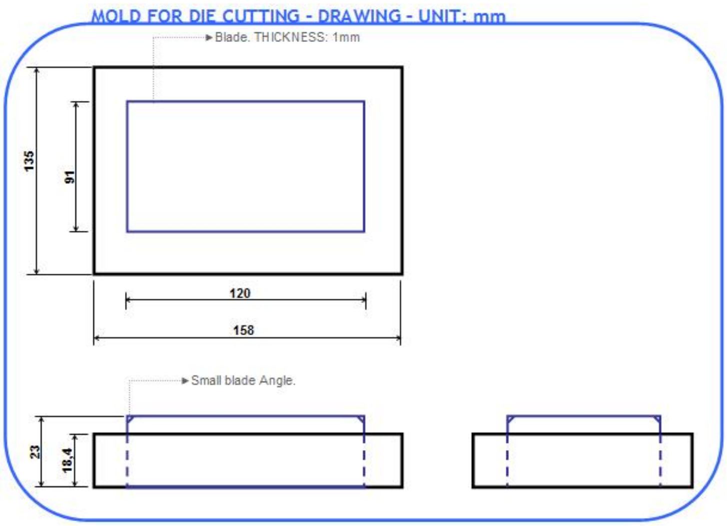
- For the tests, two different size molds were used (*see Figure 1 and 2*), both with a rectangular "cutting knife" shape. This is the most difficult shape to cut, as the highest force is needed because the knife's length is located in two opportunities 100% parallel against the roller. When this situation occurs, the whole length of the knife needs to be cut by the pressure of the roller at one time. As it is explained on the **Figure 3.**

Figure 1: Mold 1 used for the tests



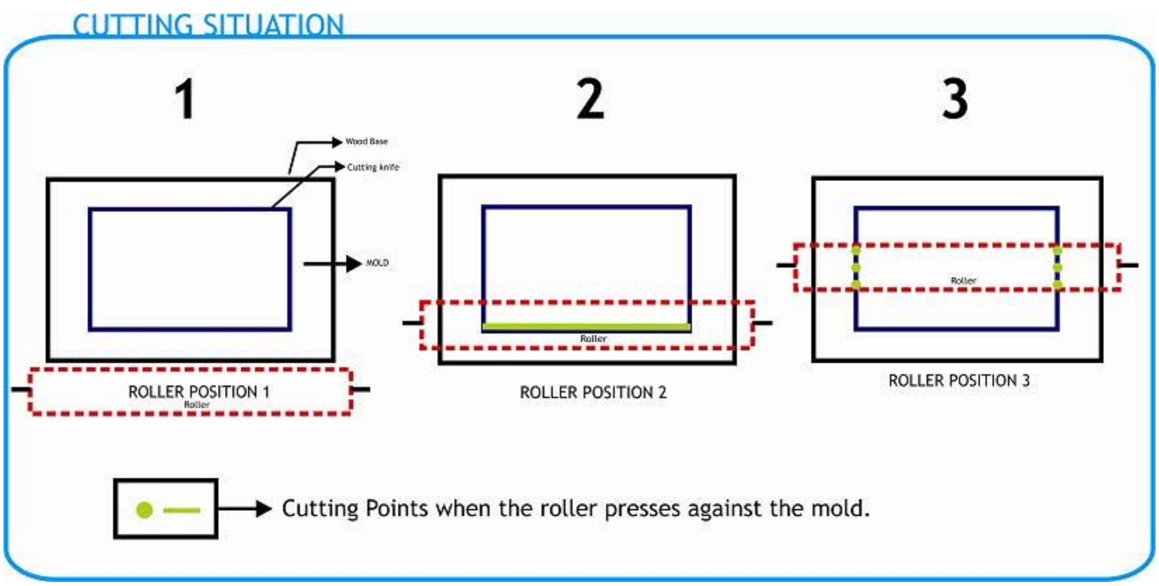
Own Elaboration

Figure 2: Mold 2 used for the tests



Own Elaboration

Figure 3: Cutting Situation



Own Elaboration

As it is shown, the points represented by circles are much easier to cut that the ones represented by lines. This is because the circles are smaller areas, like small points.

- The length (perimeter) of the knife for the "Mold 1" is **248.2 mm**. For the "Mold 2" is **422 mm**. (*See Figures 1 and 2*).

- As it is expressed on the PDS, the maximum mold size, area, (company requirement) is 400mm x 500mm. This means that the maximum length required for the rollers is 400 mm plus 10mm of advantage at both ends (designer parameter) in order to avoid the collision of the roller against the structure, as it shows in the next Figure.

Figure 4: Roller Dimensions

Own Elaboration

The function of the rollers is to compress the mold against the paper to allow the cutting and embossing and to transport or move the system (mold and paper), using friction, as they move in a rotary direction.

During the tests to determine the paper shear strength, the worst scenario was to cut 5 sheets of paper (Bond 75 GSM) at the same time: 17.6 KN. It is important to remember that that was a static test using the UNIVERSAL MACHINE.

- The tests for 5 sheets of Bond paper (75GSM) were done with the two sizes of molds explained previously. Due to that, the following analyses are done in order to get an equation to determine the force required with any length.

Table 1: Force required cutting 5 sheets of paper

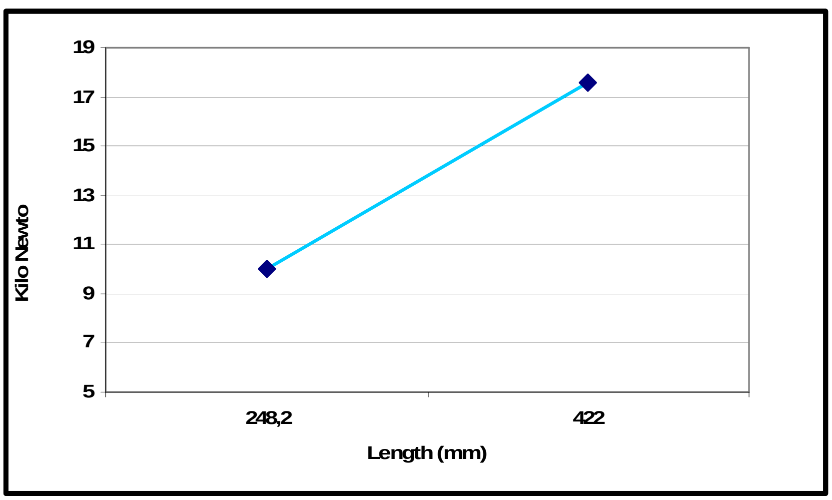
	Values from the shear paper strength test for 5 sheets of paper	
	L(mm)	F(KN)
Mold 1	248,2	10
Mold 2	422	17,6

Own Elaboration

F is the Force expressed in KN and **L** is the perimeter of the knife.

For the following analysis it is assumed that the behaviour of the necessary force to cut the 5 sheets of paper is lineal.

Figure 5: Graphic of Length Vs. Force to cut 5 sheets of paper.



Own Elaboration

Point 1: (248.2 , 10) **Point 2:** (422 , 17.6)

The equation of the line is $\boxed{Y = mx + b}$ **(1),** where: **m**= (y2 – y1)/(x2 – x1)

$$m = (17.6 - 10)/(422 - 248.2) \longrightarrow m = 0.0437$$

Now taking the **Point 1:** (248.2 , 10) and the equation (1), we have:

$$10 = (0.0437)(248.2) + b \longrightarrow b = 10 - (0.0437)(248.2) \longrightarrow b = -0.8463$$

So the final equation is: $\boxed{Y= (0.0437)X - 0.8463}$ **(2)**

- Knowing the equation (2) it is possible to get the value in KN of the force needed to apply when the length of the cutting knife is the same of the roller (maximum), it means when it is 400mm.

  $Y= (0.0437)(400) - 0.8463 \longrightarrow$ **Y= 16.663 KN** $\longrightarrow$ **FORCE**

- The calculations are done based on the Die-Cutting process, as the results on the shear strength test made to know the required force to cut the paper, were higher over the result to do paper embossing. (*Annexes 5, 6 and 7*). The Die-Cutting is the most critical case to be analysed.

1.2 Determination of the cross section of the main rollers by their resistance (Roller's size)

In order to know the exactly dimension and characteristics of the rollers it is very important to analyse "The Beam load conditions" (BLODGETT@2002) of the situation:

Problem definition

During this section it is going to be defined if the machine will work with two or three rollers for the transmission system. The criteria for the selection will be the roller's maximum deflection for the load operation conditions. The cutting load considered is **16.663 KN**. The knife's maximum length is **400mm** (same length of the roller) and the minimum is **50mm**. The percentage of cork respect to the knife's length is **100%**[1]. The roller's length is **400mm**. The maximum admissible deflection of the rollers at its centre point is **0.5mm,**

[1] To eject the paper once the mold has cut it, the industry uses a cork or sponge that is located all around the knives, on the die cutting mold, in order to facilitate the ejection. This cork represents the 100% of the knife's length. MR PRINT data.

which means that each roller (superior and lower roller) could be deflected 0,25 mm maximum [2].

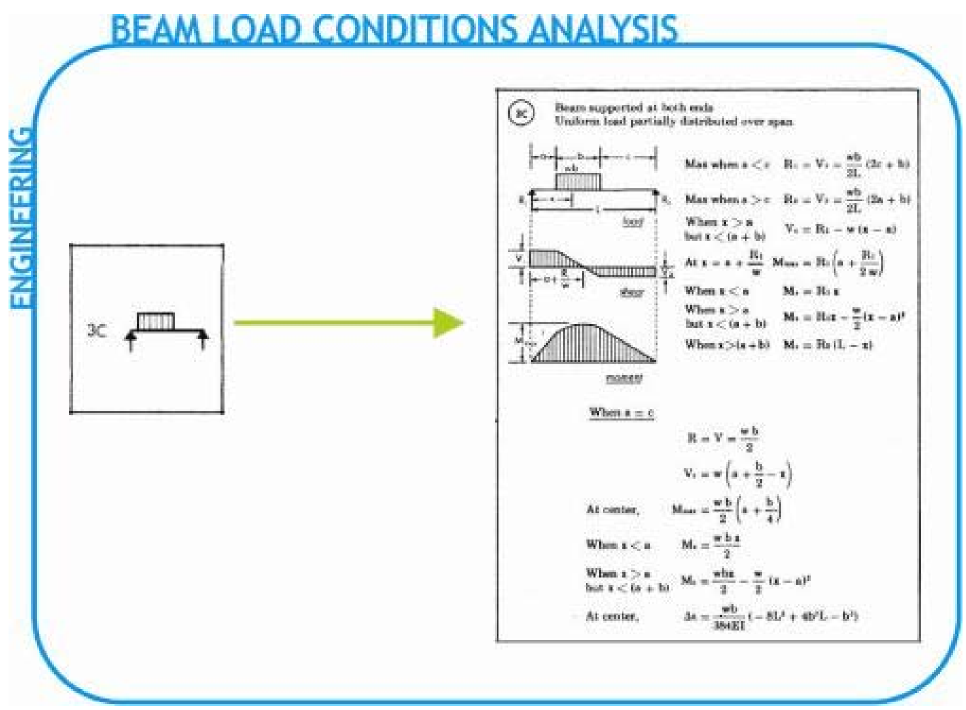
Existing conditions

All the elements estimated to be used in this design, are in good conditions: die molds, knives, rollers, etc.

Post Analysis

According to the book *"DESIGN OF STRUCTURES WELDED"* the beam related with the roller and the situation is the **"3c": Beam supported at both ends, uniform load partially distributed over span; and "3B": Beam supported at both ends, uniform load over entire span.** The equations and calculations for this kind of beam and its load distribution and geometry are shown is the next figure:

Figure 6: Beam 3C equations

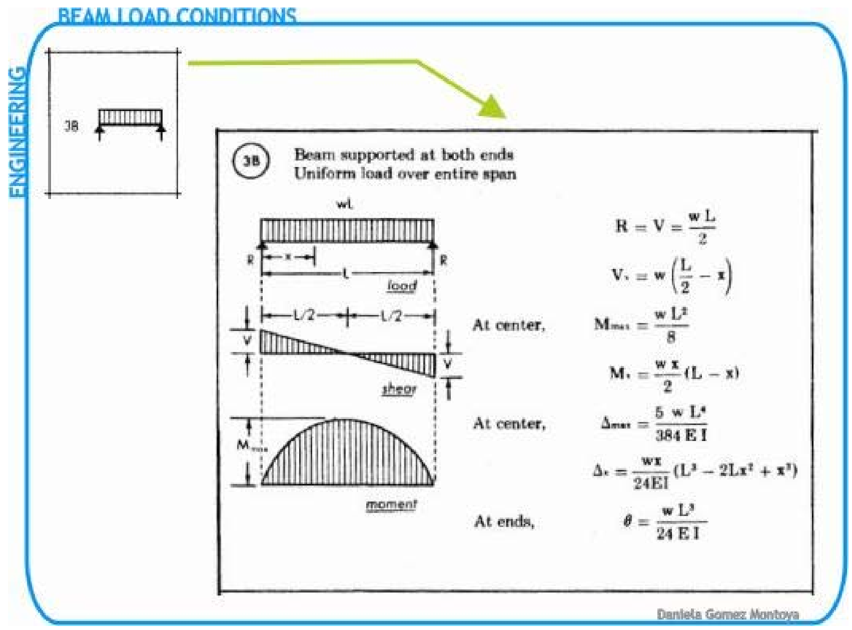


BLODGETT@2002

[2] In order to guarantee a correct cutting job, the knife is being inserted in the cutting board no more than 0,5mm. If the roller is deflected more than this condition, then the paper in not going to be cut correctly.

The Beam "3B" derives from the Beam "3C". It is used when the length of the load is the same than the roller's length. As in the following analysis:

Figure 7: Beam 3B equations



BLODGETT,2002

Roller Analysis

Based on the beam load condition model presented on the previous section, the following is the analysis to define how many rollers are needed, depending of its maximum deflection.

Table 2: Input Values for the Beam Load Analysis

VALUE	DESCRIPTION
d_{max}= 0.5 mm = 0.0005 m	Maximum Deflection
F= 16.663 KN	Design Force
W= 41657.5 N/m ***	load to be applied per m
L_{max}= 400 mm = 0.4 m	Knife's maximum length
E_{Steel} = 200 Gpa	Elasticity Modulus for Steel
R= 8331,5 N	Reaction at each end
I= ???	Geometrical Moment of Inertia

*** (16.663 KN) (1000N/1KN) = 16663 N

W= 16663 N / 0.4 m = **41657.5 N/m**

R= (41657.5 N/m x 0.4 m)/2 = **8331,5 N**

Getting to know the value of the Geometrical Moment of Inertia **(I),** it is possible to know the most suitable diameter and wall thickness of the steel roller (s) (using the fabricator's steel tube catalogues), in order to avoid its deflection more than 0.5 mm.

The equation from the BEAM LOAD CONDITION 3C is:

$$d_{max} = (5\ w\ L^4)/(384\ E\ I), \text{ where:}$$

$$\boxed{I = (5\ w\ L^4)/\ (384\ E\ d_{max})} \quad (1)$$

$$I = (5 * 41657.5\ N/m * 0.4^4)\ /\ (384 * (200 \times 10^9\ Pa) * 0.00025\ m)$$

$$\boxed{I = 27{,}7\ cm^4}$$

Knowing the Geometrical moment of Inertia for a deflection of 0.5mm, we can now know the parameters for the steel tube of the main rollers and conclude that the system is going to required only two rollers. According to the *Table 3*, a tube of outside diameter 60.5 mm, wall thickness 4 mm will be enough and it won't deflect more than 0.25 mm for each roller. In fact, as the exact moment of inertia of this tube is **28,5 cm^4**, (as 27,7 is not on the catalogue) it is possible to know the exact deflection:

$$d_{max} = (5\ w\ L^4)/(384\ E\ I), \text{ where:}$$

$$d_{max} = (5 * 41657.5\ N/m * 0.4^4)\ /\ (384 * (200 \times 10^9\ Pa) * 28{,}5\ cm^4)$$

$\boxed{d_{max} = 0{,}24\ mm}$ for a tube with an outside diameter of 60.5 mm and wall thickness of 4 mm.

Table 3: Carbon Steel Tubes for general Structural Purpose

HIAPTECK GROUP

CARBON STEEL TUBES FOR GENERAL STRUCTURAL PURPOSE

JIS G 3444 - 1988 - STK 290
JIS G 3444 - 1988 - STK 400

JIS G 3444 - 1988 - STK
JIS G 3444 - 1988 - STK

Outside Diameter	Wall Thickness	Calculated Weight	Cross-Sectional Area	Geometrical Moment of Inertia	Modulus of Section	Radius of Gyrat of Area
mm	mm	kg/mm	cm^2	cm^4	cm^3	cm
21.7	2.0	0.972	1.238	0.607	0.560	0.700
27.2	2.0	1.24	1.583	1.26	0.930	0.890
	2.3	1.41	1.799	1.41	1.03	0.880
34.0	2.3	1.80	2.291	2.89	1.70	1.12
42.7	2.3	2.29	2.919	5.97	2.80	1.43
	2.5	2.49	3.157	6.40	3.00	1.42
	2.8	2.76	3.510	7.02	3.29	1.41
48.6	2.3	2.63	3.345	8.99	3.70	1.64
	2.5	2.84	3.621	9.65	3.97	1.63
	2.8	3.16	4.029	10.6	4.36	1.62
	3.2	3.58	4.564	11.8	4.86	1.61
60.5	2.3	3.30	4.205	17.8	5.90	2.06
	3.2	4.52	5.760	23.7	7.84	2.03
	4.0	5.57	7.100	28.5	9.41	2.00

(HIAPTECK, 2007)

According to the previous analysis it is possible to know the value of **(I)** for the whole range of mold's length as follows:

Table 4: Geometrical Moment of Inertia for the range of mold's length available

E Steel (GPa)	d_{max} mm
2E+11	0.00025

	Length mm	Length m	Force KN	Force N	LOAD (w) N/m	I m^4	I cm^4
1	400	0.4	16.6337	16633.7	41584.25	2.77228E-07	27.72283333
2	350	0.35	14.4487	14448.7	41282	1.61325E-07	16.13250033
3	300	0.3	12.2637	12263.7	40879	8.62291E-08	8.622914063
4	250	0.25	10.0787	10078.7	40314.8	4.10103E-08	4.101033529
5	200	0.2	7.8937	7893.7	39468.5	1.64452E-08	1.644520833
6	150	0.15	5.7087	5708.7	38058	5.01741E-09	0.501741211
7	100	0.1	3.5237	3523.7	35237	9.1763E-10	0.091763021
8	50	0.05	1.3387	1338.7	26774	4.35775E-11	0.004357747

Own Elaboration

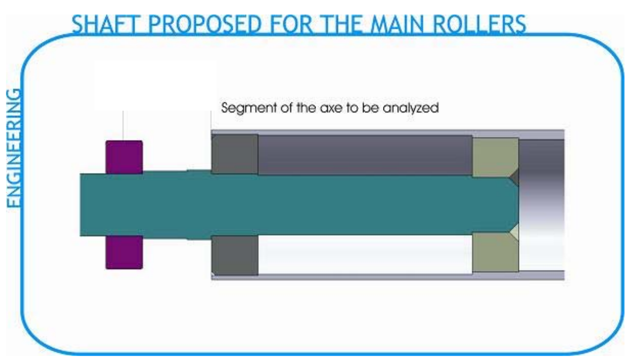
1.3 Validation of the Main Rollers shaft's resistance (Calculus of the Security Factor)

In order to know if the proposed shaft for the main roller will resist to the forces once the machine is working, the following calculation is necessary, to know the value of the "*Security Factor*"[3] and prove that the calculation is correctly and secure to be trusted.

Problem definition

During this section it is going to be defined if the proposed shaft for the main roller will work properly. The idea is to check if shaft's length showed on the **Figure 8** will resist the work without failures. The Reaction value or load is the same of the whole system. The force comes from the pressure that the power screws give to the superior roller to do the die cutting or embossing. The criteria for conclusion will be the Security Factor result. The **diameter** for the shaft's section to be analysed is 28 mm. The steel used is **AISI SAE 1045 Hot Rolled**[4]; the **Tensile Strength (yield)** of the material is 310 MPa (SUMITEC@2007); The force value (P) is 8331,5 N; the **Section Modulus** is 2,155 x 10^-6 m^3[5]; and finally the shaft's length (segment) is 0,0166 m.

Figure 8: Shaft's Geometry proposed for the design



Own Elaboration

[3] The Security Factor is a value used in engineering calculations to guarantee the performance of the element being tested. The result of the calculus is multiplied by this value to assure that it is being considered in higher risk level.
[4] FERROINDUSTRIAS LTDA. Product Catalogue. The AISI SAE 1045 is well used in machine parts that required strength as: cranks, shafts, screws, gears, join elements, etc.
[5] **Section Modulus=** π x D^3/32

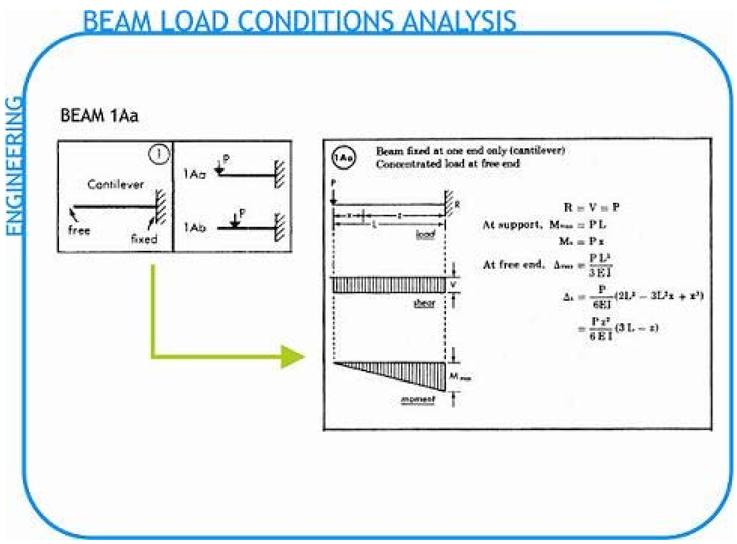
Existing conditions

All the elements estimated to be used in this design, are in good conditions.

Post Analysis

To define the element condition to be analysed, the book *"DESIGN OF STRUCTURES WELDED"* was used as a source of information for the analysis of the beam that represents the situation: **"Beam 1Aa": Cantilever: Beam supported at one end only, concentrated load at free end.** The equations and calculations for this kind of beam and its load distribution and geometry are shown is the next figure:

Figure 9: Beam 1Aa equations



BLODGETT,2002

Security Factor Analysis

Based on the beam load condition model presented on the previous section, the following analysis is done:

Mmax= Maximum Momentum = 138,30 Nm

Mmax = R x L = 8331,5 N x 0,0166 m = **138,30 Nm**

SD = Shaft's Diameter = 28mm = 0,028m

It is assumed that shaft is a cylinder without scales, and the value represents the smallest value of the sections.

R = Reaction = 8331, 5 N

TS = Tensile Strength = 310 Mpa = 310000000 Pa

MS = Modulus of Section = 2155 mm^3 = 2,155 x 10^-6 m^3

L= Length = 0,0166 m

N= Security Factor =???

$$M_{max} / MS = TS / N$$

$$\boxed{N = (TS \times MS) / M_{max}}$$

N= (310000000 Pa x 2,155 x 10^-6 m^3) / 138,30 Nm

N= 4,83 ⟶ GOOD

1.4 Validation of the Security Factor of the Power Screw's plate to check its resistance

Problem definition

During this section it is going to be defined if the proposed dimensions for the plate that support the Power Screw and its axial efforts, will work properly. As the plate is supported at both ends with screws and the Power Screw is making a pressure down, the plate will need to resist this force without deflection (**See Figure 11 and 12**). The criteria for conclusion will be the Security Factor result. The dimensions for the **transversal section** of the plate are **b=** 31,05 mm , **h=** 30 mm; the steel used is **AISI SAE 1020 Hot Rolled**; the **Tensile Strength (Yield)**[6] of the material is 205 MPa; The Reaction value (P) is 8331,5 N; the **Section Modulus**[7] is 4,65 x 10^-6 m^3 and **L** = 0,205 m.

[6] Compania General de Aceros.

[7] http://www.engineersedge.com/calculators/section_round_case_12.htm

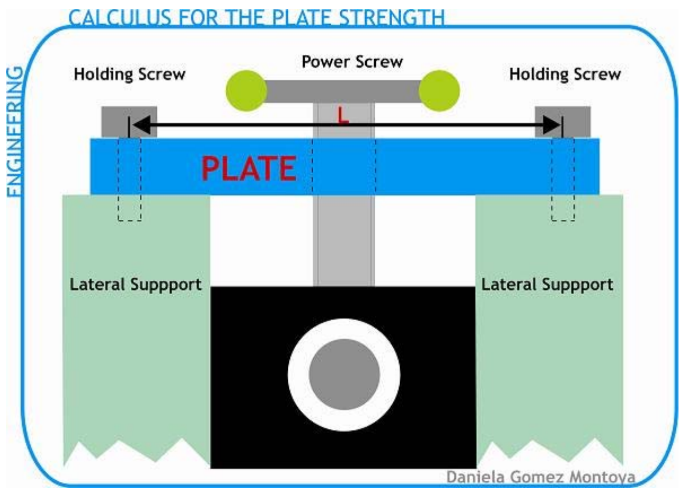
The following **Figure 11** shows the plate's geometry and its transversal section. For the calculation of the Modulus of Section, is very important to substrate the diameter of the power screw when **"b"** is being measure.

MS = Modulus of Section = (b h^2)/6. (GIECK, 1993, P-3)

MS = ((15,525 + 15,525) 30^2) mm^3/6

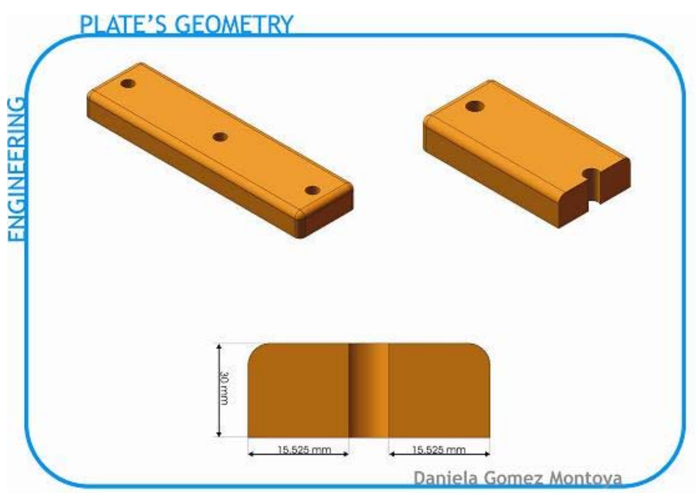
MS= 4657,5 mm^3 = 4,65 x 10^-6 m^3

Figure 10: Diagram of the power screw's plate



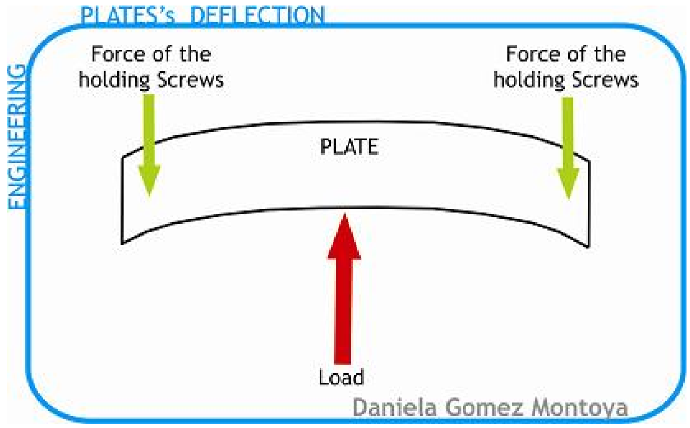
Own Elaboration

Figure 11: Plate's Geometry



Own Elaboration

Figure 12: Plate's Deflection



Own Elaboration

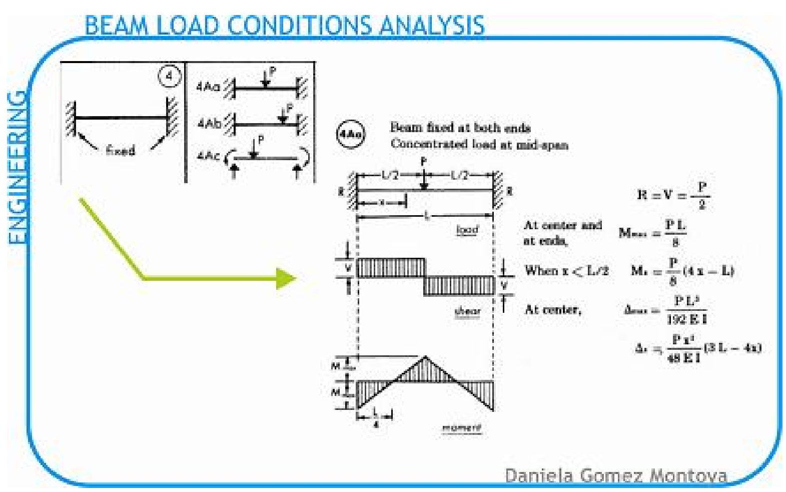
Existing conditions

All the elements estimated to be used in this design, are in good conditions.

Post Analysis

To define the element condition to be analysed, the book *"DESIGN OF STRUCTURES WELDED"* was used as a source of information for the analysis of the beam that represents the situation: **"4Aa": Beam fixed at both ends. Concentrated load at mid-span.** The equations and calculations for this kind of beam and its load distribution and geometry are shown is the next figure:

Figure 13: Beam 4Aa equations



BLODGETT,2002

Security Factor Analysis

Based on the beam load condition model presented on the previous section, the following analysis is done:

M_{max}= Maximum Momentum = 213,49 Nm

$$M_{max} = (R \times L)/8 = (8331{,}5\ N \times 0{,}205\ m)/8 = \mathbf{213{,}49\ Nm}$$

Dimensions of the Transversal Section of the plate = 0,015525 m x 0,03 m

R = Reaction = 8331, 5 N

TS = Tensile Strength = 205 Mpa = 205000000 Pa

MS = Modulus of Section = 4657,5 mm^3 =4,65 x 10^-6 m^3

L= Length = 0,205 m

N= Security Factor =???

$$M_{max} / MS = TS / N$$

$$\boxed{N = (TS \times MS) / M_{max}}$$

$$N = (205000000\ Pa \times 4{,}65 \times 10^{-6}\ m^3)/213{,}49\ Nm$$

$$N = 4{,}46 \longrightarrow \text{VERY GOOD}$$

1.5 Gear's calculations

A **gear** is a component within a transmission device that transmits rotational force to another gear or device. A gear is different from a pulley in that a gear is a round wheel which has linkages ("teeth" or "cogs") that mesh with other gear teeth, allowing force to be fully transferred without slippage. Depending on their construction and arrangement, geared devices can transmit forces at different speeds, torques, or in a different direction, from the power source. Gears are a very useful simple machine. The most common situation is for a gear to mesh with another gear, but a gear can mesh with any device having compatible teeth, such as linear moving racks. A gear's most important feature is that gears of unequal sizes (diameters) can be combined to produce a mechanical advantage, so that the rotational speed and torque of the second gear are different from that of the first. (WIKIPEDIA-Gear@2008)

1.5.1 Initial Considerations

- According to the proposed design of the product and its function, the system to be used for the transmission is a simple gear system, "Spur Gears" (WIKIPEDIA-Gear@2008)
- The initial step was to select an approximate diameter for the pinion and the gear[8] in order to consider the geometry and design of the product. It is important to note that the speed for the pinion is 60 rpm, considering that the crank will turn at 1 revolution per second.
- The relation of transmission will be 2:1, which means that two turning of the pinion correspond to a one turning of the gear. In other words, the gear will turn at 30 rpm.
- The teeth Number for the Pinion could be 19 and for the Gear 38.
- The catalogue of reference will be from the producer "ENGRANAJES MIRALLES"[9]

These initial considerations are susceptible to change depending on the result of the calculations and the standard gear systems to be found.

1.5.2 Definition of the gear system

Equations

- **Dp** = Primitive Diameter. Is the dimension of reference for the calculations of the gears. It is the circumference where the teeth make the transmission.

[8] Biggest Gear.
[9] ENGRANAJES MIRALLES. [Internet Article]. http://www.engranajesmiralles.com/Engramir5.htm

- **M =** Modulus = Is the relation between the **Dp** and the number of teeth (**Z**). it is expressed in millimetres. It is the same value for the pinion and the gear.
- **De =** External Diameter. It is the most outside diameter, boarding the tooth's head.
- **Di =** Internal Diameter. It is the most internal diameter, boarding the tooth's foot.
- **CD=** Centre Distance. Is the distance between the shafts or axis.
- **P =** Is the length of a tooth and a space on the **Dp.**

M = Dp/Z **P=** π x M **Z=** Dp/M

CD= (Dp1 +Dp2) /2

Tooth's Foot = 1,25 x M **Tooths' Head =** M

According to the product's geometry, the initial idea was to use a Pinion with a Primitive Diameter of 45 mm and a Gear of 90 mm:

Dp1= 90mm **Dp2=** 45mm

Z1 = 38 **Z2** = 19

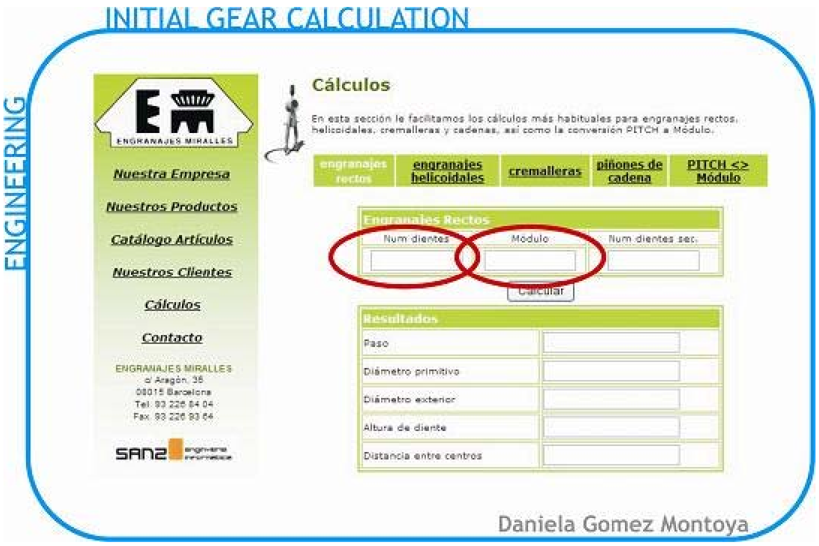
Due to these considerations, we have:

M = 90mm/38 = 2,368 mm or **M=** 45mm/19 = 2,368 mm

With this initial data, we can use the calculator available on the website of "ENGRANAJES MIRALLES" to have a preliminary idea of the initial system. The **Figures 14, 15 and 16** can illustrate this situation.

Once this step is done, the following action is to look on the catalogue for a standard gear system with similar conditions to be accommodated to the design.

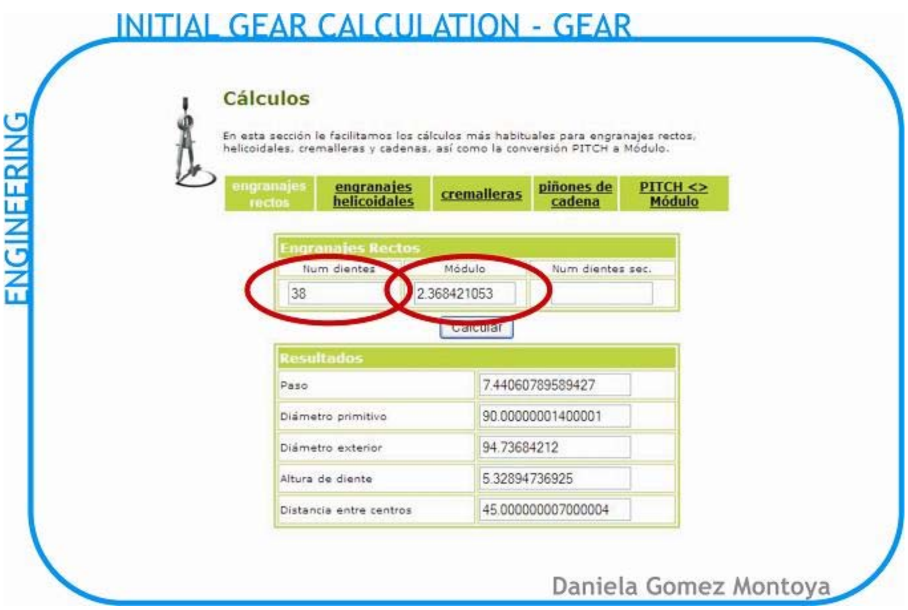
Figure 14: Initial Gear Calculation 1



ENGRANAJES MIRALLES

For the biggest gear we have:

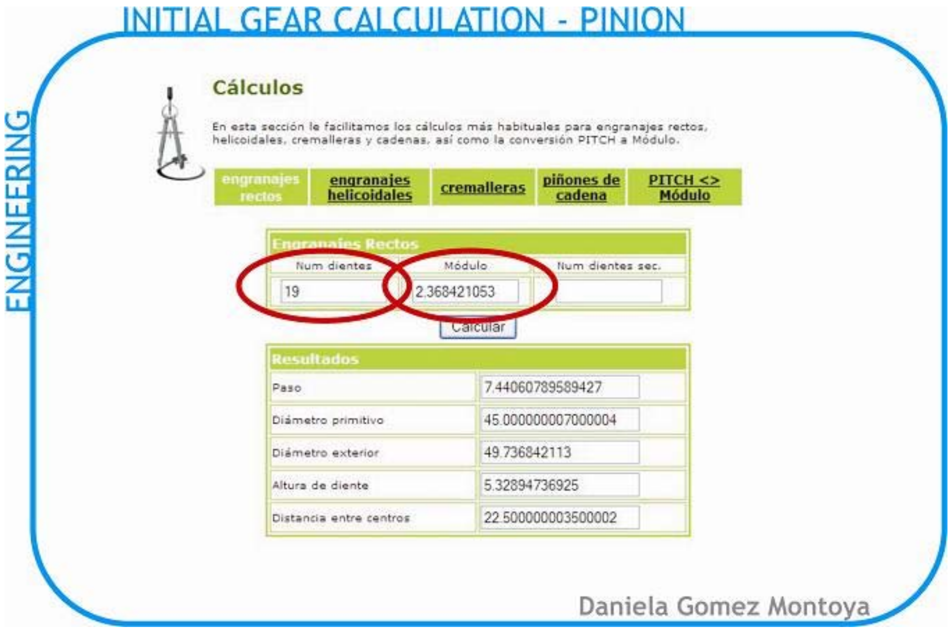
Figure 15: Initial Gear Calculation - GEAR



ENGRANAJES MIRALLES

For the pinion we have:

Figure 16: Initial Gear Calculation - PINION



ENGRANAJES MIRALLES

The previous figures are useful, as well, to validate the equations. Note that the primitive diameters for the gear and the pinion correspond with the initial ones proposed: 90 mm and 45 mm respectively. Now checking with the catalogue and the standard references, the producer has some of the M normalized, so the closest to our M's value is: 2 mm[10].

[10]ENGRANAJES MIRALLES. Gears with M= 2 mm
http://www.engranajesmiralles.com/Catalogo/CATALOGO%20%20PAG.%203%20DCR.%20M-2.pdf

Figure 17: Gears with M=2 mm

ENGRANAJES MIRALLES

According to the catalogue, the final dimension for the gear and pinion are:

GEAR:

Z1 = 40 **Dp1** = 80 mm **De1** = 84 mm **Daxis1** = 14 mm

PINION:

Z2 = 20 **Dp2** = 40 mm **De2** = 44 mm **Daxis2** = 10 mm

P= π x M **P=** π x 2,3684 P= 7,44 mm

CD= (Dp1 +Dp2) /2 **CD** = (80 mm +40 mm)/2 **CD=60 mm**

Tooth's Foot = 1,25 x M = 1,25 x 2,3684 mm = 2,96 mm

Tooths' Head = M = 2,3684 mm

Finally, it is important to know the lineal speed of the matrix of the mold that pass through the rollers as follow:

The gear speed is: 30 rpm

Converting this value to Angular Speed, rad/s we have:

30 rpm x (2π rad/s)/60 rpm = **3,14 rad/s**

The value of the Angular Speed multiplied by the radius of the roller is the Lineal Speed of the matrix:

3,14 rad/s x (60,5 mm / 2) = $\boxed{\textbf{95 mm/s}}$

1.6 Power Screw Validation

The Power Screws are highly used to transfer or transmit movement in a soft and uniform way. They can transform rotary in lineal movement. The difference with normal screws is that the Power Screws are movement devices, and the others are normally used to join parts. In this case, the Power Screws (2) are going to be used to adjust the superior roller, against the matrix, in order to guarantee the force to be applied to make the cutting or embossing.

1.6.1 Design of Compression Members: "Column" of the Power Screw

Problem definition

This analysis is made to check load machinery elements exposed to a compression load. This is important as the length of the proposed power screw (3/4 – 6 Acme – 2G) is big compare with his diameter, so its resistance needs to be validate, in case of an overload situation.

Existing conditions

All the elements estimated to be used in this design, are in good conditions.

Post Analysis

To define the element condition to be analysed, the book *"DESIGN OF WELDED STRUCTURES"* was used as a source of information for the analysis of the column of the Power Screw. The objective of this analysis is to define the

Critical Load value, in order to know if the system load is lower to the load that the column of the power screw (its length in relation to its diameter) can support before deflection. The system load for each screw is **8331,5 N.**

Power Screw Analysis

As it was mentioned before, the proposed Screw to validate is: 3/4 – 6 Acme – 2G [11]**.** There are two different equations to use for this analysis:

EULER EQUATION

P_{cr} = (S_y A r^2)/Q

J.B JHONSON EQUATION

P_{cr} = A S_y (1 – (Q/(4 r^2)

Where: **Q= (S_y L^2) / (n π^2 E)**

P_{cr} = Critical Load

D= Diameter of the transversal section = **16,93 mm = 0,01693 m**

A = Area of the transversal section = **225 mm^2 =0,000225 m^2**

S_y = Tensile Strength yield = **205000000 Pa**

r = Minimum turning radius of the transversal section = 16,93 mm/4 =

4,23 mm = 0,00423 m

E = Modulus of elasticity = 200 Gpa = **200 x 10^9 Pa**

L= Column Length= **74,5 mm = 0,0745**

n = Coefficient of the ends conditions: one end fixed and the other free, but guided = **2**[12]

In order to define which one of the two equations can be applied to the situation, it is necessary to find the value of **Q/r^2.** If this value is higher than

[11] Table 15-1 from the reference book for the Power Screw Analysis.
[12] Pre- fixed value. MANUAL UNIVERSAL DE LA TECNICA MECANICA, Volume 1.

2, the **EULER** equation should be used. If the value is lower than 2, the **J.B JHONSON** equation should be used.

$$Q/r^2 = ((S_y\ L^2) / (n\ \ \pi^2\ \ E)) / r^2$$

$$Q/r^2 = ((205000000\ Pa \times 0{,}0745^2)/(2 \times \pi^2 \times 200 \times 10^9\ Pa)) / 0{,}00423^2)$$

$$Q/r^2 = 0{,}01610$$

As 0,01610 < 2 the we need to used the **J.B JHONSON equation**:

$$P_{cr} = A\ S_y\ (1 - (Q/(4\ r^2)$$

$$P_{cr} = (0{,}000225 \times 205000000)\ (1-(0{,}0288 \times 10^{-9}/4 \times 0{,}00423^2)$$

$$\boxed{P_{cr} = 45939{,}26\ N}$$

Knowing the Critical Load that the Power Screw of 3/14" can support, the Security Factor can be found as follow:

$$45939{,}26\ N / 8331{,}5\ N = 5{,}51 \longrightarrow \quad \textbf{GOOD!}$$

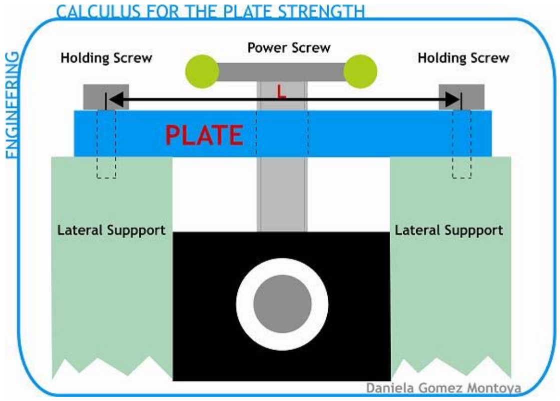
As a conclusion, the Power Screw's specifications are very good defined, according to the system conditions.

1.6.2 Hand force Validation

Problem definition

The proposed Power Screw to use, according to the geometry of the product and its function is a **3/4 - 6 Acme - 2G.** The **Figure 18** shows a diagram of the use situation for the Power Screw. The idea is to allow the movement of the superior roller and adjust it against the matrix giving it pressure to guarantee the cutting and embossing process. This analysis will let us know if the force that the operator need to apply to power screw is suitable according to ergonomic parameters and it will define the dimension of the lever to operate the screw.

Figure 18: Power Screw System



Own Elaboration

Existing conditions

All the elements estimated to be used in this design, are in good conditions.

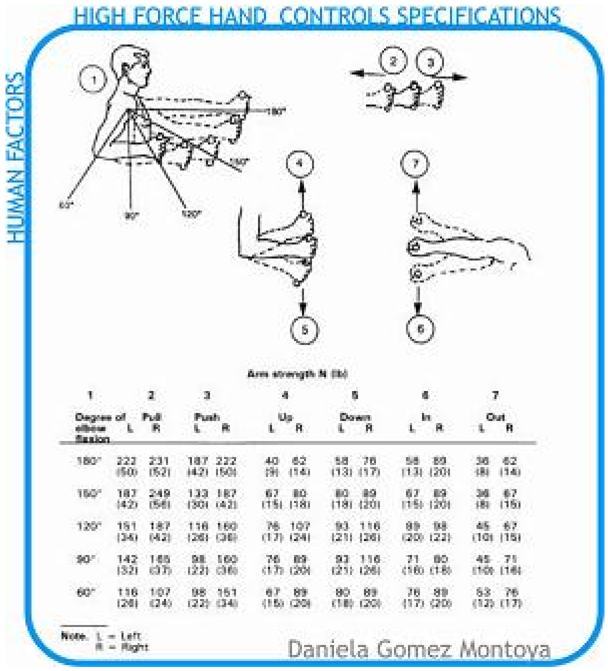
Post Analysis

To define the element condition to be analysed, the book *"DISEÑO DE MÁQUINAS, TEORÍA Y PRÁCTICA"*[13] was used as a source of information for the analysis of Power Screw.

The objective of this analysis is to define the force required to operate and move the Power Screw, taking as a reference the Anthropometric Value presented on the next figure, which shows the **maximum force that can be apply by a human hand: 222 N** for the right hand. The idea is to find a lower value, defining the correct dimension for the lever's radius.

[13] DEUTSCHMAN, Aron. MICHELS, Walter. WILSON, Charles. DISEÑO DE MÁQUINAS, Teoría y Práctica. Compañía Editorial Continental, Mexico. Sixth Edition. 1995 CHAPTER 15.

Figure 19: High Force of the Hand



(Wagner, 1996)

- *Power Screw Analysis*

As it was mentioned before, the proposed Screw to validate is: **3/4 - 6 Acme - 2G.**

α= Screw angle = 4.33°

β= 14,5°

φ= Friction angle = Tan φ= $(\mu/(\text{Cos}\beta/2))$

Φ_{Max}= Biggest Screw's diameter = 0,75 Inch

Φ_{Min}= Smallest Screw's diameter = 0,5833 Inch

F= System Force = 8331,5 N

R= Medium Thread Radius = $(\Phi_{Max} - \Phi_{min})/2 + (\Phi_{min}/2)$

μ =Friction Coefficient = 0,15 [14]

M= Momentum

$$\boxed{M = F \times R \times \operatorname{Tan}(\alpha + \varphi)}$$ Where:

$$\operatorname{Tan} \varphi = (\mu / (\operatorname{Cos} \beta/2)) = (0{,}15 / (\operatorname{Cos} 14{,}5^\circ/2)$$

$$\varphi = \mathbf{19{,}01^\circ}$$

$$R = (\Phi_{Max} - \Phi_{min})/2 + (\Phi_{min}/2) = (0{,}75 - 0{,}5833)/2 + (0{,}5833/2) \text{ Inch}$$

$$R = 0{,}0727 \text{ Inch} \times 25{,}4 \text{ mm} = 1{,}847\text{mm} = \mathbf{1{,}847 \times 10^{-3}\ m}$$

$$M = 8331{,}5 \text{ N} \times 1{,}847 \times 10^{-3} \text{ m} \times \operatorname{Tan}(4{,}33^\circ + 19{,}01^\circ)$$

$$\boxed{M = 5{,}91 \text{ Nm}}$$

Once it is known the value for the momentum, it is possible to know the hand's force to operate the Power Screw, with the following relation:

F = M/Y

Where **Y=** is the lever's radius, **F=** the resulting force and **M=** Momentum.

If **Y=** 0,10 m, **F=** 5,91 Nm / 0,10 m = 59,1 N = GOOD!

If **Y=** 0,15 m, **F=** 5,91 Nm / 0,15 m = 39,4 N = VERY GOOD!

Due to the previous two analyses it is confirm that the proposed Power Screw is more than suitable for the function and performance of the product and it is in accordance with the design and geometry.

---

[14] The Friction coefficient is a value according to the screw's material: Steel. The book shows a table (15,4) where the coefficient for this material is 0,15.

1.7 Definition of the holding screws to join the plate of the Power Screws to the lateral supports.

In order to know if the proposed screws to hold the plate to the lateral supports, are strong enough, the following calculation is necessary, to know the value of the "*Security Factor*"[15] and prove that the calculation is correctly and secure to be trusted.

Problem definition

The failure criteria used in this case to define the specifications to select the screws is basically "Pure Tensile Strength". This selection was made using the book "*DISEÑO EN INGENIERÍA MECÁNICA*"[16]. The criteria for conclusion will be the security factor result. The Reaction value of the system (R) is **8331,5 N**; Minimum Tensile Strength Limit = **380 MPa**; Area of the minimum Diameter = **52,3 mm^2**.

According to product's geometry it is proposed to use a screw aesthetically accorded with the following characteristics, for the joining of the plate to the lateral supports:

Metric system screw: M10 – 5,8 class of property[17]

The analysis to check its strength for the use is presented as follows.

Added to the analysis of the previous proposed screw, you will find afterwards, some more types of screws (in denomination or material) analysed, in order to make a comparison and have options to choose.

Existing conditions

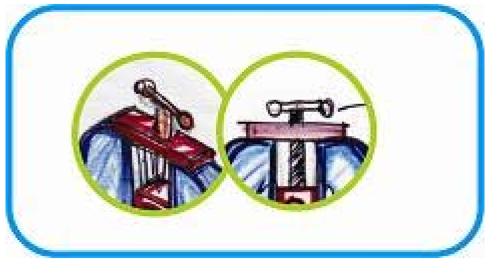
All the elements estimated to be used in this design, are in good conditions.

[15] The Security Factor is a value used in engineering calculations to guarantee the performance of the element being tested. The result of the calculus is multiplied by this value to assure that it is being considered in higher risk level.

[16] SHIGLEY, Joseph Edward. DISEÑO EN INGENIERÍA MECÁNICA. Mc Graw Hill. Fifth Edition

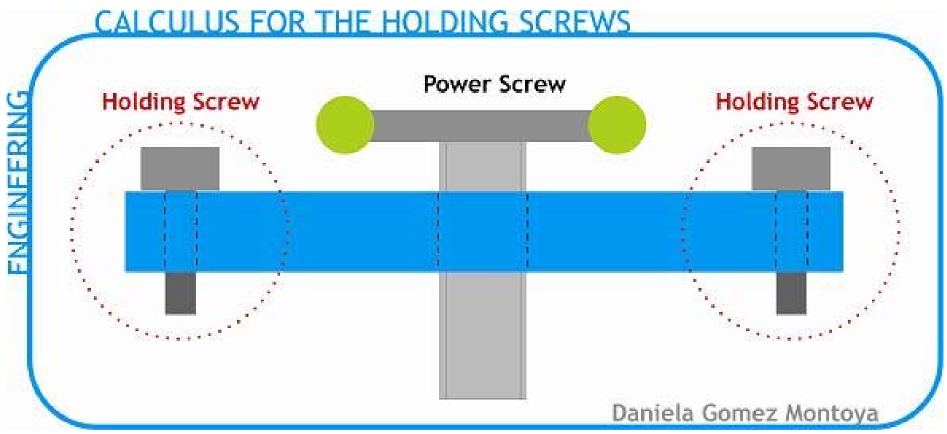
[17] Medium Steel, low Carbon.

Figure 20: Plate for the power screw.



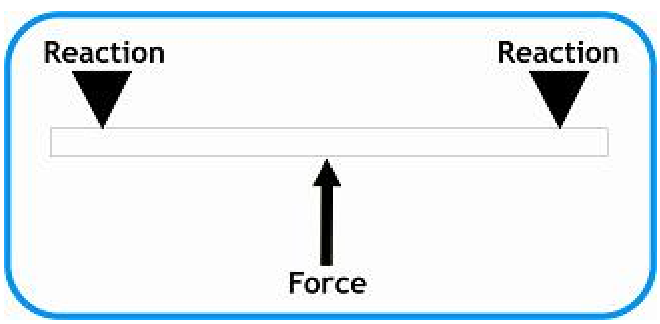
Own Elaboration

Figure 21: Calculus for the Holding Screws.



Own Elaboration

Figure 22: Diagram of the beam load, according to the case



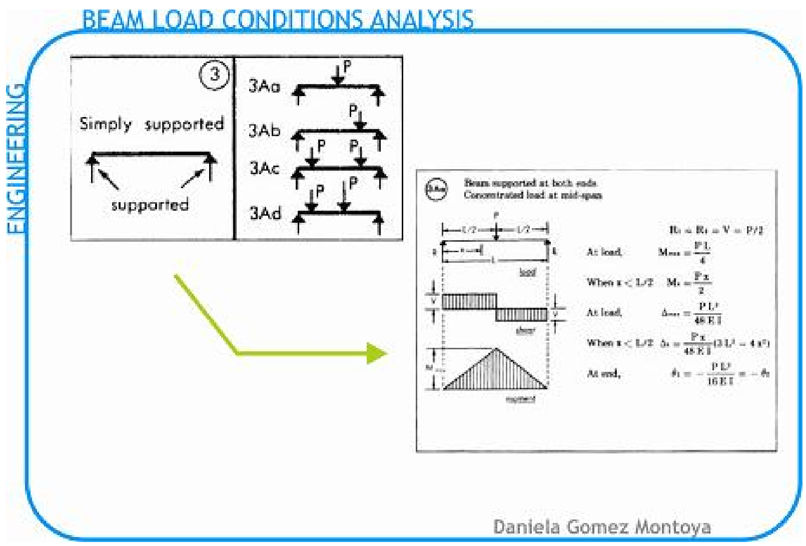
Own Elaboration

Post Analysis

To define the element condition to be analysed, the book *"DESIGN OF STRUCTURES WELDED"* was used as a source of information for the analysis of the beam that represents the situation: **"3Aa": Beam supported at both ends.**

Concentrated load at mid-span. The equations and calculations for this kind of beam and its load distribution and geometry are shown in **Figure 23.**
For the Security Factor analysis, it is important to check the properties of the proposed screw, but also there are going to be analysed another two options: the previous and the next denomination to the proposed: M10 – 5,8 class.

Figure 23: Beam 3Aa equations



BLODGETT,2002

- *Security Factor Analysis Proposed screw 1:* **Metric system screw: M10 – 5,8 class of property**[18]

Based on the beam load condition model presented on the previous section, the following analysis is done:

Rb = Reaction of the plate
R= System - reaction = 8331,5 N
TR[19] = Minimum Tensile Strength Limit = 380 MPa
A[20] = Area of the Minimum Diameter = 52,3 mm^2 = 0,0000523 m^2

[18] Medium Steel, low Carbon.
[19] Property of the screw M10, class 5,8. DISENO EN INGENIERIA MECANICA. Pag. 388
[20]Property of the screw M10. DISENO EN INGENIERIA MECANICA. Pag. 369

N= Security factor = ???

G= Effort

Rb = R/2 **Rb** = 8331,5 N/2 $\boxed{\textbf{Rb = 4165,75 N}}$

G= F/A **G** = Rb/A **G=** 4165,75 N / 0,0000523 m^2 **G** = 79651051,63 Pa

$\boxed{\textbf{G= 79,65 Mpa < 380 Mpa}}$

N= 380 Mpa / 79,65 Mpa $\boxed{\textbf{N = 4,77 GOOD!!!}}$

- *Security Factor Analysis Proposed screw 1:* **Metric system screw: M8 - 5,8 class of property**[21]

Based on the beam load condition model presented on the previous section, the following analysis is done:

Rb = Reaction of the plate

R= System - reaction = 8331,5 N

TR[22] = Minimum Tensile Strength Limit = 380 MPa

A[23] = Area of the Minimum Diameter = 32,8 mm^2 = 0,0000328 m^2

N= Security factor = ???

G= Effort

Rb = R/2 **Rb** = 8331,5 N/2 $\boxed{\textbf{Rb = 4165,75 N}}$

G= F/A **G** = Rb/A **G=** 4165,75 N / 0,0000328 m^2 **G** = 127004573,32 Pa

$\boxed{\textbf{G= 127 Mpa < 380 Mpa}}$

[21] Medium Steel, low Carbon.

[22] Property of the screw M10, class 5,8. DISENO EN INGENIERIA MECANICA. Pag. 388

[23] Property of the screw M10. DISENO EN INGENIERIA MECANICA. Pag. 369

N= 380 Mpa / 127 Mpa $\boxed{\textbf{N = 2,99 \quad GOOD!!!}}$

- *Security Factor Analysis Proposed screw 1:* **Metric system screw: M12 - 5,8 class of property**[24]

Based on the beam load condition model presented on the previous section, the following analysis is done:

Rb = Reaction of the plate

R= System - reaction = 8331,5 N

TR[25] = Minimum Tensile Strength Limit = 380 MPa

A[26] = Area of the Minimum Diameter = 76,3 mm^2 = 0,0000763 m^2

N= Security factor = ???

G= Effort

Rb = R/2 **Rb** = 8331,5 N/2 $\boxed{\textbf{Rb = 4165,75 N}}$

G= F/A **G** = Rb/A **G=** 4165,75 N / 0,0000763 m^2 **G** = 54596985,58 Pa

$\boxed{\textbf{G= 54,59 Mpa < 380 Mpa}}$

N= 380 Mpa / 54,59 Mpa $\boxed{\textbf{N = 6,96 \quad GOOD!!!}}$

As a conclusion, any of three proposed screws or their equivalent in ANSI or any other standard system, are good for the proposed use.

Screws **Class of property 4,6** where Minimum Tensile Strength Limit (TR) is 225 MPa or **Class of property 4,8** where Minimum Tensile Strength Limit (TR) is 310

---

[24] Medium Steel, low Carbon.
[25] Property of the screw M10, class 5,8. DISENO EN INGENIERIA MECANICA. Pag. 388
[26] Property of the screw M10. DISENO EN INGENIERIA MECANICA. Pag. 369

MPa, are good for the proposed use based on the results of the previous analysis where we used M8, M10 and M12 screws. The following Classes are ok as well, as their TR is higher.

1.8 Spring Validation

Problem definition

The function of the springs located on the plate that supports the Power Screw, is to control the pressure apply to the roller through the Power Screw, in order to protect the system of an overload and damage. The calculation or validation is based on the deformation that the springs can support with the system load.

Existing conditions

All the elements estimated to be used in this design, are in good conditions.

Post Analysis

To define the element condition to be analysed, the book of OBERG, E. was used as a source of information. The units for this analysis are inches, Lb and PSI. The proposed spring to be validated is a Die-set spring, with rectangular section, pitch of 6.35 mm. The equation and calculations for the deformation for a specified load **P** are:

$$\mathbf{f=}\ 7{,}2\ \pi\ r^3\ P\ (b^2 + h^2) / b^3\ h^3\ G$$

The value of **P** is considered with an addition of a 10% more, as a security factor.

Deformation Analysis

P= Specified Load = 4582, 325 N = 1028, 68 Lb

f= Deformation for an specific Load (P)

G= Modulus of rigidity = 200 Gpa = 29007547,546 PSI

b= Biggest dimension of the rectangular transversal section of the spring.

b= 4,76 mm = 0,187 Inches

h= Smallest dimension of the rectangular transversal section of the spring.

h= 3,175 mm = 0,125 Inches

r= Radius of the spring (Primitive) = 9,5875 mm = 0,377 Inches

f= 7,2 π r^3 P (b^2 + h^2)/ b^3 h^3 G

f=(7,2 x π X 0,377^3 x 1028, 68 (0,187^2 + 0,125^2))**/**

0,187^3 x 0,125^3 x 29007547,546

f= 0,170 Inches = 4,325 mm = GOOD!

The geometry and specification of the proposed spring are OK for the purpose of use.

1.9 Determination of Bearings for the main roller

Considering the height graduation of the roller, with a power screw at both ends, the bearings used need to allow a movement not-aligned while the roller is being adjusted. For this purpose the kind of bearing selected, according to SKF's catalogue[27] (one of the biggest bearing producers in the world) was: Self – Aligning Ball Bearings. The self-aligning ball bearing was invented by SKF. It has two rows of balls and a common concave sphered raceway in the outer ring. The bearing is consequently self-aligning and insensitive to angular misalignments of the shaft relative to the housing. It is particularly suitable for applications where considerable shaft deflections or misalignment are to be expected. Additionally, the self-aligning ball bearing has the lowest friction of all rolling bearings, which enables it to run cooler even at high speeds.[28]

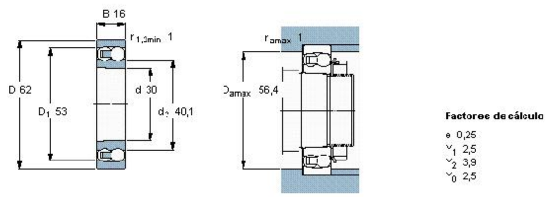
[27] SKF. Self-Aligning ball bearings. [Internet article]. http://www.skf.com/portal/skf/home/products?maincatalogue=1&lang=en&newlink=1_2_2 [February 20th 2008].
[28] Ibid. SKF.

From this category, the bearing was selected from the "Basic Design" reference 1206 ETN9, as follow:

Figure 24: Self-Aligning ball bearing. 1206

Rodamientos de bolas a rótula, agujero cilíndrico y cónico

Dimensiones principales			± dinámica	estática	Carga límite de fatiga	Velocidades Velocidad de referencia	Velocidad límite	Masa	Designación
d	D	B	C	C_0	P_u				
mm			kN		kN	rpm		kg	-
30	62	16	15,6	4,65	0,24	24000	15000	0,22	1206 EKTN9



Agujero cónico, coricidad 1: 12

This specified reference of bearing can support 15,6 KN by itself[29], even though there are going to be used one bearing at each end of the roller. It means that the load will be shared by both. It is important to remember that the system load for each end is 8.3315 KN (previously calculated), which means that the proposed bearings are ok for the design.

[29] During the last section the maximum load was defined by tests of paper shear strength as almost 17 KN.

ANNEX No. 11 Product's 3D Modelation

This section contains the CAD 3D modelation of the product: Parts, Sub-Assemblies, Final Assembly. For this purpose the software used was PRO-ENGINEER.

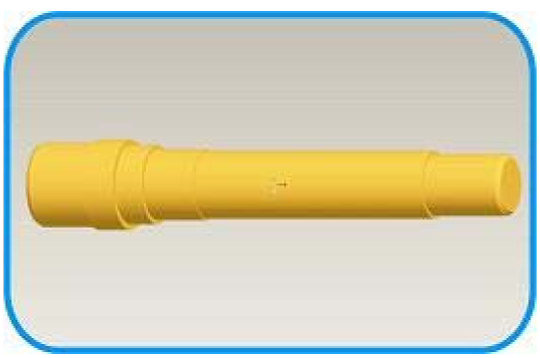
1. Main Roller

Figure 1: Roller

Own Elaboration

2. Superior Roller's shaft

Figure 2: Shaft of the superior Roller

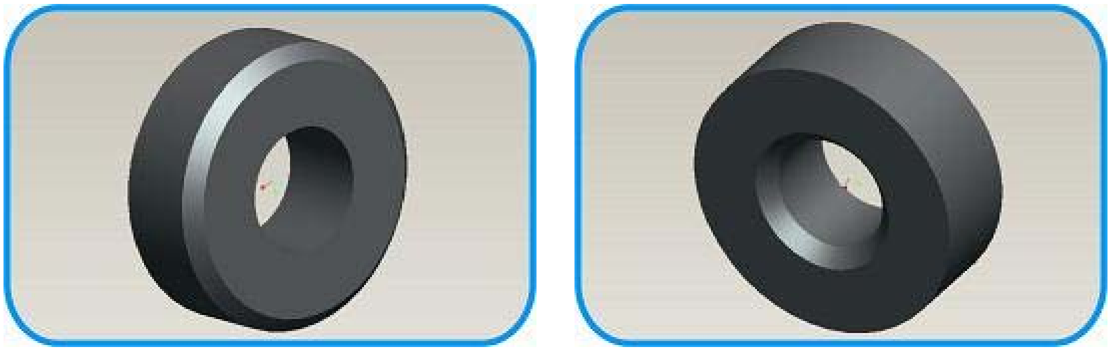


Own Elaboration

3. Washers 1 and 2

The washers are located inside the Roller to support the shaft and to give stiffness to the roller in order to avoid deflection.

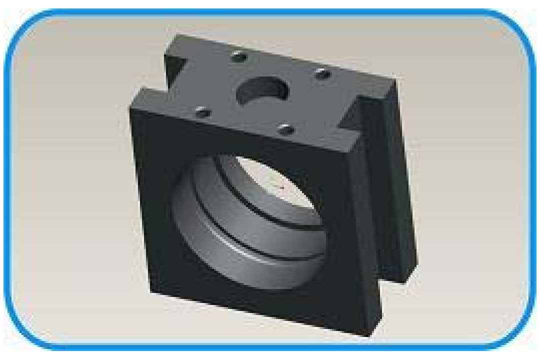
Figure 3: Roller 3D - Washers



Own Elaboration

4. Bearing's Support (superior)

Figure 3: Superior bearing's Support

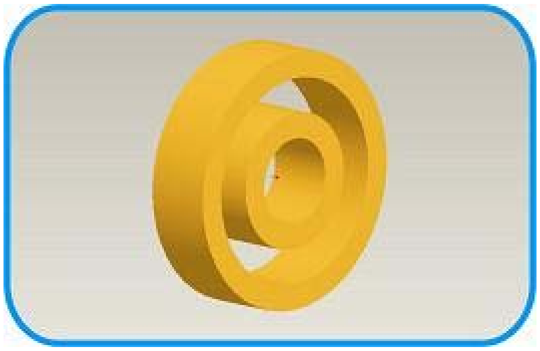
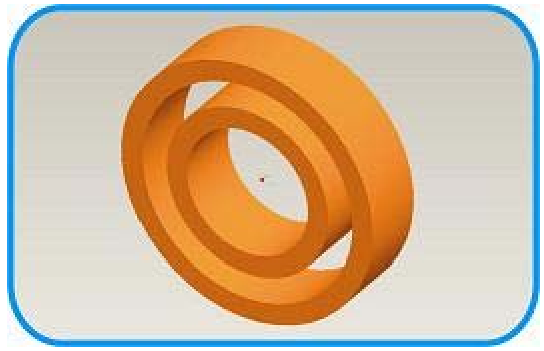


Own Elaboration

5. Bearings

As it is explained in the final Report, the Bearings are from the world producer SKF. There are three different kind of bearings: "Self – Aligning ball Bearings" reference 1206 and the other two are basic rigid Bearings.

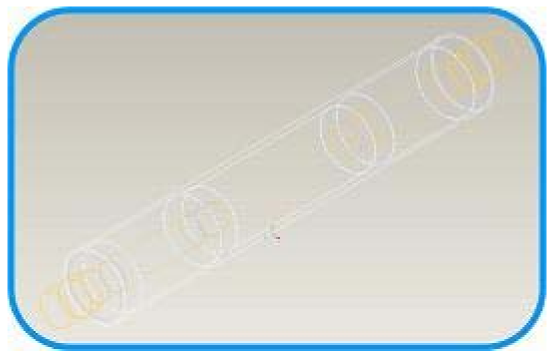
Figure 4: Bearings

Own Elaboration

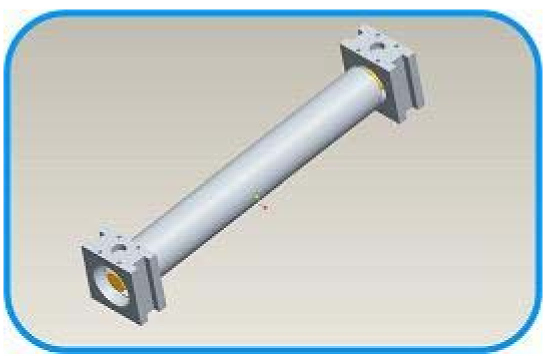
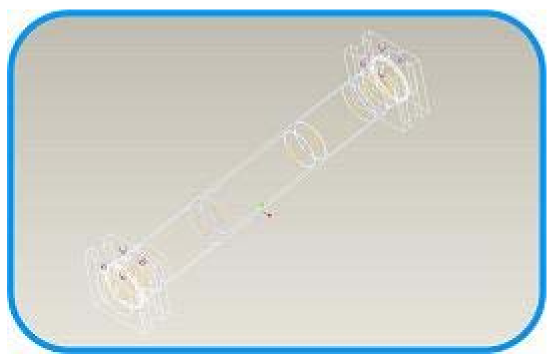
6. Sub - Assembly Superior Roller

Figure 5: Sub-Assembly Superior Roller

Own Elaboration

Figure 6: Sub-Assembly Superior Roller 2

Own Elaboration

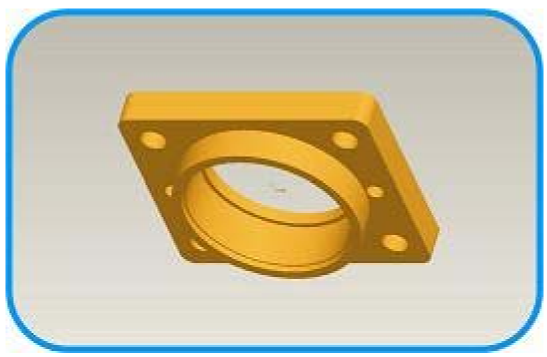
7. Inferior Roller's Shaft

Figure 7: Shaft of the Inferior Roller

Own Elaboration

8. Inferior Roller's Shaft

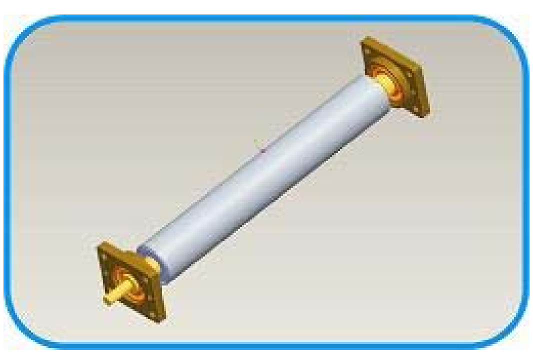
Figure 8: Inferior Die

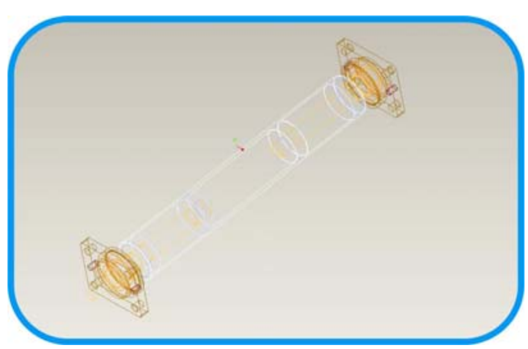


Own Elaboration

9. Sub – Assembly Superior Roller

Figure 9: Sub-Assembly Inferior Roller 2





Own Elaboration

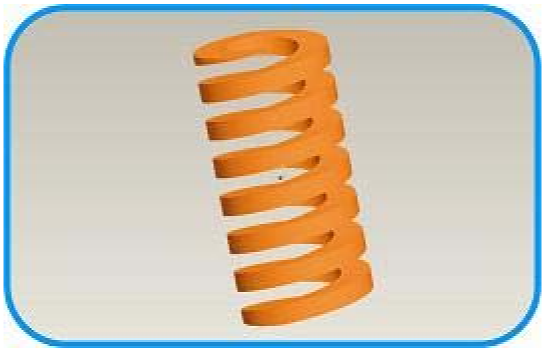
10. Lever of the Power Screw

Figure 10: Lever of the Power Screw

Own Elaboration

11. Spring of the Power Screw

Figure 11: Spring of the Power Screw



Own Elaboration

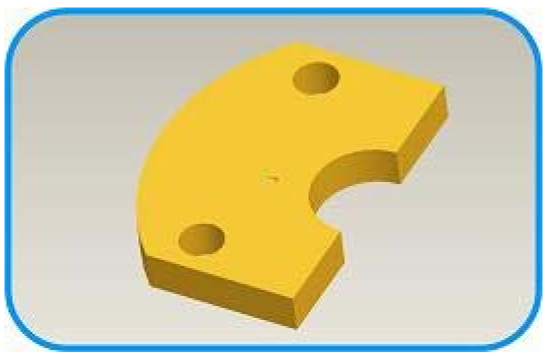
12. Power Screw

Figure 12: Power Screw

Own Elaboration

13. Plate to support the Power Screw

Figure 13: Plate to support the Power Screw



Own Elaboration

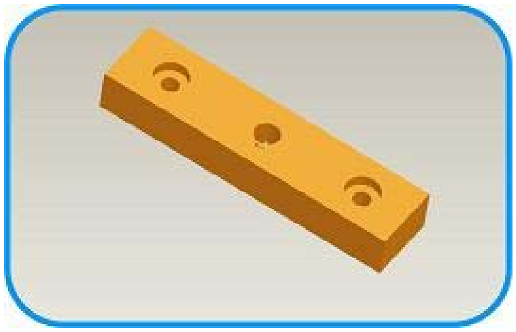
14. Screw of the Spring

Figure 14: Screw of the spring

Own Elaboration

15. Plate of the Power Screw

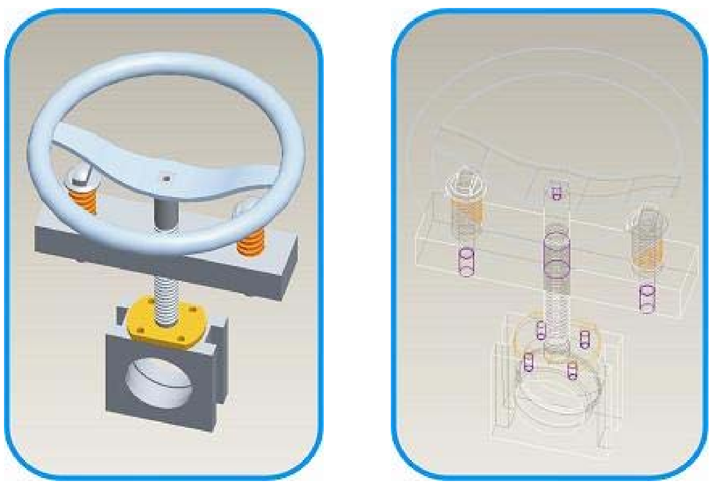
Figure 15: Plate of the Power Screw



Own Elaboration

16. Sub-Assembly of the Power Screw

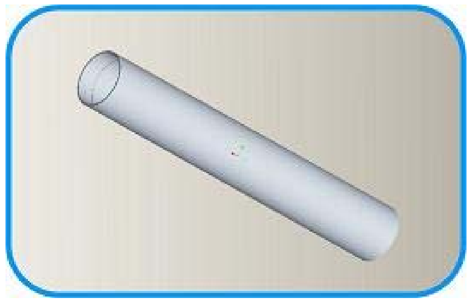
Figure 16: Sub-Assembly of the Power Screw



Own Elaboration

17. Small Inferior Roller

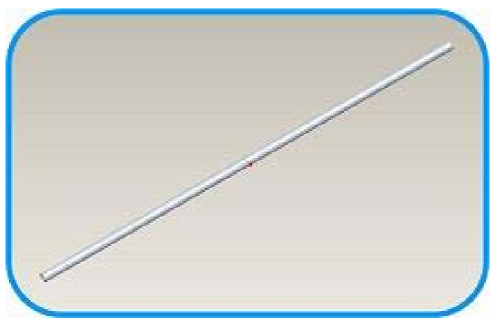
Figure 17: Small Inferior Roller



Own Elaboration

18. Small Inferior Roller's Shaft

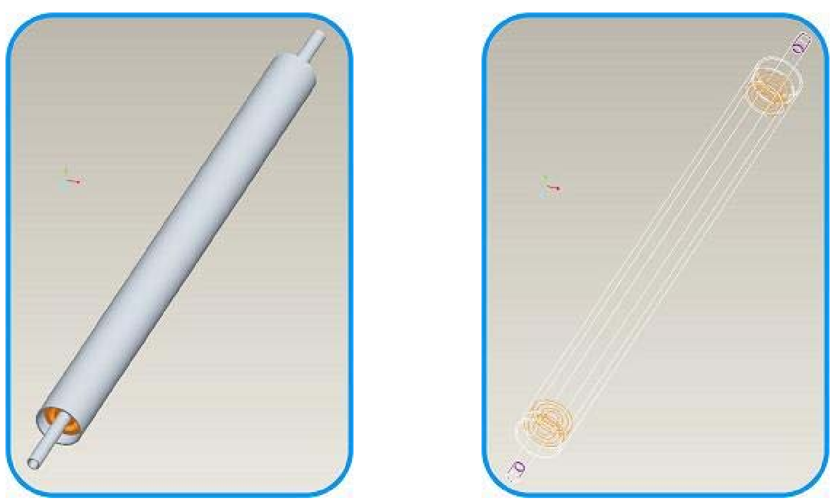
Figure 18: Small Inferior Roller's Shaft



Own Elaboration

19. Sub-Assembly of the Small Inferior Rollers

Figure 19: Sub-Assembly of the Small Inferior Rollers



Own Elaboration

20. Lateral Support

Figure 20: Lateral Support

Own Elaboration

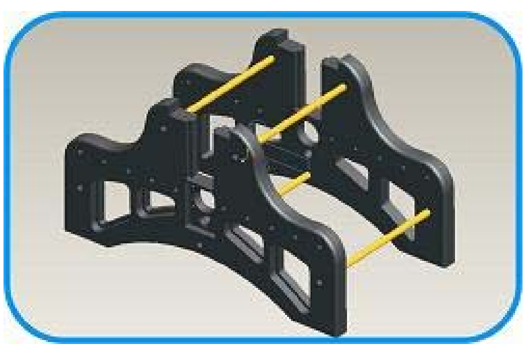
21. Separator - Holder of the Lateral Support

Figure 21: Separator-Holder of the Lateral Support

Own Elaboration

22. Sub-Assembly of the Lateral Support (Separators)

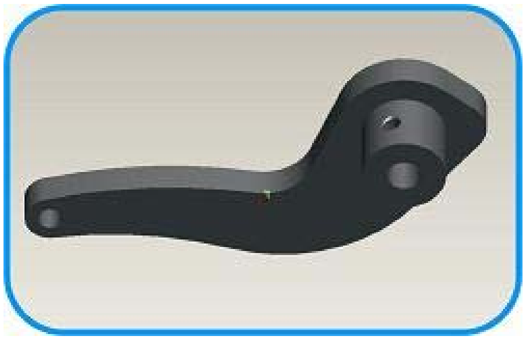
Figure 22: Sub-Assembly of the Lateral Support (Separators)



Own Elaboration

23. Connecting Rod

Figure 23: Connecting Rod



Own Elaboration

24. Handle

Figure 24: Handle

Own Elaboration

25. Gear

Figure 25: Gear

Own Elaboration

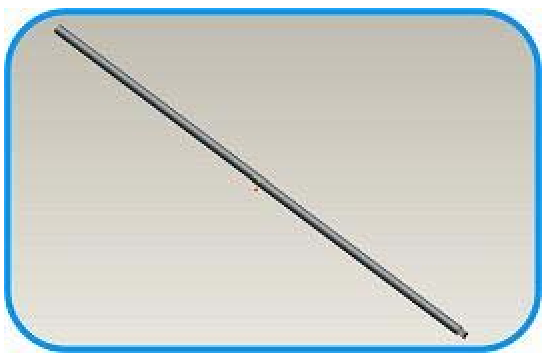
26. Pinion

Figure 26: Pinion

Own Elaboration

27. Pinion's Shaft

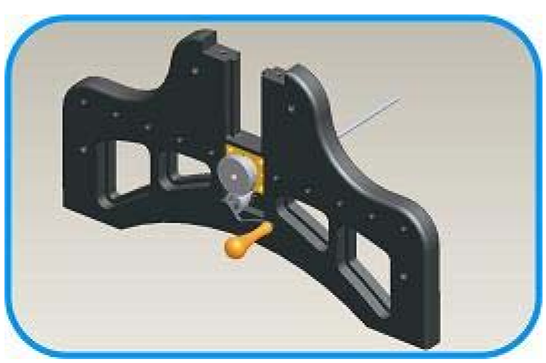
Figure 27: Pinion's Shaft



Own Elaboration

28. Sub-Assembly of the Crank

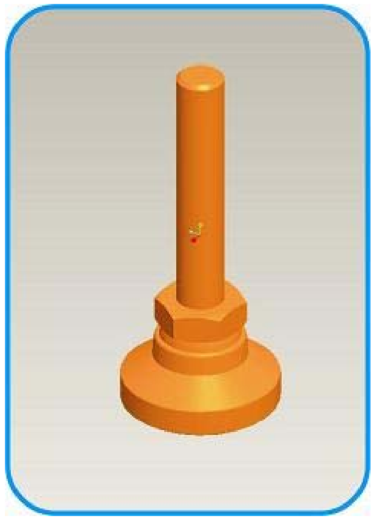
Figure 28: Sub-Assembly of the Crank



Own Elaboration

29. Level

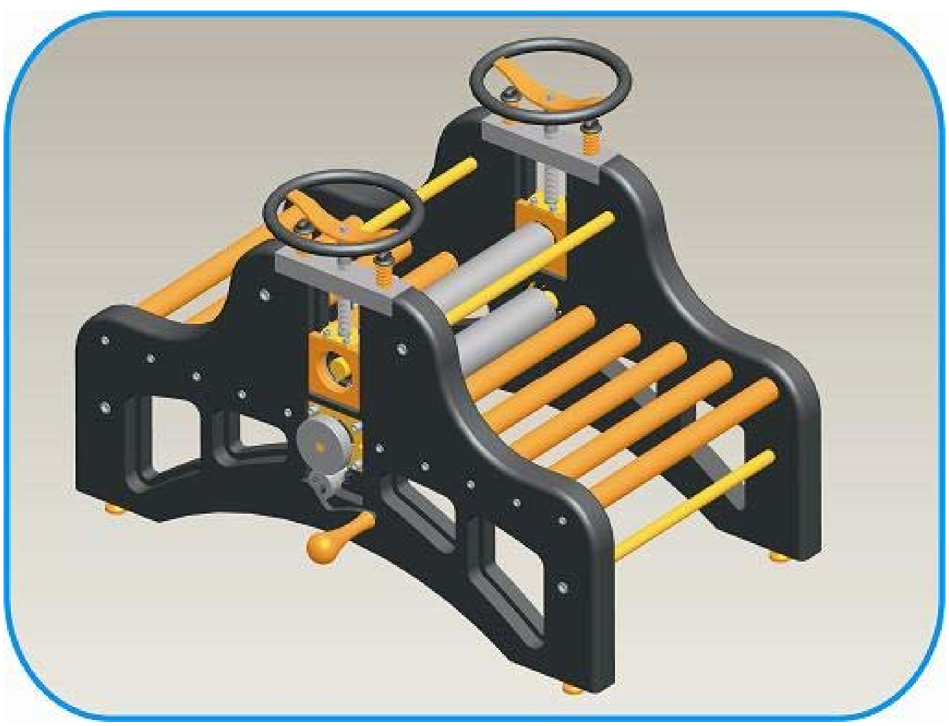
Figure 29: Sub-Assembly of the Crank



Own Elaboration

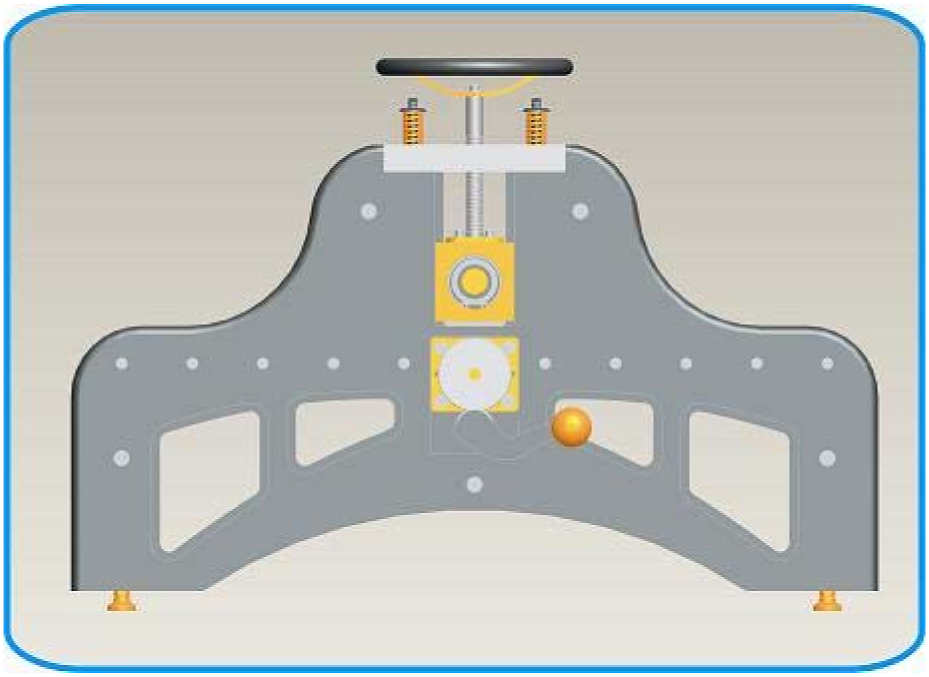
30. FINAL ASSEMBLY

Figure 30: Final Modelation Isometric



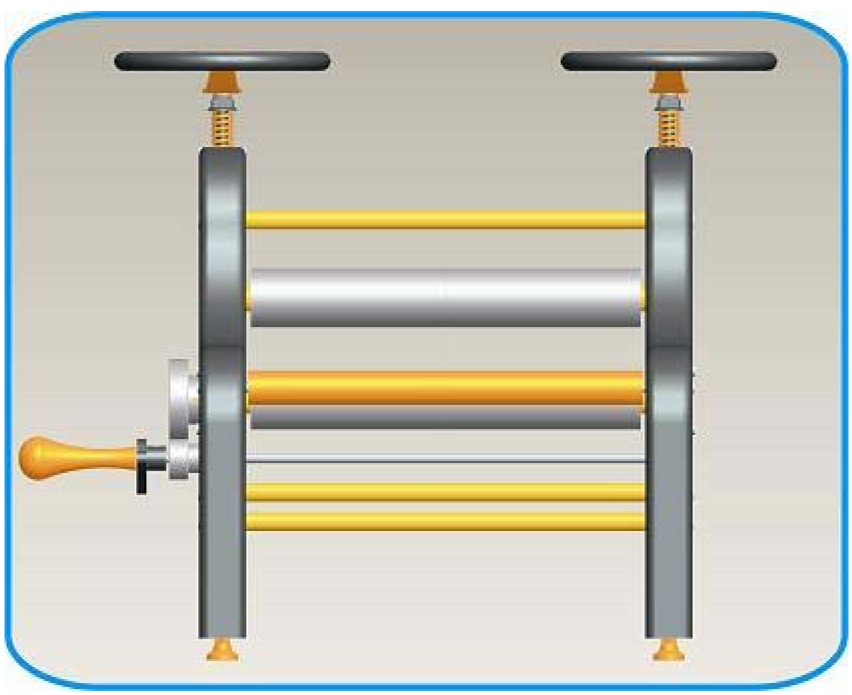
Own Elaboration

Figure 31: Final Modelation Frontal View



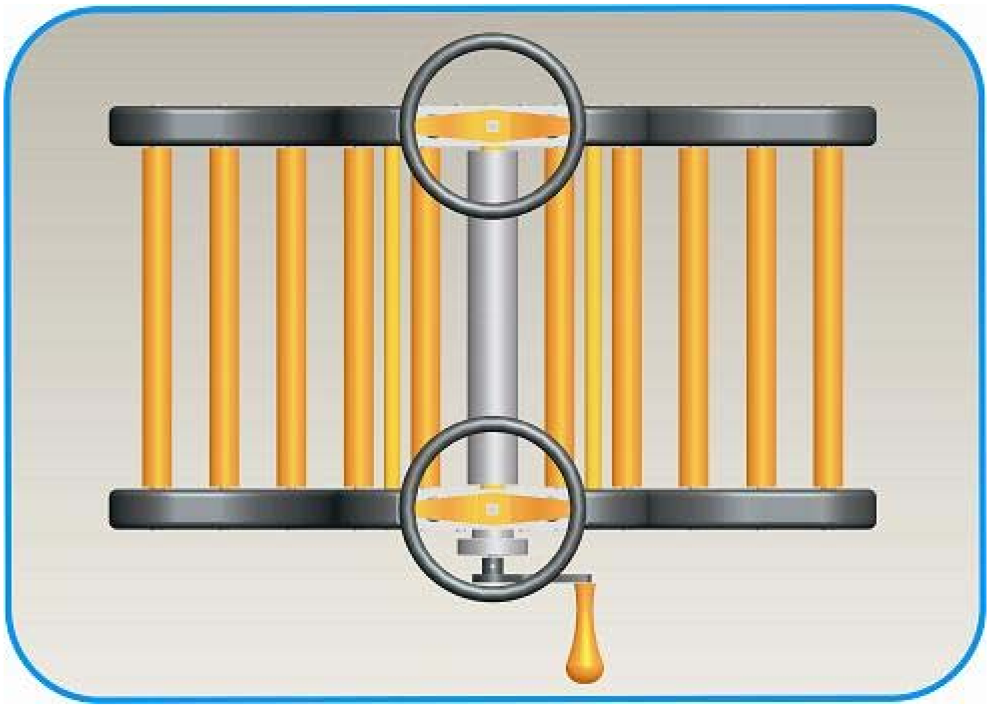
Own Elaboration

Figure 32: Final Modelation Lateral View



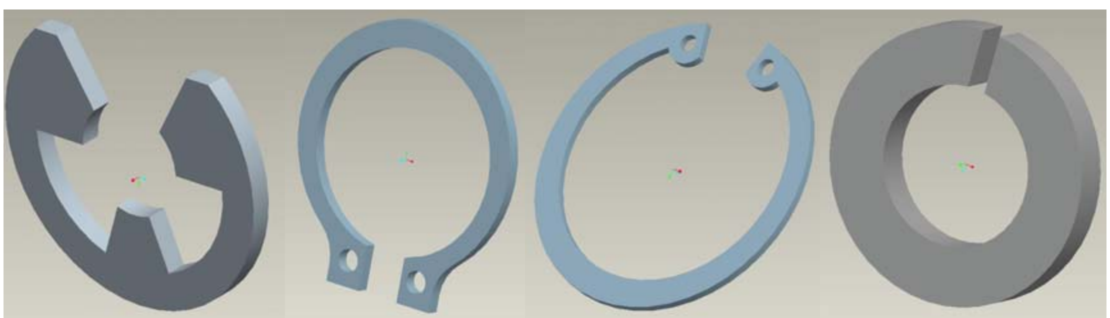
Own Elaboration

Figure 33: Final Modelation Top View



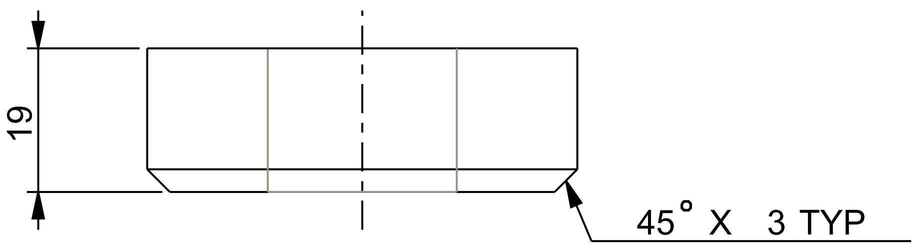
Own Elaboration

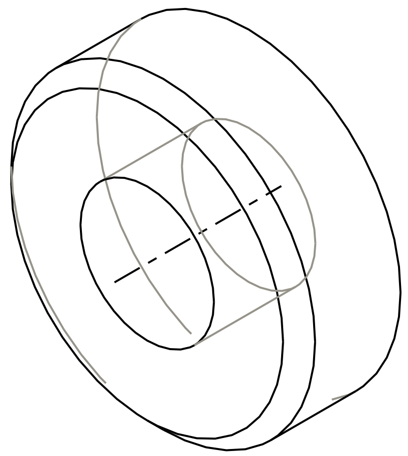
31. Other Components

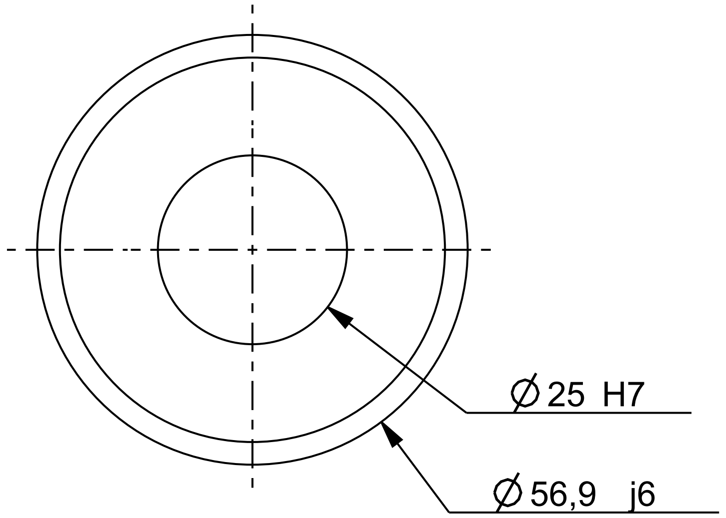


Daniela Gomez Montoya

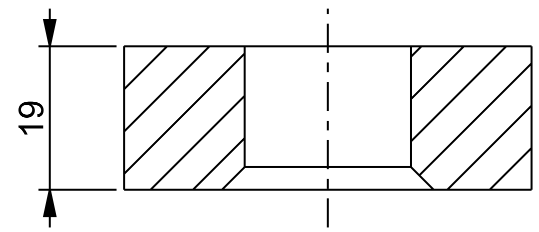
DRAWING NÂº1:
PRT-001-1&2



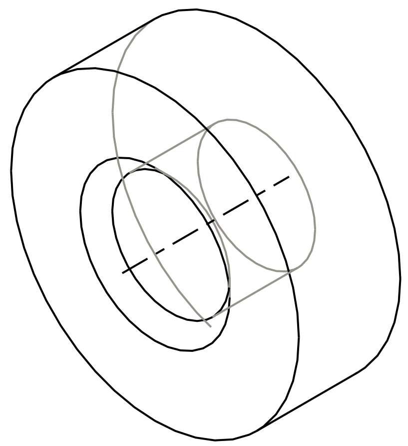




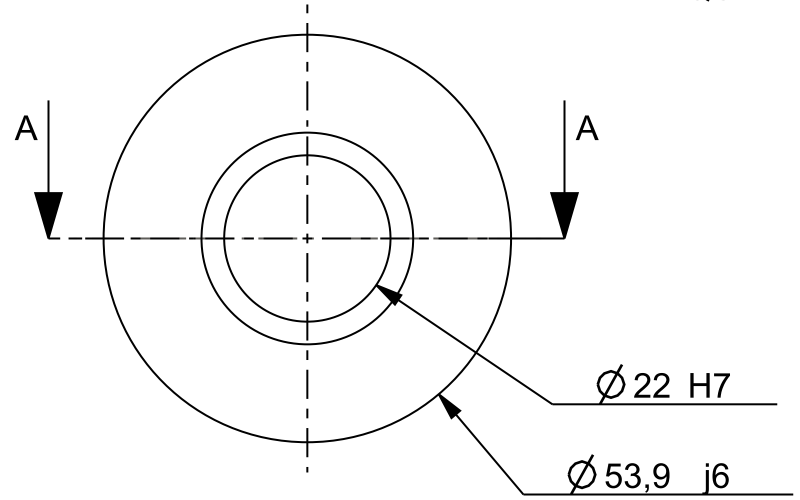
PART: DISC-1
PART NUMBER: 1
MATERIAL: AISI/SAE 1020
QUANTITY: 4 UNT



SECTION A-A



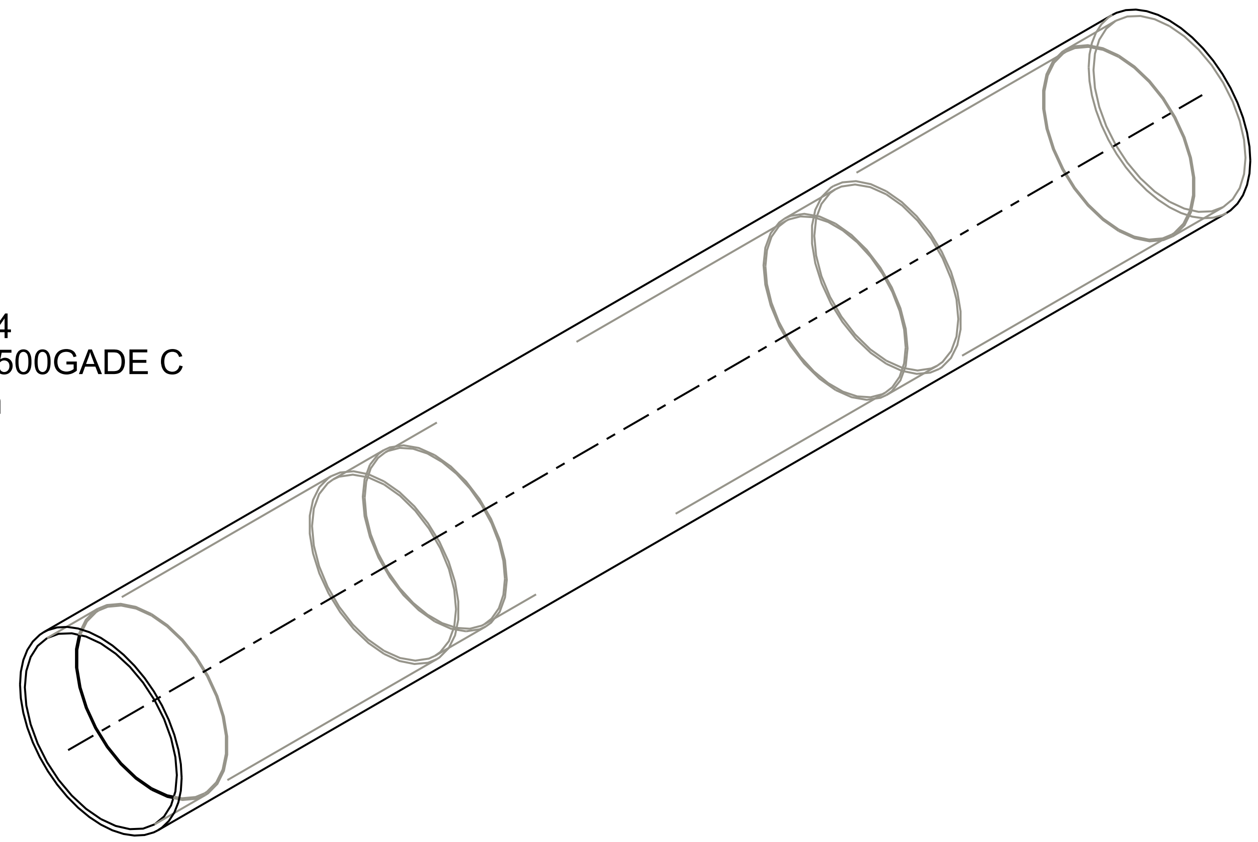
PART: DISC-2
PART NUMBER: 2
MATERIAL: AISI/SAE 1020
QUANTITY: 4 UNT

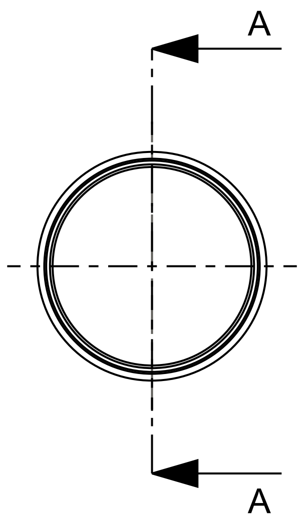


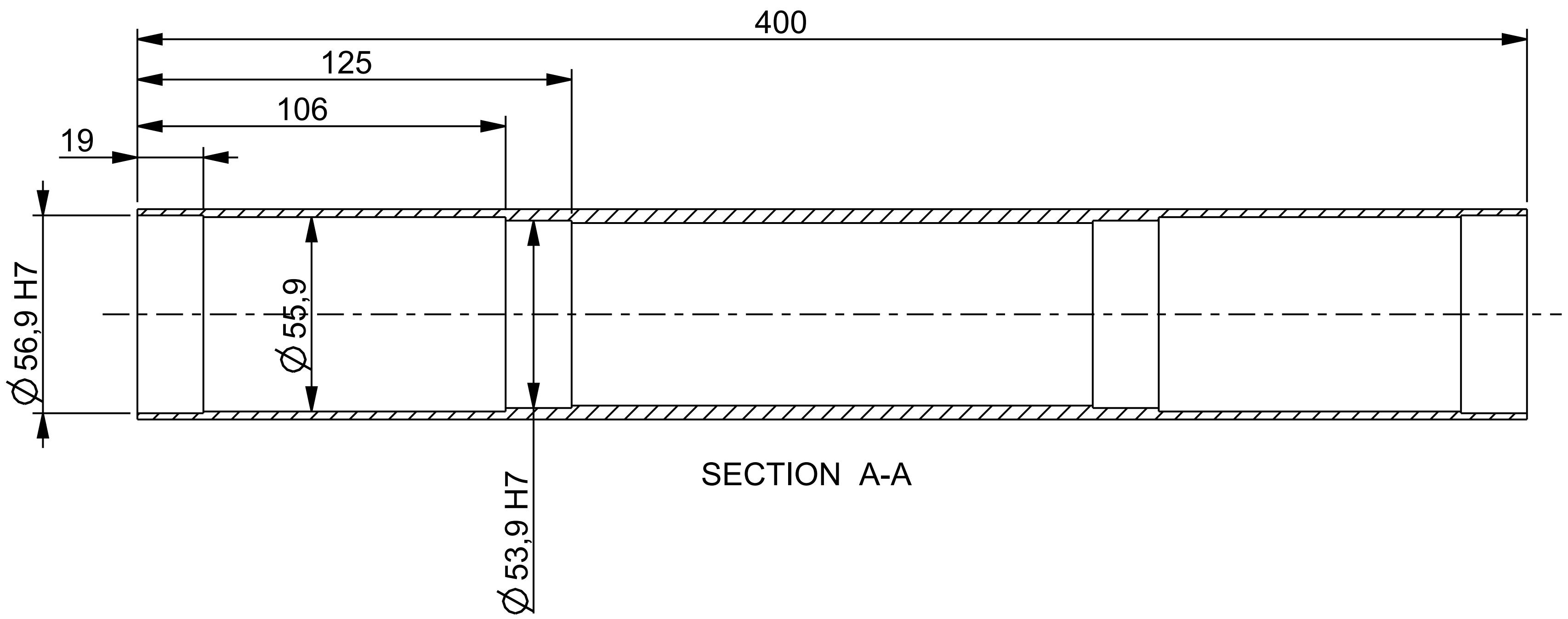
		NAME INITIALS	SIGNATURE	DATE	DRAWING NÂº 1
DANIELA GOMEZ MONTOYA PRODUCT DESIGN ENGINEERING EAFIT UNIVERSITY	DESIGN:	DGM		MAYO -2008	PRT-001-1&2
	DRAW:	DGM		MAYO -2008	REFERENCE:
	APROVE:	VMC		MAYO -2008	REF1 REF2 REF3 REF4
DATE: MAY 2008	DESCRIPTION: DISCS 1 & 2				SCALE: 1:1 / SHEET: 1/1
UNITS: mm	GROUP / SUBGROUP: ROLLER				FILE: ARCHIVO / NÂº REV: 0

DRAWING NÂº2:
PRT-001-3&4

PART: ROLLER 1 & 2
NUMBER PART: 3 & 4
MATERIAL: ASTM A-500GADE C
OD 60.5 - 5.57 kg/mm
QUANTITY: 2 UNT



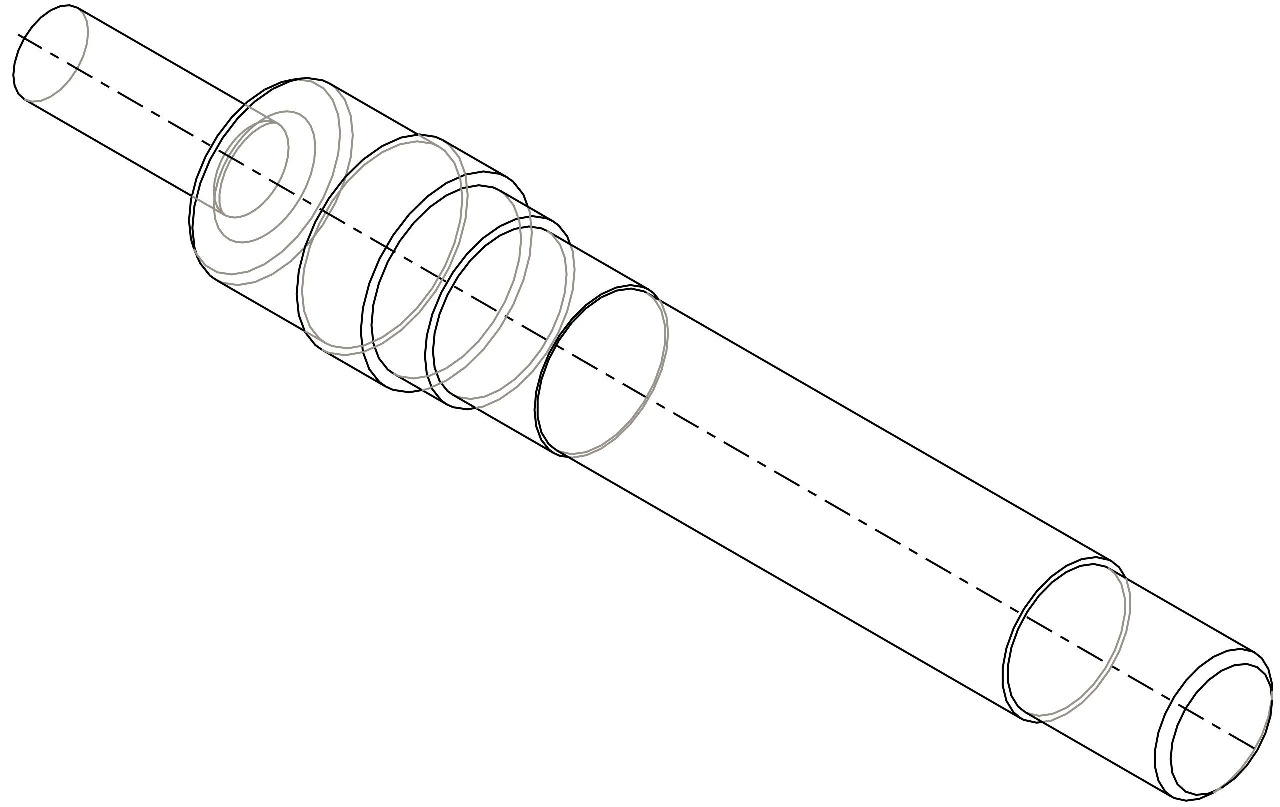




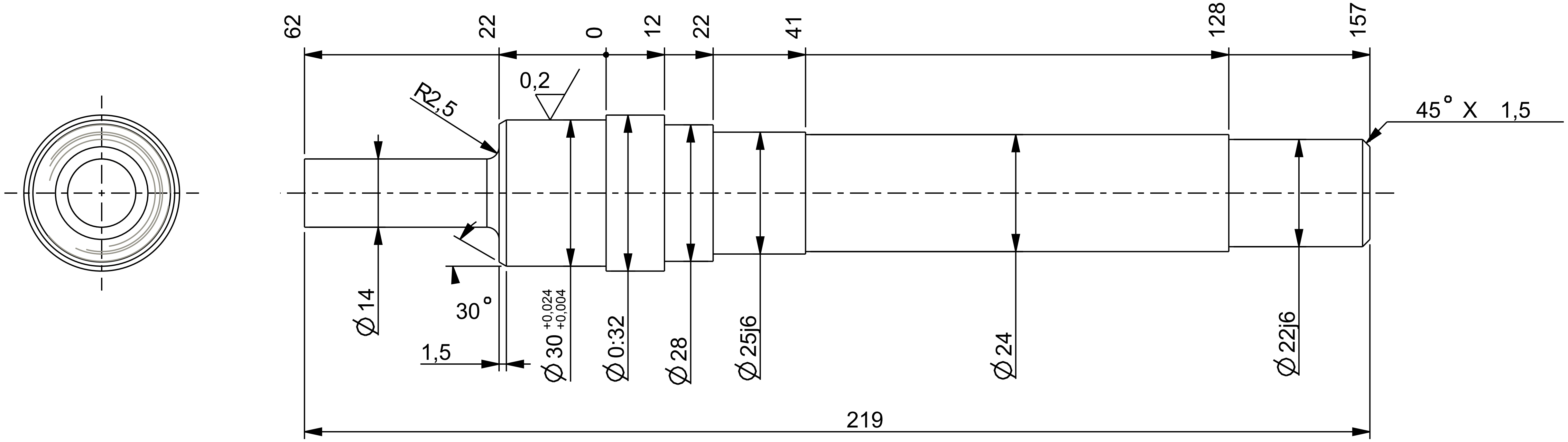
SECTION A-A

DANIELA GOMEZ MONTOYA PRODUCT DESIGN ENGINEERING EAFIT UNIVERSITY		NAME INITIALS	SIGNATURE	DATE	DRAWING NÂº 2 PRT-001-3&4
	DESIGN:	DGM		MAYO -2008	
	DRAW:	DGM		MAYO -2008	REFERENCE:
	APROVE:	VMC		MAYO -2008	REF1 REF2 REF3 REF4
DATE: MAY 2008	DESCRIPTION: ROLLER 1 & 2				SCALE: 1:2 / SHEET: 1/1
UNITS: mm	GROUP / SUBGROUP: ROLLER				FILE: ARCHIVO / NÂº REV: 0

DRAWING Nº3:
PRT-002-5



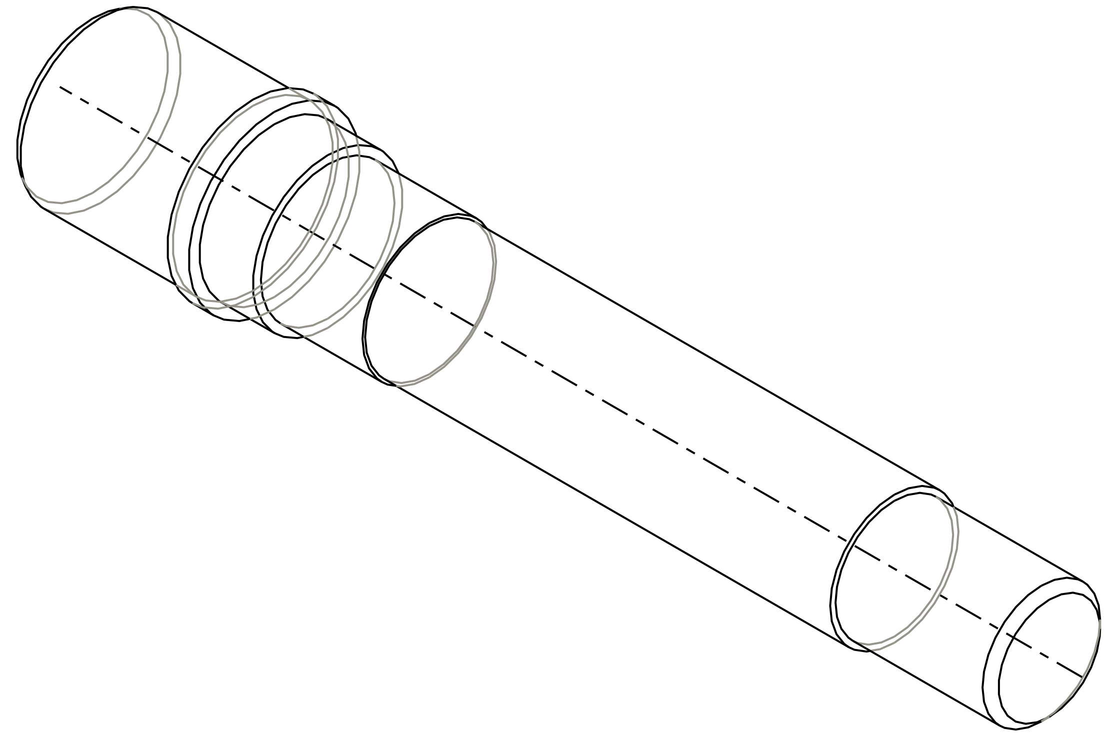
PART: LOWER SHAFT
NUMBER PART: 5
MATERIAL: AISI/SAE 1045
XXXX
QUANTITY: 1 UNT



DANIELA GOMEZ MONTOYA PRODUCT DESIGN ENGINEERING EAFIT UNIVERSITY		NAME INITIALS	SIGNATURE	DATE	DRAWING NÂº 3 PRT-002-5
	DESIGN:	DGM		MAYO -2008	
	DRAW:	DGM		MAYO -2008	REFERENCE:
	APROVE:	VMC		MAYO -2008	REF1 REF2 REF3 REF4
DATE: MAY 2008	DESCRIPTION: LOWER SHAFT				
UNITS: mm					SCALE: 1:1 / SHEET: 1/1
	GROUP / SUBGROUP: ROLLER				FILE: ARCHIVO / NÂº REV: 0

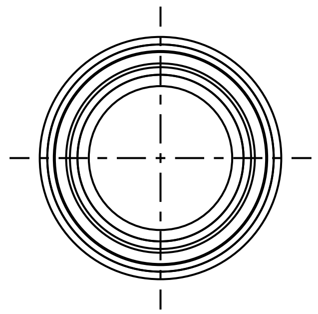
DRAWING Nº4

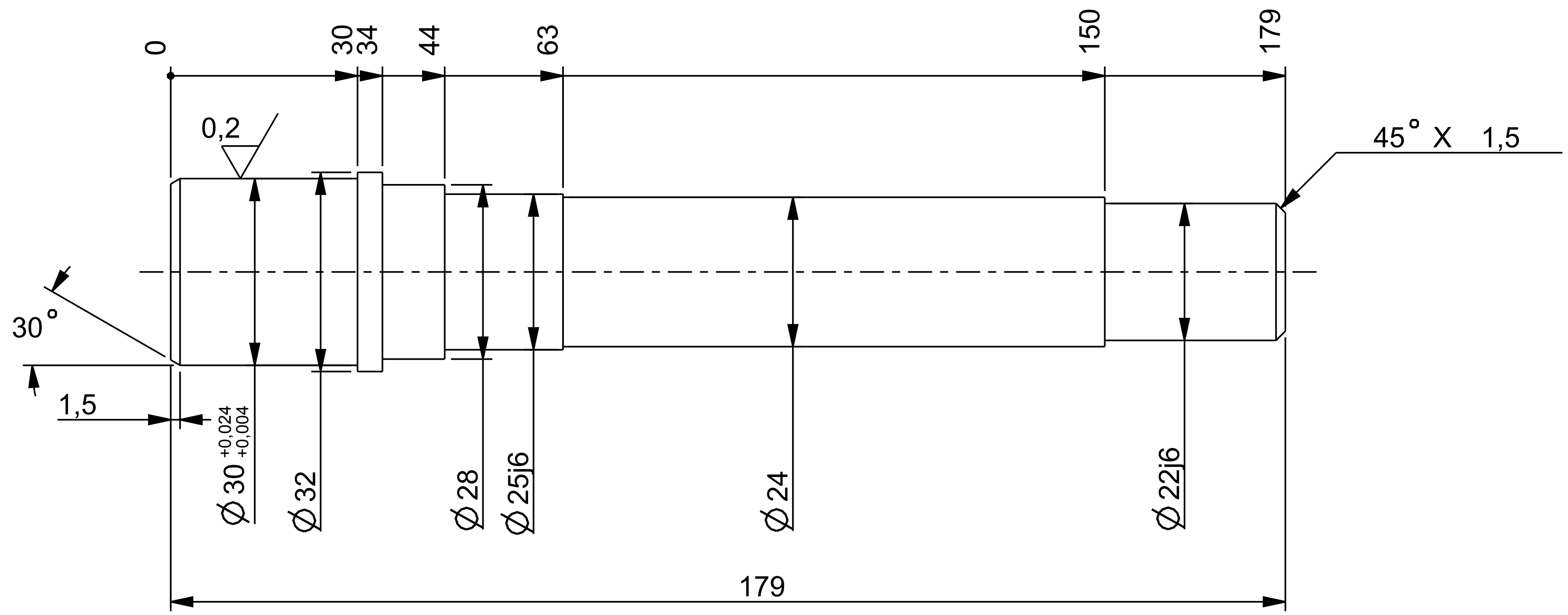
PRT-001 & 002-6



PART: UPPER SHAFT
NUMBER PART: 6
MATERIAL: AISI/SAE 1045

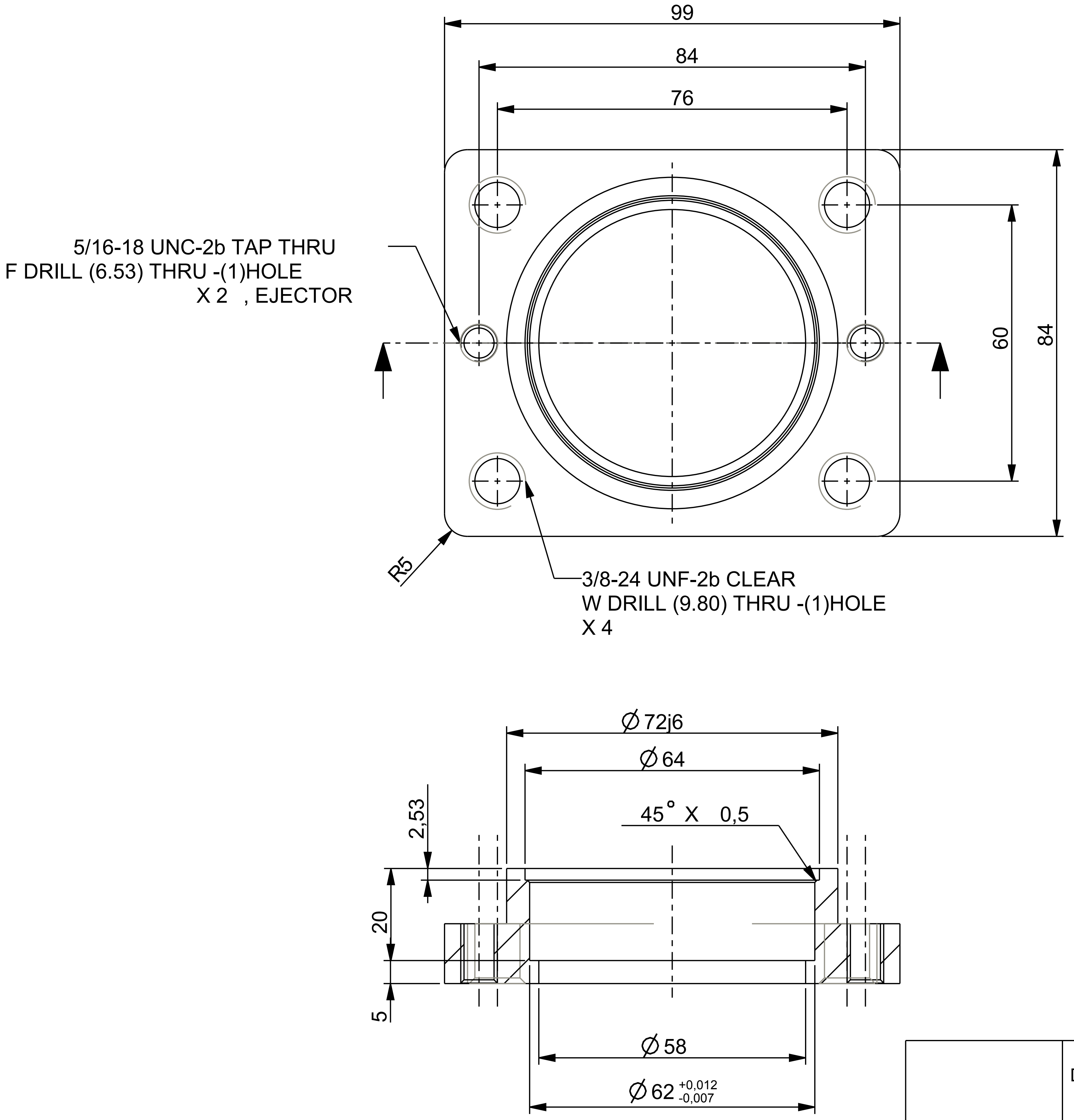
QUANTITY: 3 UNT

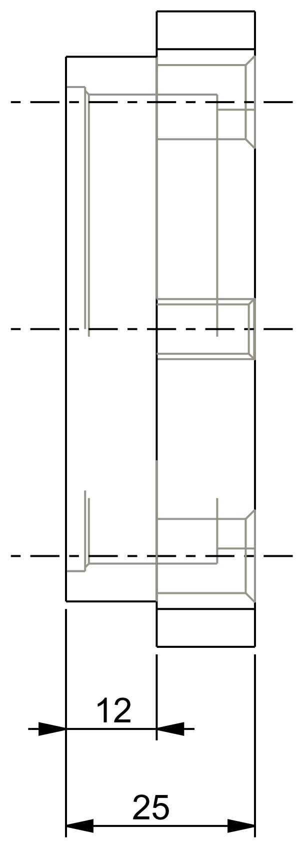


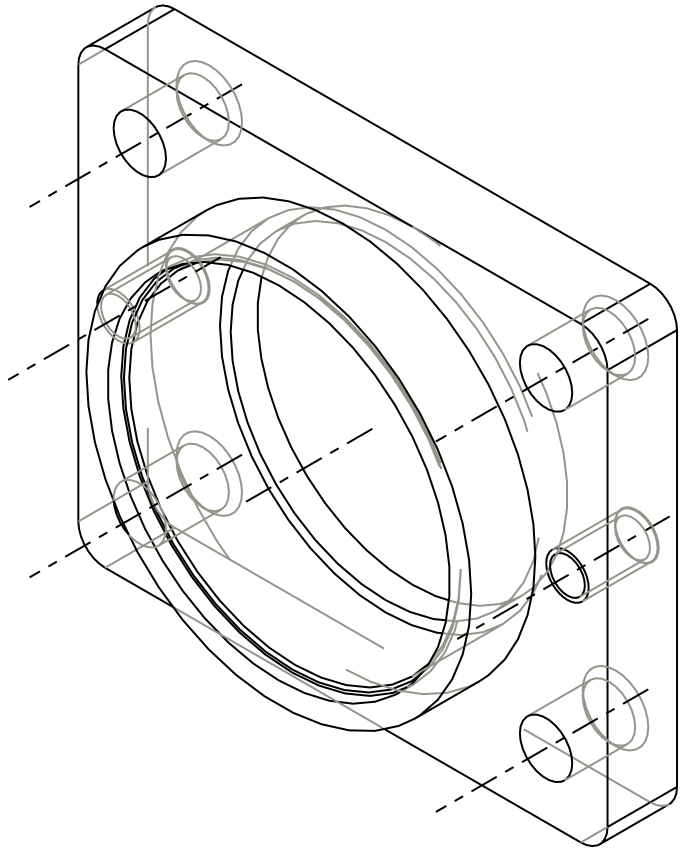


		NAME INITIALS	SIGNATURE	DATE	DRAWING Nº 4
DANIELA GOMEZ MONTOYA PRODUCT DESIGN ENGINEERING EAFIT UNIVERSITY	DESIGN:	DGM		MAYO -2008	PRT-001&002-6
	DRAW:	DGM		MAYO -2008	REFERENCE:
	APROVE:	VMC		MAYO -2008	REF1 REF2 REF3 REF4
DATE: MAY 2008	DESCRIPTION: LOWER SHAFT				SCALE: 1:1 / SHEET: 1/1
UNITS: mm					
	GROUP / SUBGROUP: ROLLER				FILE: ARCHIVO / Nº REV: 0

DRAWING NÃº 5
PRT-002-7





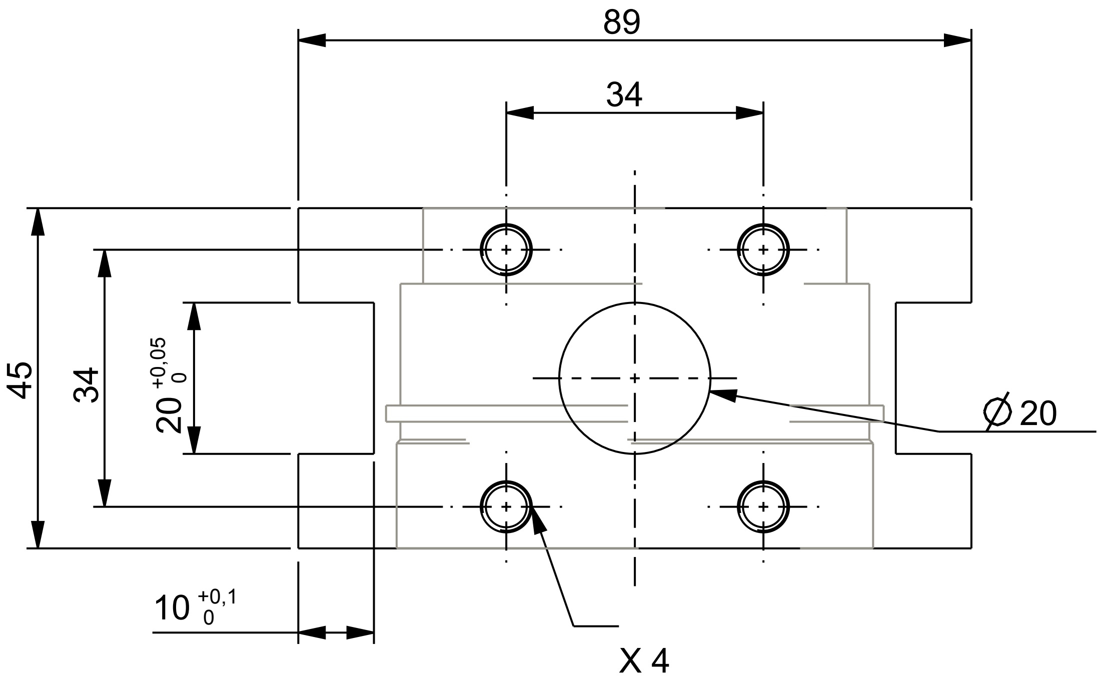


PART: BEARING LOWER DIE
NUMBER PART: 7
MATERIAL: ASTM A-36 HR
QUANTITY: 2 UNT

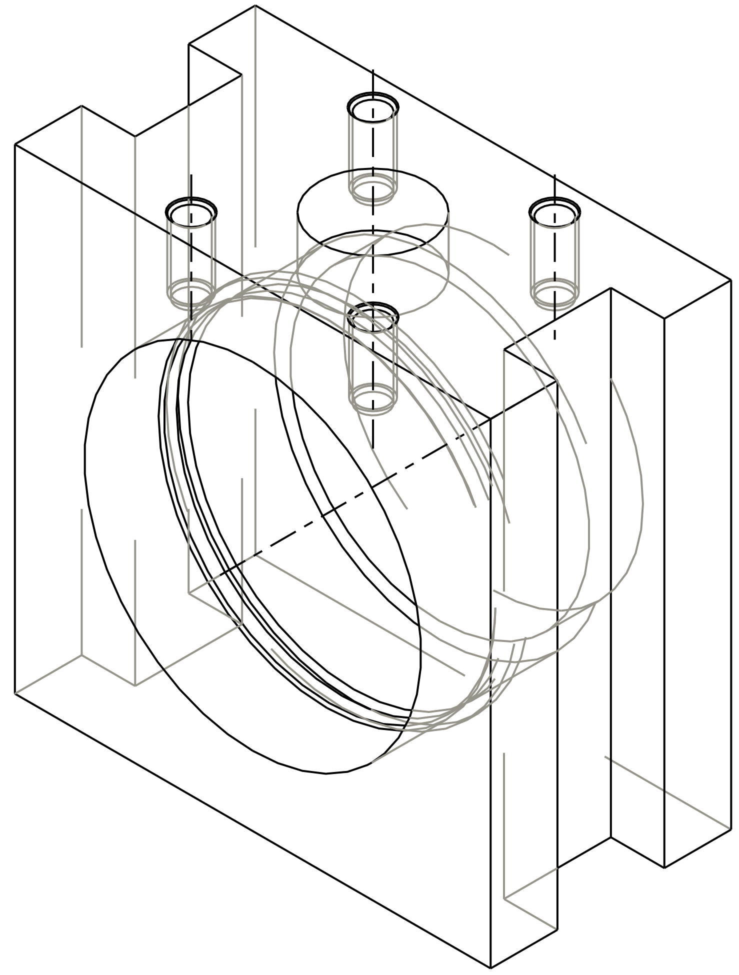
DANIELA GOMEZ MONTOYA PRODUCT DESIGN ENGINEERING EAFIT UNIVERSITY		NAME INITIALS	SIGNATURE	DATE
	DESIGN:	DGM		MAYO -2008
	DRAW:	DGM		MAYO -2008
	APROVE:	VMC		MAYO -2008

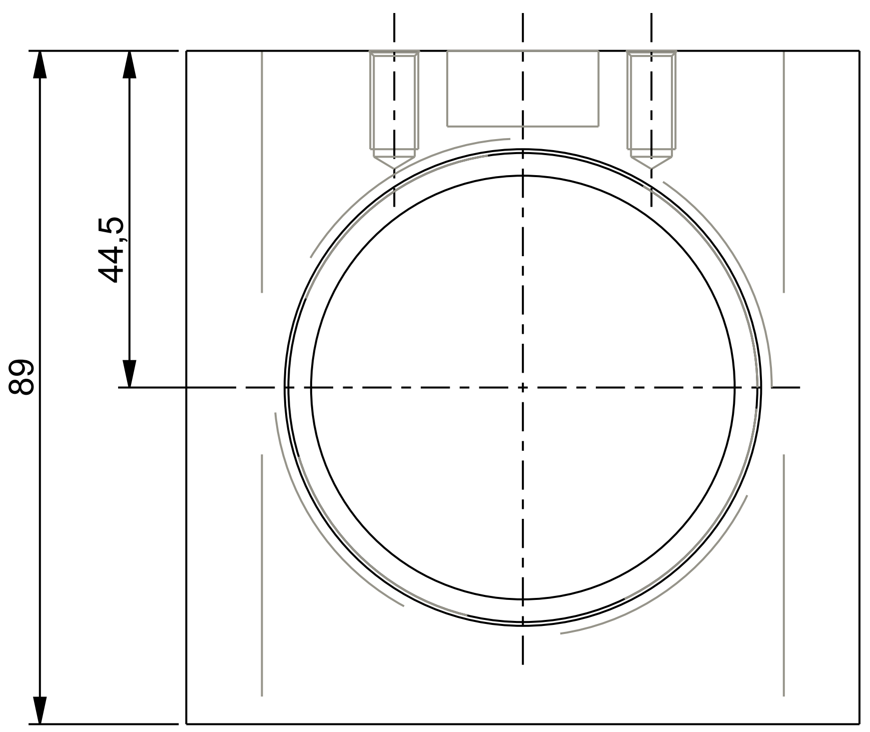
DRAWING NÃº 5: PRT-002-7
REFERENCE: REF1, REF2, REF3, REF4

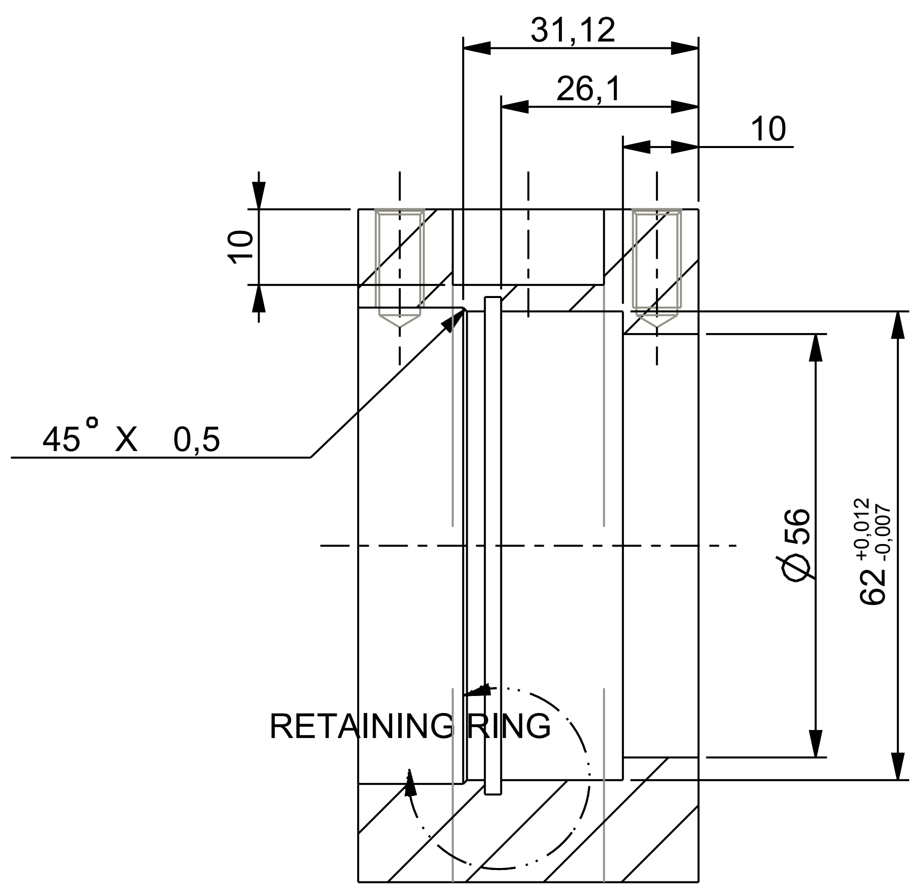
DATE: MAY 2008	DESCRIPTION: BEARING LOWER DIE	SCALE: 1/1		SHEET: 1/1
UNITS: mm	GROUP / SUBGROUP: ROLLER	FILE: ARCHIVO		NÃº REV: 0



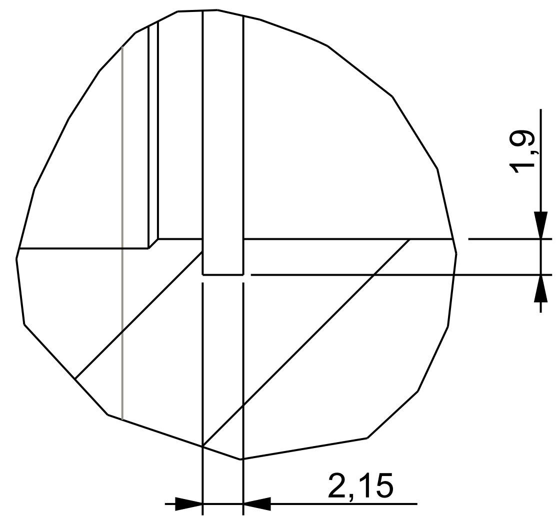
PART: BEARING UPPER DIE
NUMBER PART: 8
MATERIAL: ASTM A-36 HR
QUANTITY: 2 UNT







SECTION B-B

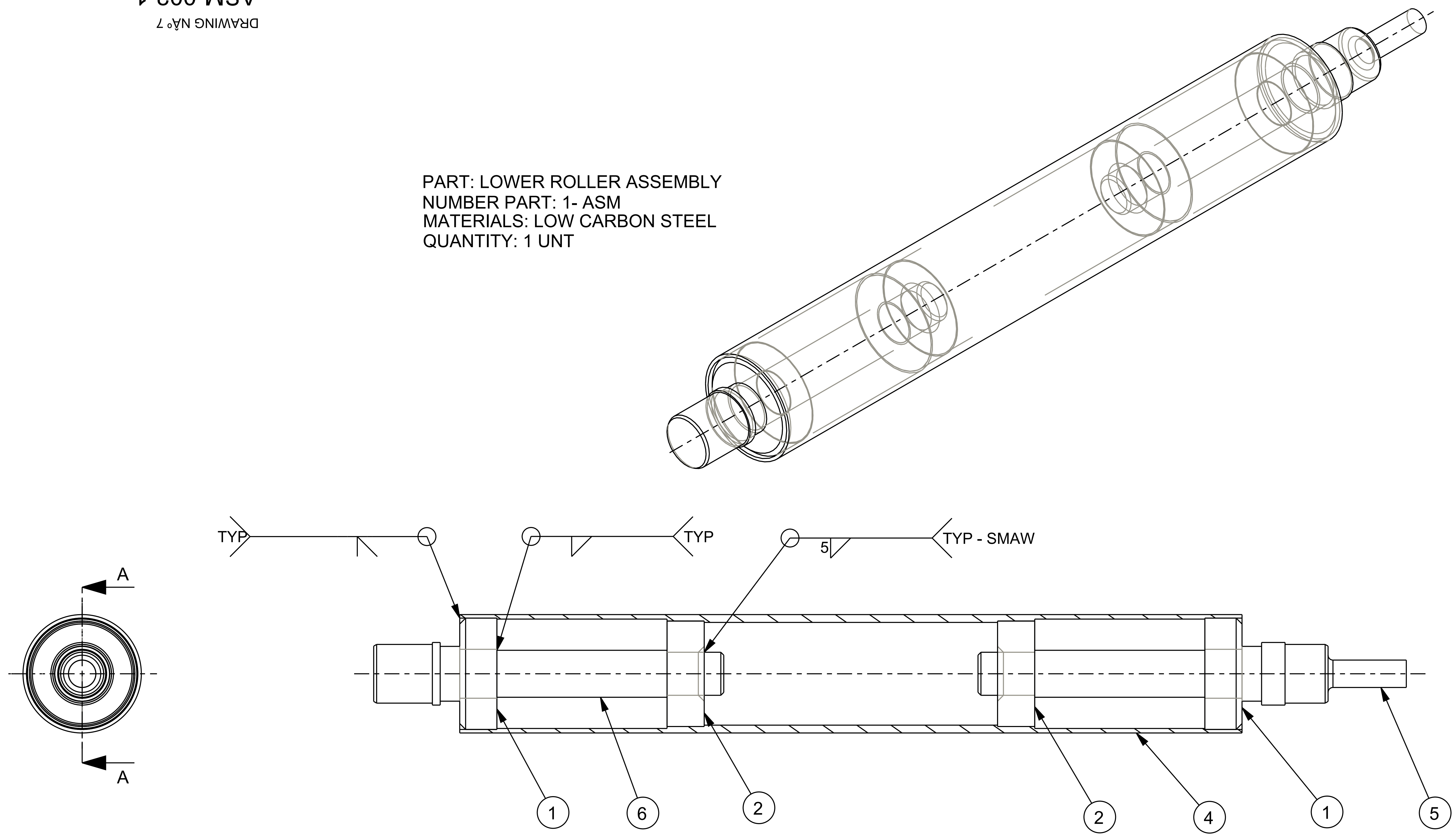


DETAIL RETAINING RING
SCALE 2,500

DANIELA GOMEZ MONTOYA PRODUCT DESIGN ENGINEERING EAFIT UNIVERSITY		NAME INITIALS	SIGNATURE	DATE	DRAWING NÂº 6 PRT-001-8
	DESIGN:	DGM		MAYO -2008	
	DRAW:	DGM		MAYO -2008	REFERENCE:
	APROVE:	VMC		MAYO -2008	REF1 REF2 REF3 REF4
DATE: MAY 2008	DESCRIPTION: BEARING UPPER DIE				SCALE: 1/1 — SHEET: 1/1
UNITS: mm	GROUP / SUBGROUP: ROLLER				FILE: ARCHIVO — NÂº REV: 0

DRAWING Nº 7
ASM-002-1

PART: LOWER ROLLER ASSEMBLY
NUMBER PART: 1- ASM
MATERIALS: LOW CARBON STEEL
QUANTITY: 1 UNT



SECTION A-A

DANIELA GOMEZ MONTOYA
PRODUCT DESIGN ENGINEERING
EAFIT UNIVERSITY

	NAME INITIALS	SIGNATURE	DATE
DESIGN:	DGM		MAYO -2008
DRAW:	DGM		MAYO -2008
APROVE:	VMC		MAYO -2008

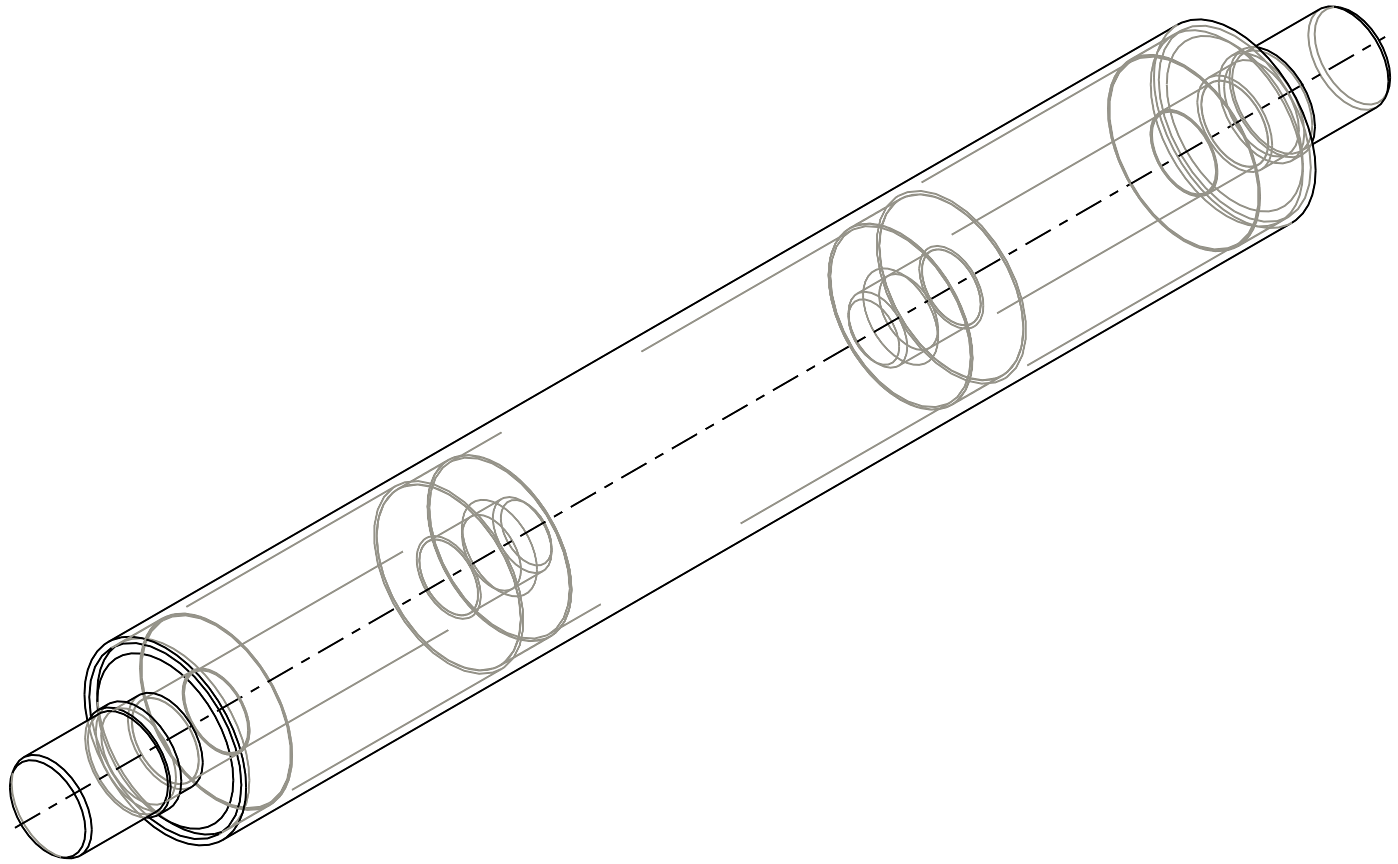
DRAWING NÂº 7
ASM-002-1

REFERENCE:
REF1
REF2
REF3
REF4

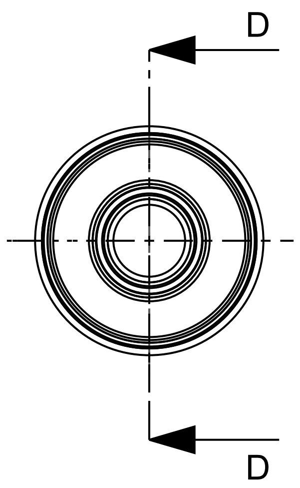
DATE: MAY 2008
UNITS: mm
DESCRIPTION: LOWER ROLL WELDMENT
GROUP / SUBGROUP: ROLLER

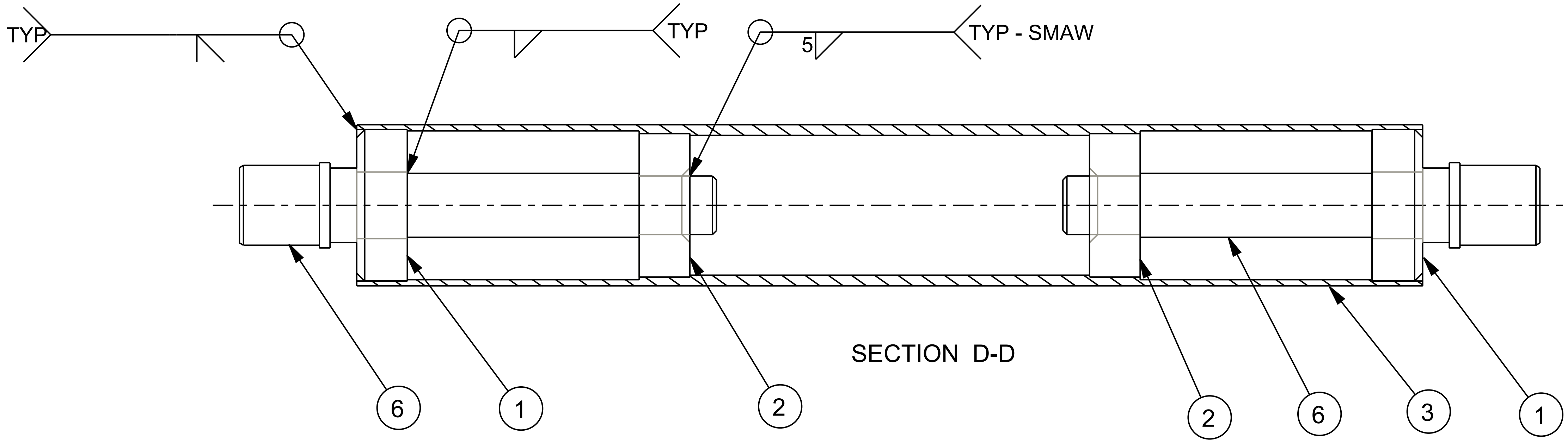
SCALE: 1/2
SHEET: 1/1
FILE: ARCHIVO
NÂº REV: 0

DRAWING NÂº8
ASM-001-2



PART: UPPER ROLLER ASSEMBLY
NUMBER PART: 2- ASM
MATERIALS: LOW CARBON STEEL
QUANTITY: 1 UNT



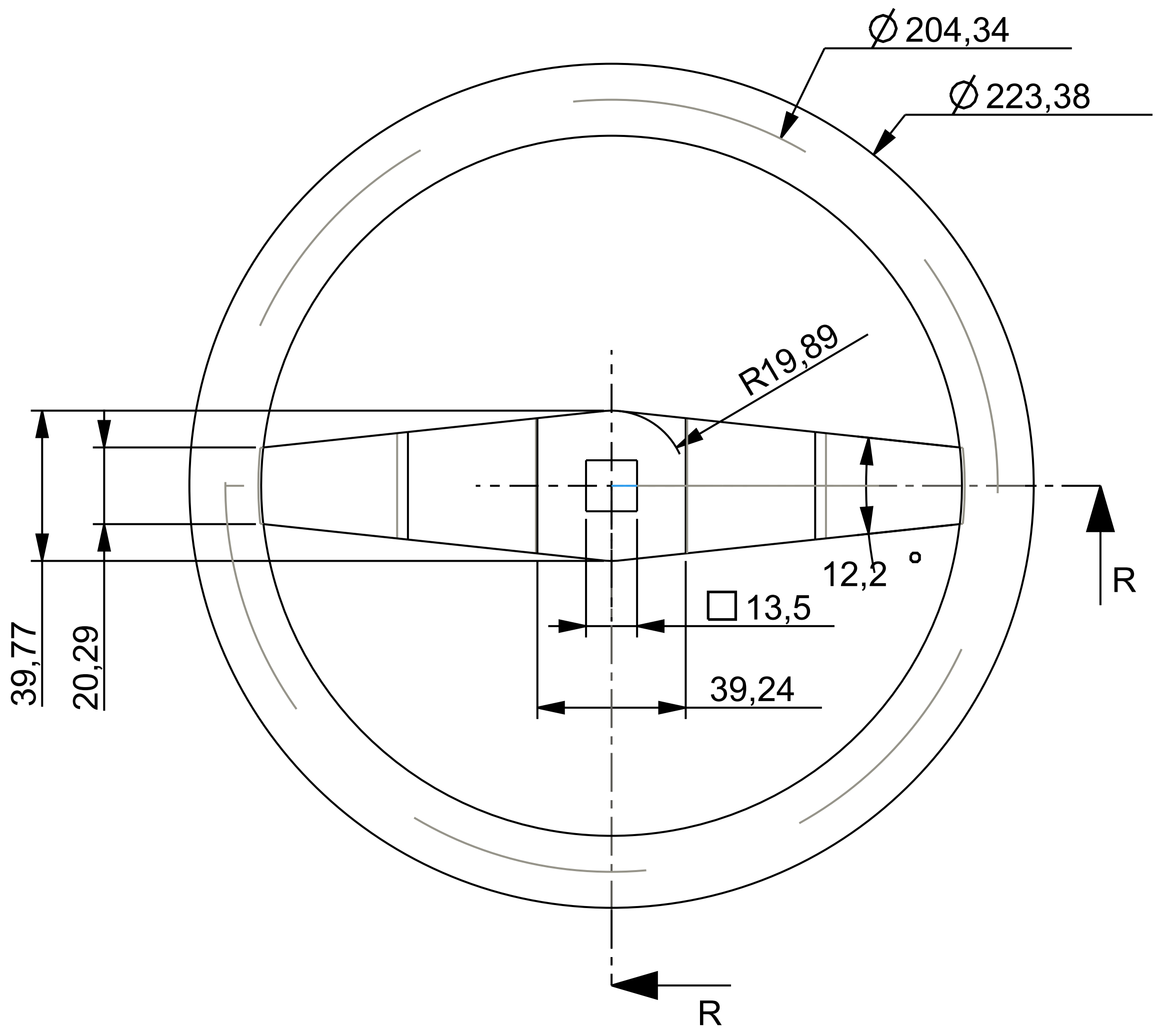


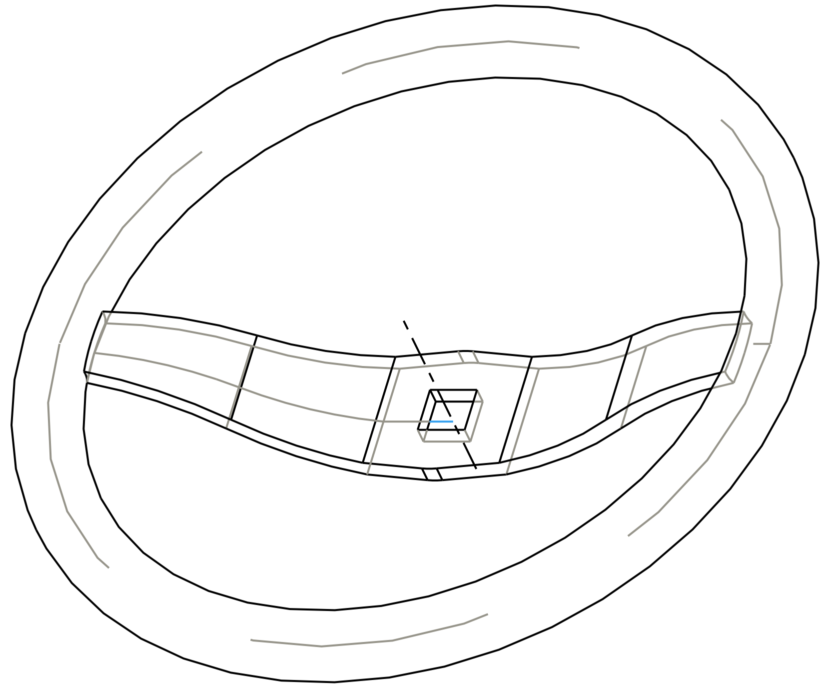
SECTION D-D

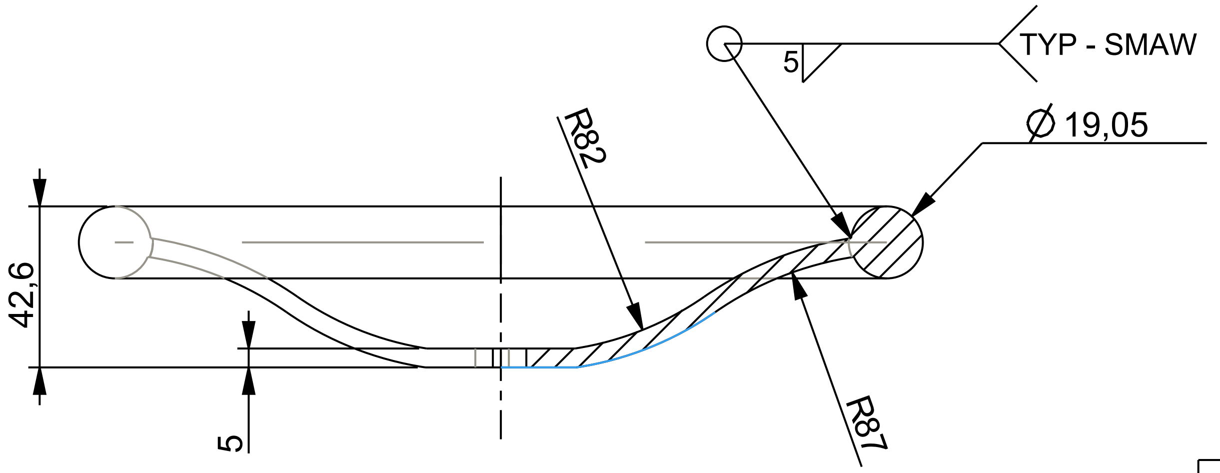
		NAME INITIALS	SIGNATURE	DATE	DRAWING NÂº 8
DANIELA GOMEZ MONTOYA PRODUCT DESIGN ENGINEERING EAFIT UNIVERSITY	DESIGN:	DGM		MAYO -2008	ASM-001-2
	DRAW:	DGM		MAYO -2008	REFERENCE:
	APROVE:	VMC		MAYO -2008	REF1 REF2 REF3 REF4
DATE: MAY 2008	DESCRIPTION: UPPER ROLL WELDMENT				SCALE: 1/2 — SHEET: 1/1
UNITS: mm					
	GROUP / SUBGROUP: ROLLER				FILE: ARCHIVO — NÂº REV: 0

DRAWING NÂº 9

PRT-003-9







SECTION R-R

PART: WHEEL WELDMENT
NUMBER PART: 9
MATERIALS: ASTM A-36
QUANTITY: 2 UNT

NOTE:
ANY DIMENSION THAT DOES NOT APPEAR IN THE DRAWING AND WILL BE REQUIRED TO BUILD THE WHEEL, SHOULD BE TAKEN DIRECTLY FROM THE MODEL.

ALL EDGES SHOULD BE SOFTENED

DANIELA GOMEZ MONTOYA
PRODUCT DESIGN ENGINEERING
EAFIT UNIVERSITY

	NAME INITIALS	SIGNATURE	DATE
DESIGN:	DGM		MAYO -2008
DRAW:	DGM		MAYO -2008
APROVE:	VMC		MAYO -2008

DRAWING NÂº 9: PRT-003-9

REFERENCE: REF1 REF2 REF3 REF4

DATE: MAY 2008

UNITS: mm

DESCRIPTION: WHEEL WELDMENT

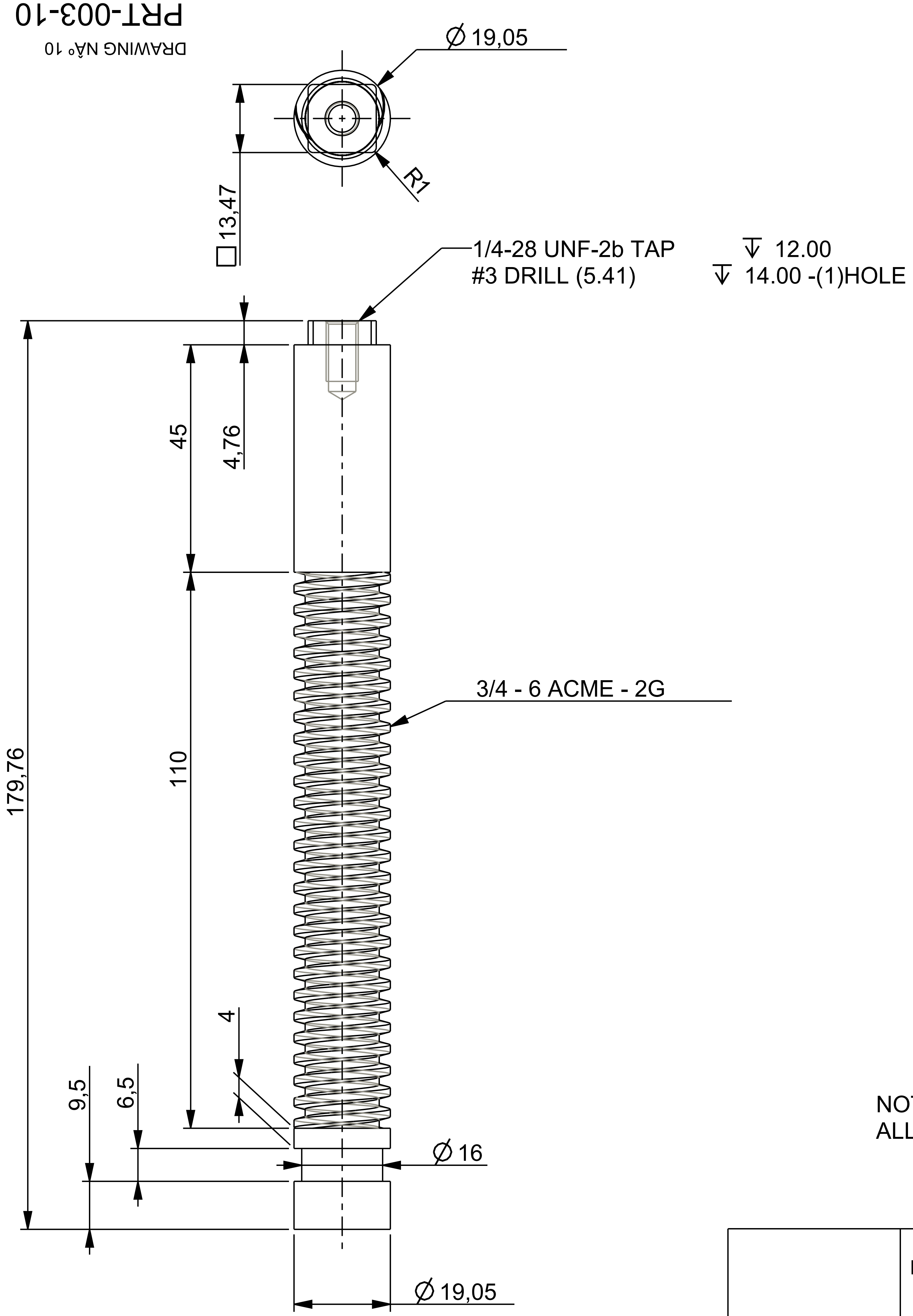
GROUP / SUBGROUP: POWER SCREW

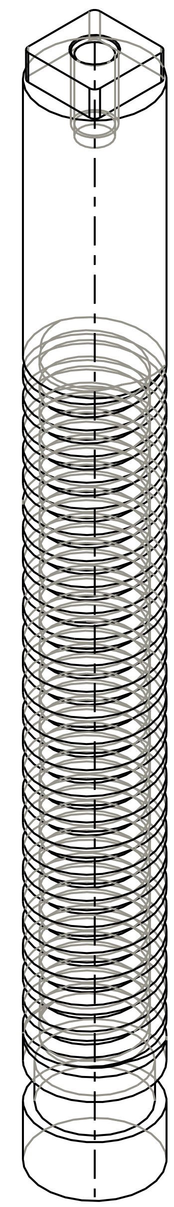
SCALE: 1/2

SHEET: 1/1

FILE: ARCHIVO

NÂº REV: 0



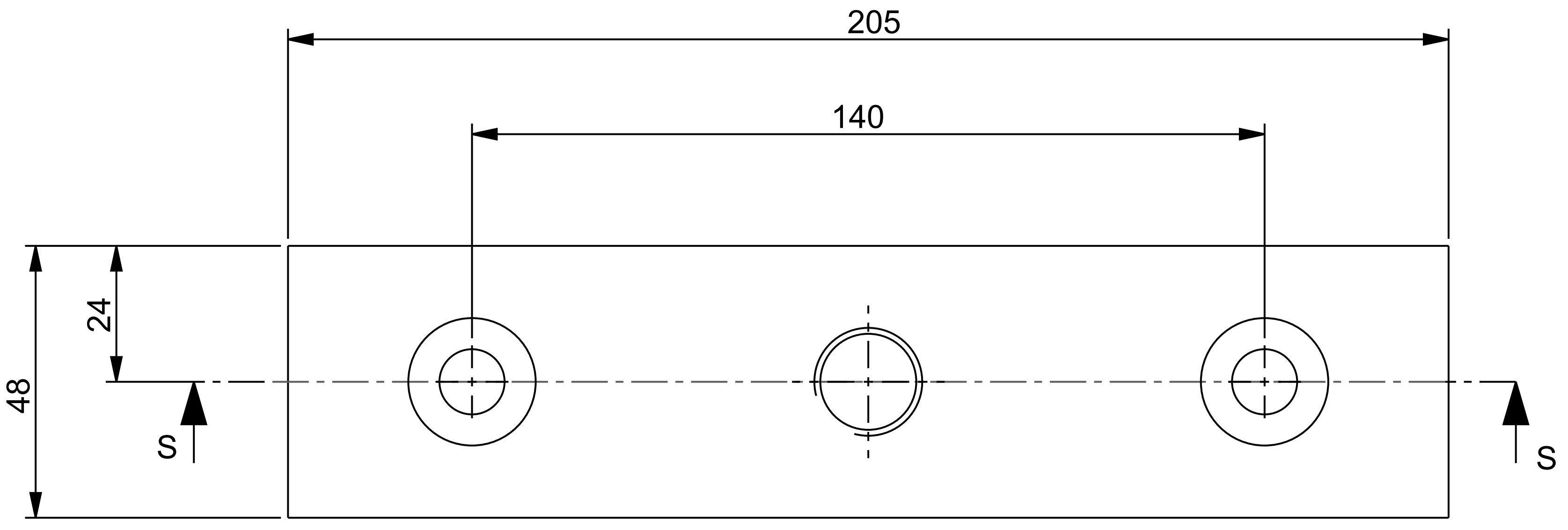


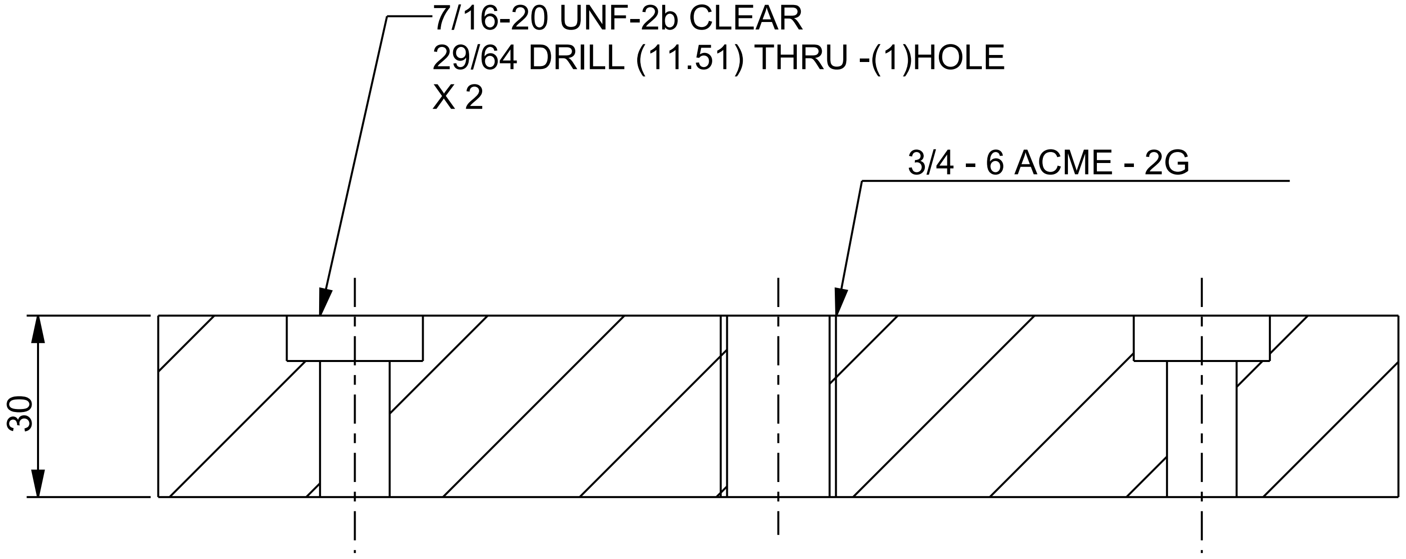
PART: POWER SCREW
NUMBER PART: 10
MATERIALS: AISI/SAE 1020
QUANTITY: 2 UNT

NOTE:
ALL EDGES SHOULD BE SOFTENED

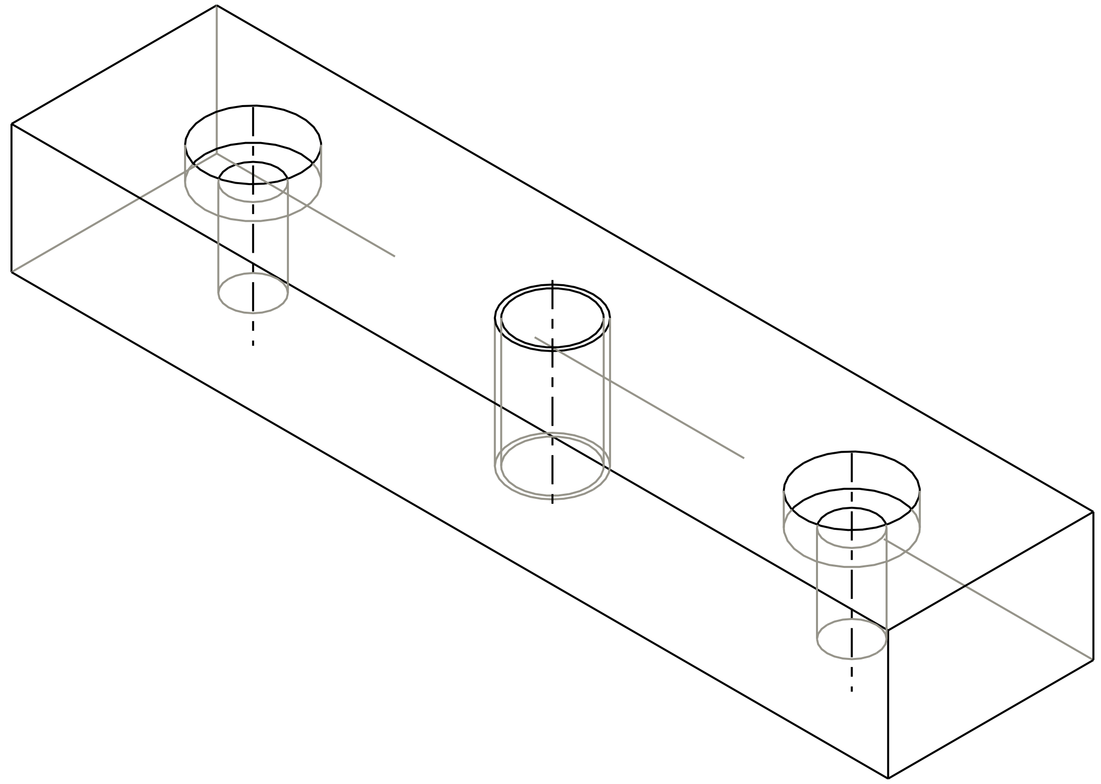
		NAME INITIALS	SIGNATURE	DATE	DRAWING NÂº 10
DANIELA GOMEZ MONTOYA PRODUCT DESIGN ENGINEERING EAFIT UNIVERSITY	DESIGN:	DGM		MAYO -2008	PRT-003-10
	DRAW:	DGM		MAYO -2008	REFERENCE:
	APROVE:	VMC		MAYO -2008	REF1 REF2 REF3 REF4
DATE: MAY 2008	DESCRIPTION: POWER SCREW				SCALE: 1:1 / SHEET: 1/1
UNITS: mm					
	GROUP / SUBGROUP: POWER SCREW				FILE: ARCHIVO / NÂº REV: 0

PRT-003-11
DRAWING NÂº 11





SECTION S-S



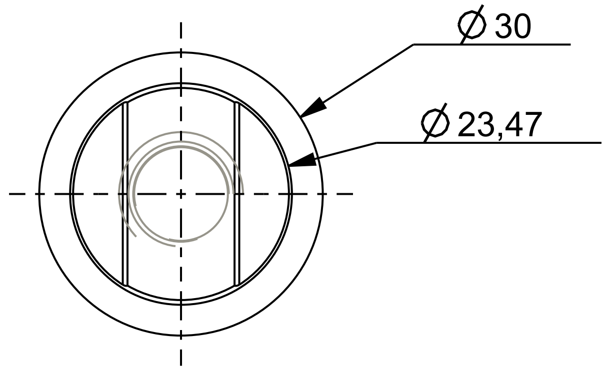
PART: NUT PLATE
NUMBER PART: 11
MATERIALS: ASTM A-36
QUANTITY: 2 UNT

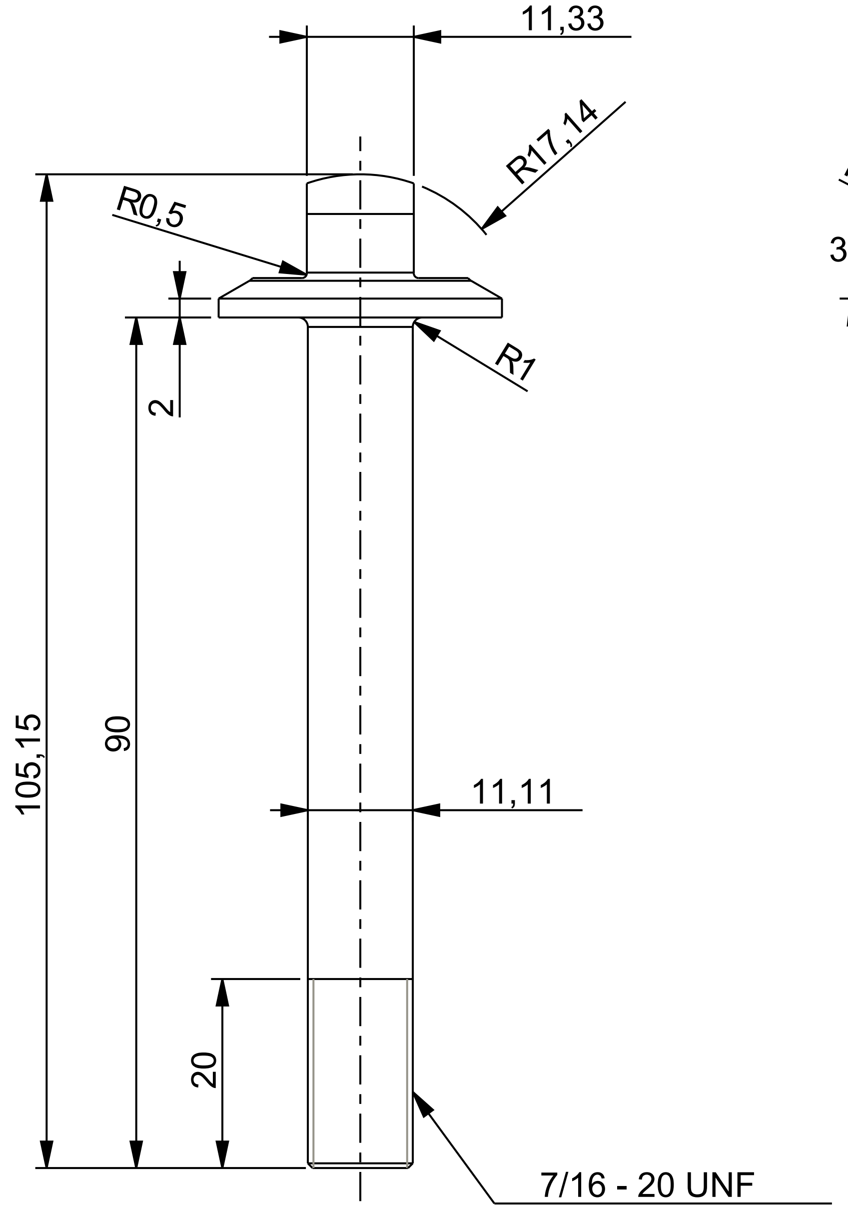
NOTE:
ALL EDGES SHOULD BE SOFTENED

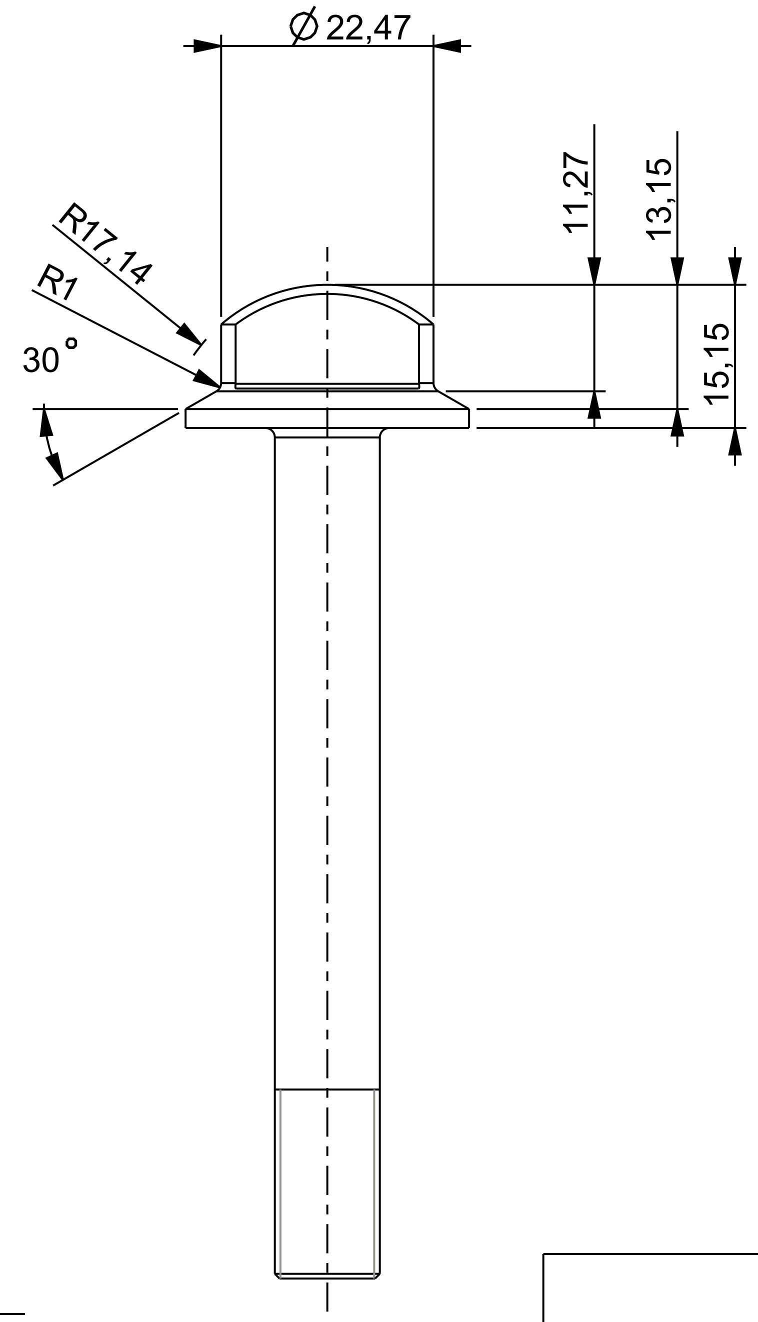
		NAME INITIALS	SIGNATURE	DATE	DRAWING NÂº 11
DANIELA GOMEZ MONTOYA PRODUCT DESIGN ENGINEERING EAFIT UNIVERSITY	DESIGN:	DGM		MAYO -2008	PRT-003-11
	DRAW:	DGM		MAYO -2008	REFERENCE:
	APROVE:	VMC		MAYO -2008	REF1 REF2 REF3 REF4
DATE: MAY 2008	DESCRIPTION: NUT PLATE				SCALE: 1:1.25 / SHEET: 1/1
UNITS: mm	GROUP / SUBGROUP: POWER SCREW				FILE: ARCHIVO / NÂº REV: 0

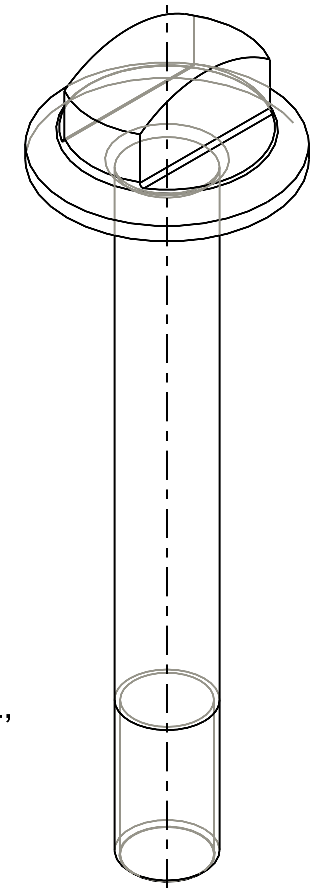
DRAWING NÂº 12

PRT-003-12









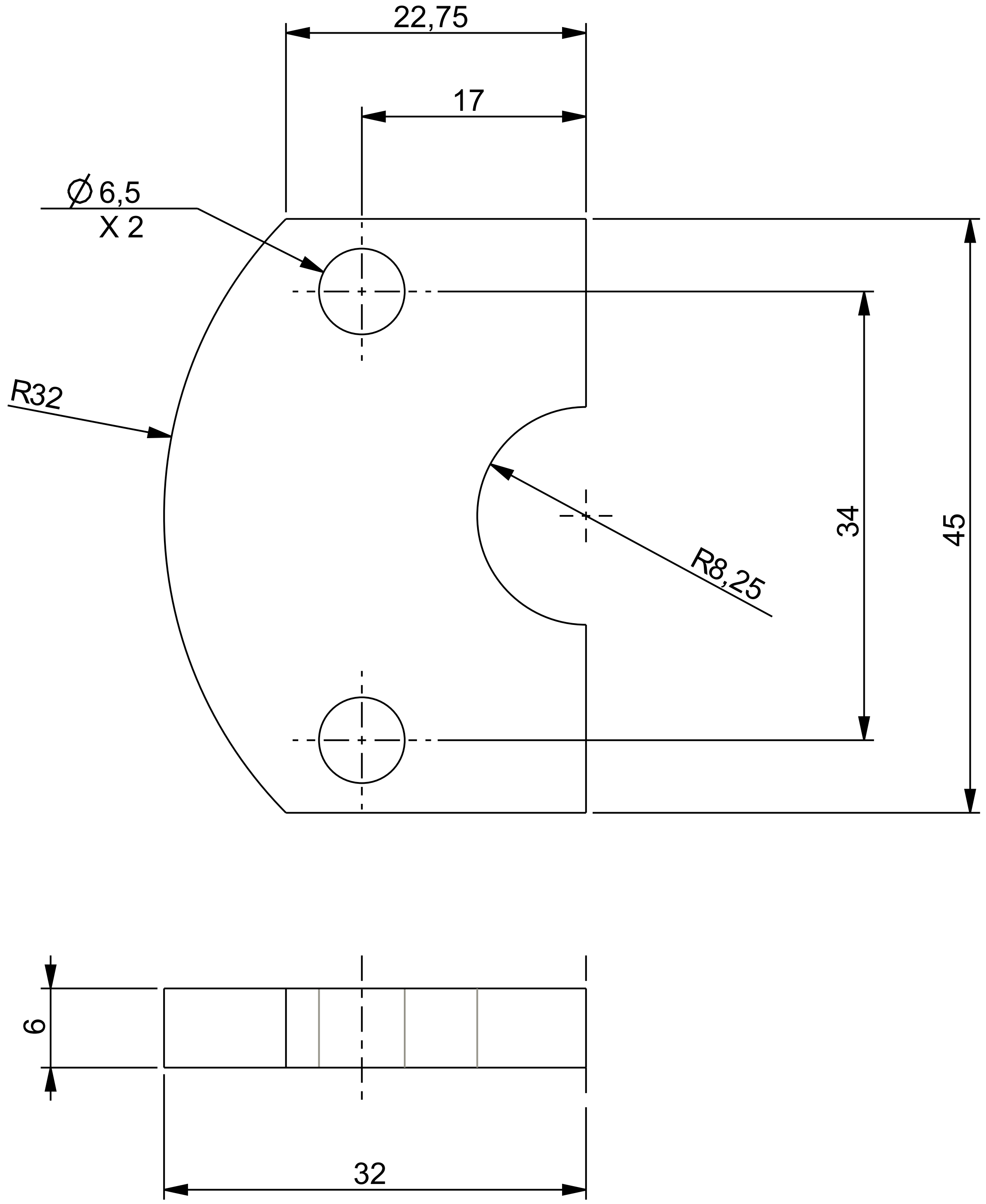
PART: SPRING-SCREW
NUMBER PART: 12
MATERIALS: LOW CARBON STEEL,
ISO 5.8 CLASS OR SAE GRADE 2
QUANTITY: 4 UNT

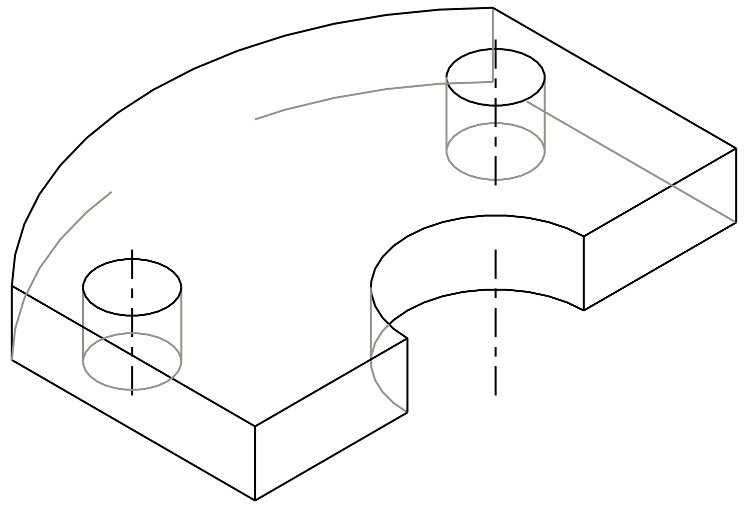
NOTE:
ANY DIMENSION THAT DOES NOT APPEAR IN THE DRAWING AND WILL BE REQUIRED TO BUILD THE WHEEL SHOULD BE TAKEN DIRECTLY FROM THE MODEL.

ALL EDGES SHOULD BE SOFTENED

		NAME INITIALS	SIGNATURE	DATE	DRAWING NÂº 12
DANIELA GOMEZ MONTOYA PRODUCT DESIGN ENGINEERING EAFIT UNIVERSITY	DESIGN:	DGM		MAYO -2008	PRT-003-12
	DRAW:	DGM		MAYO -2008	REFERENCE:
	APROVE:	VMC		MAYO -2008	REF1 REF2 REF3 REF4
DATE: MAY 2008	DESCRIPTION: SPRING SCREW				SCALE: 1.25:1 / SHEET: 1/1
UNITS: mm	GROUP / SUBGROUP: POWER SCREW				FILE: ARCHIVO / NÂº REV: 0

PRT-003-13
DRAWING Nº 13





PART: SUFERING PLATE
NUMBER PART: 13
MATERIALS: Cu ALLOY SAE 795
QUANTITY: 4 UNT

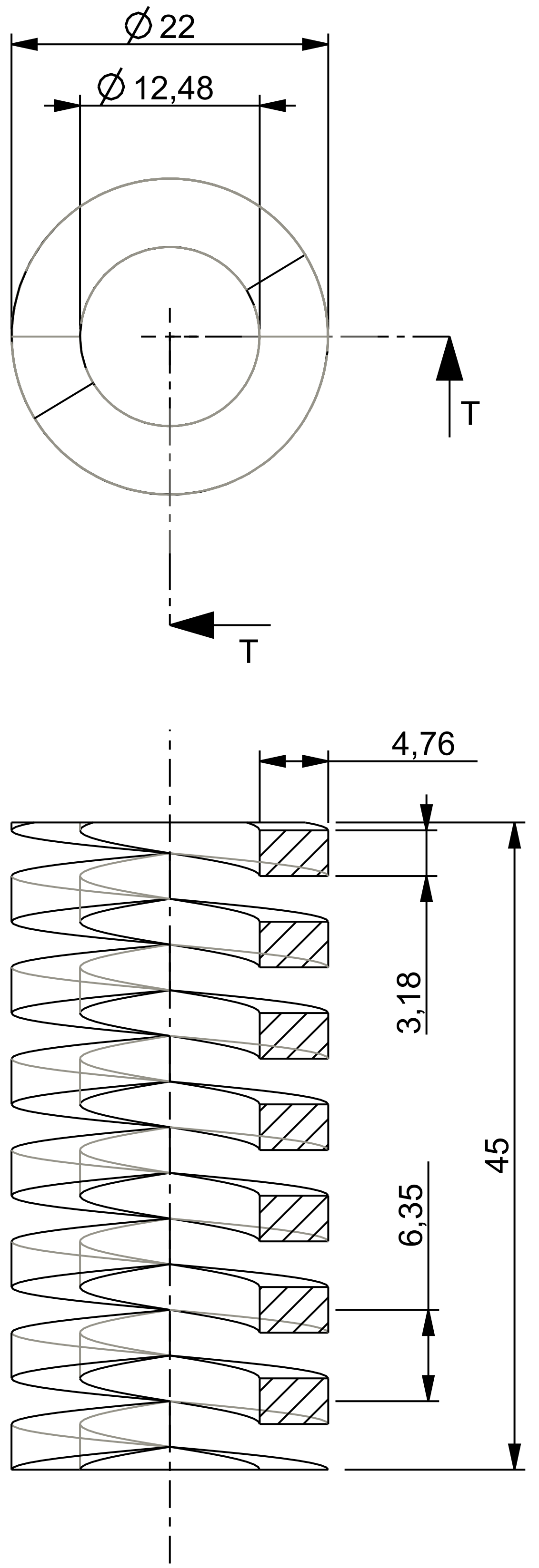
NOTE:
ALL EDGES SHOULD BE SOFTENED

DANIELA GOMEZ MONTOYA
PRODUCT DESIGN ENGINEERING
EAFIT UNIVERSITY

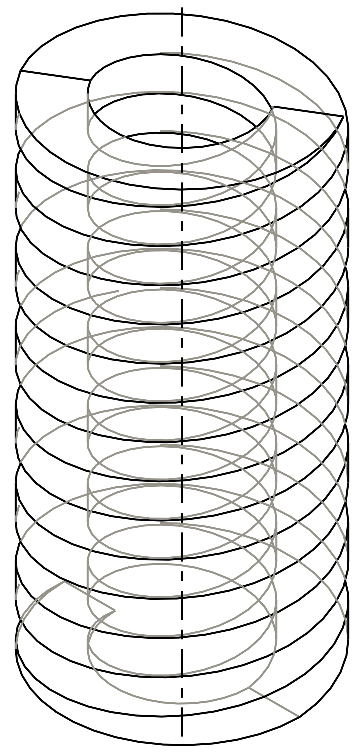
	NAME INITIALS	SIGNATURE	DATE
DESIGN:	DGM		MAYO -2008
DRAW:	DGM		MAYO -2008
APROVE:	VMC		MAYO -2008

DRAWING Nº 13	PRT-003-13
REFERENCE:	REF1 REF2 REF3 REF4
DATE:	MAY 2008
DESCRIPTION:	SUFERING PLATE
UNITS:	mm
GROUP / SUBGROUP:	POWER SCREW
SCALE:	2:1
SHEET:	1/1
FILE:	ARCHIVO
Nº REV:	0

DRAWING Nº 14
PRT-003-14



SECTION T-T



PART: COMPRESSION SPRING, MACHINED GROUND ENDS
NUMBER PART: 14
MATERIALS: AISI/SAE 304 OR 420
QUANTITY: 4 UNT

DANIELA GOMEZ MONTOYA
PRODUCT DESIGN ENGINEERING
EAFIT UNIVERSITY

	NAME INITIALS	SIGNATURE	DATE
DESIGN:	DGM		MAYO -2008
DRAW:	DGM		MAYO -2008
APROVE:	VMC		MAYO -2008

DRAWING NÂº 14
PRT-003-14

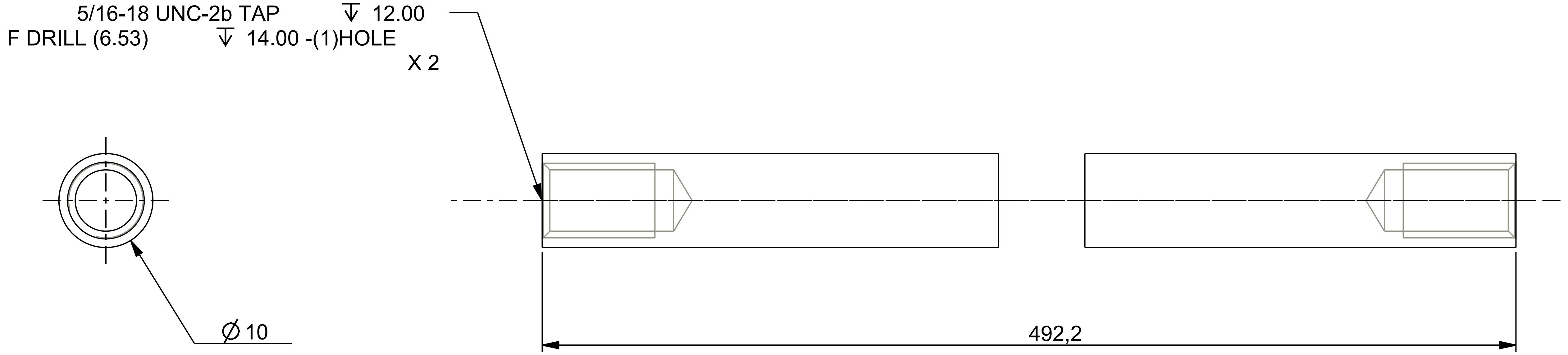
REFERENCE:
REF1
REF2
REF3
REF4

DATE: MAY 2008	DESCRIPTION: COMPRESSION SPRING, MACHINED GROUND ENDS
UNITS: mm	
	GROUP / SUBGROUP: POWER SCREW

SCALE:		SHEET:
2:1		1/1
FILE: ARCHIVO		NÂº REV: 0

DRAWING NÂº 15:
PRT-004-15

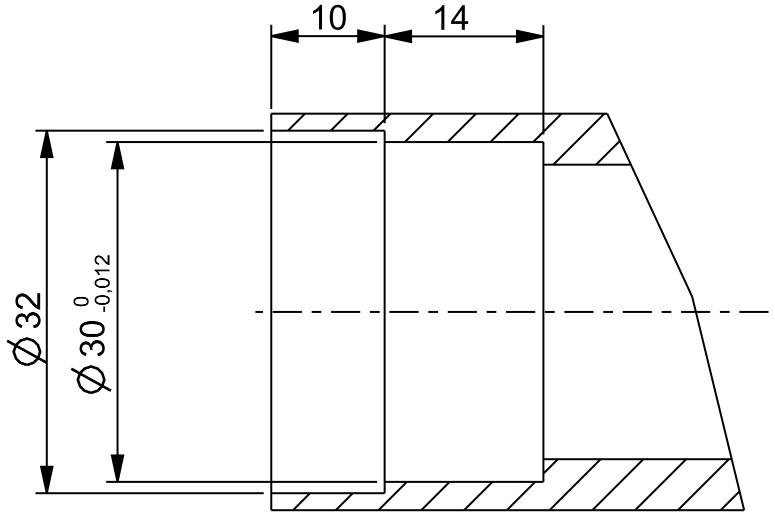
PART: GUIDE ROLLER SHAFT
PART NUMBER: 15
MATERIAL: AISI/SAE 1020
QUANTITY: 10 UNT



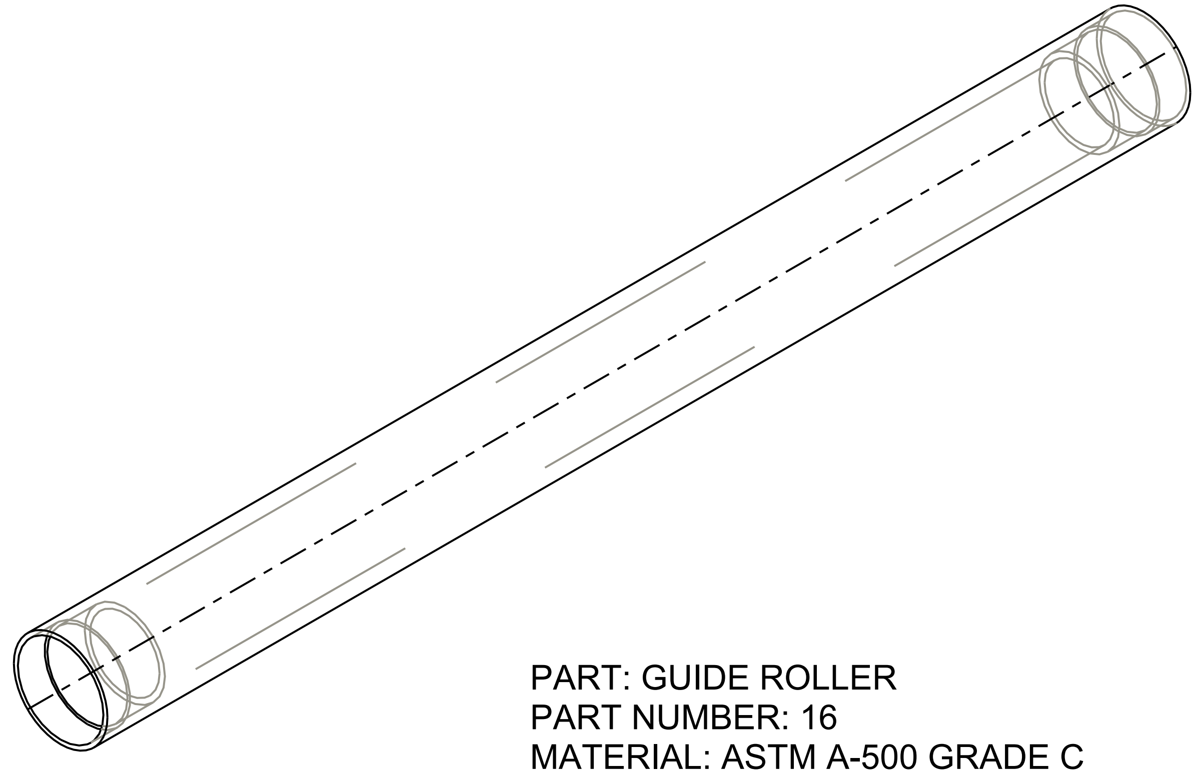
NOTE:
ALL EDGES SHOULD BE SOFTENED

DANIELA GOMEZ MONTOYA PRODUCT DESIGN ENGINEERING EAFIT UNIVERSITY		NAME INITIALS	SIGNATURE	DATE	DRAWING NÂº 15 PRT-004-15
	DESIGN:	DGM		MAYO -2008	
	DRAW:	DGM		MAYO -2008	REFERENCE:
	APROVE:	VMC		MAYO -2008	REF1 REF2 REF3 REF4
DATE: MAY 2008	DESCRIPTION: GUIDE ROLLER SHAFT				SCALE: 2:1 / SHEET: 1/1
UNITS: mm					
	GROUP / SUBGROUP: GUIDE ROLLER				FILE: ARCHIVO / NÂº REV: 0

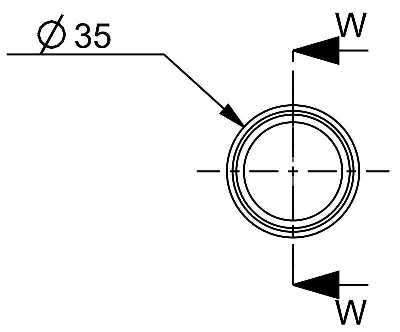
PRT-004-16
DRAWING NÂº1:

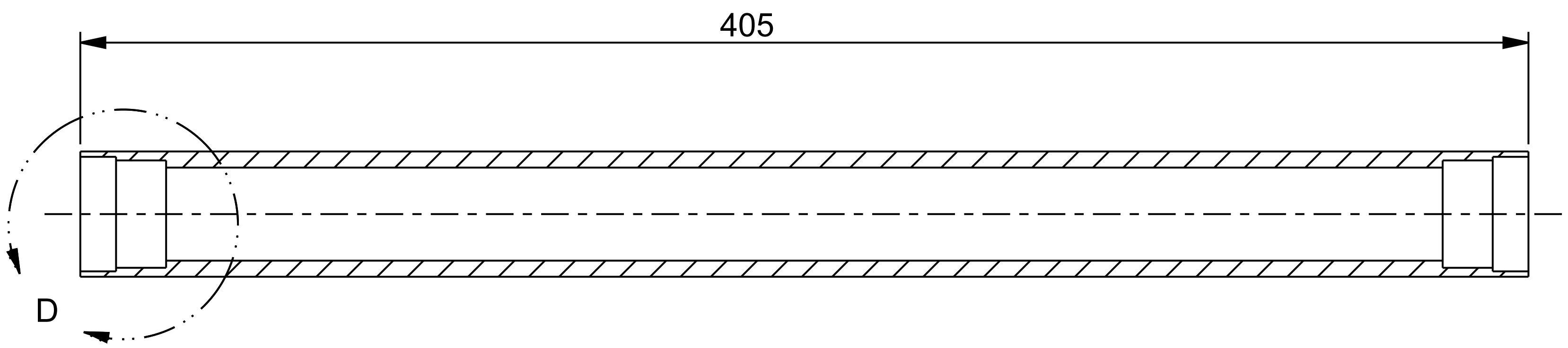


DETAIL D
SCALE 1,500



PART: GUIDE ROLLER
PART NUMBER: 16
MATERIAL: ASTM A-500 GRADE C
QUANTITY: 10 UNT



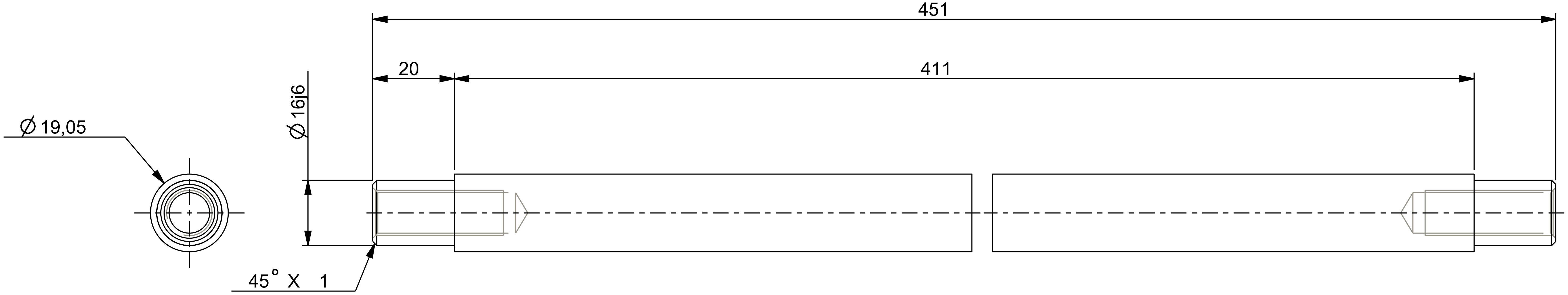


SECTION W-W

NOTE:
ALL EDGES SHOULD BE SOFTENED

DANIELA GOMEZ MONTOYA PRODUCT DESIGN ENGINEERING EAFIT UNIVERSITY		NAME INITIALS	SIGNATURE	DATE	DRAWING NÂº 16 PRT-004-16
	DESIGN:	DGM		MAYO -2008	
	DRAW:	DGM		MAYO -2008	REFERENCE:
	APROVE:	VMC		MAYO -2008	REF1 REF2 REF3 REF4
DATE: MAY 2008	DESCRIPTION: GUIDE ROLLER				SCALE: 1:2 / SHEET: 1/1
UNITS: mm	GROUP / SUBGROUP: GUIDE ROLLER				FILE: ARCHIVO / NÂº REV: 0

DRAWING NÂ°1:
PRT-005-17



PART: SEPARETOR
PART NUMBER: 17
MATERIAL: AISI/SAE 1020
QUANTITY: 5 UNT

NOTE:
ALL EDGES SHOULD BE SOFTENED

DANIELA GOMEZ MONTOYA
PRODUCT DESIGN ENGINEERING
EAFIT UNIVERSITY

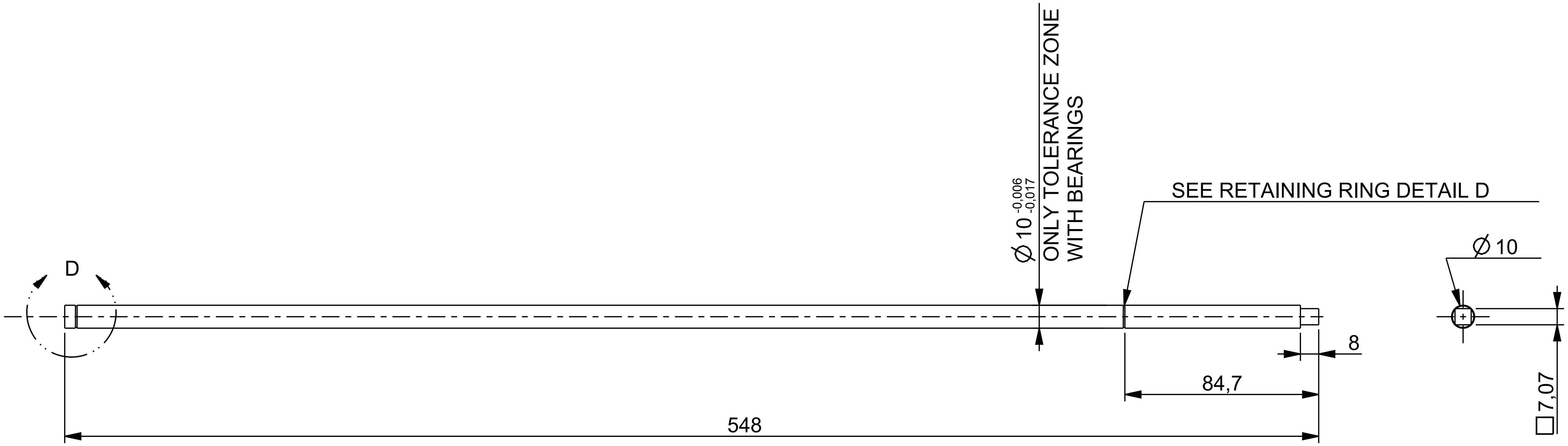
	NAME INITIALS	SIGNATURE	DATE
DESIGN:	DGM		MAYO -2008
DRAW:	DGM		MAYO -2008
APROVE:	VMC		MAYO -2008

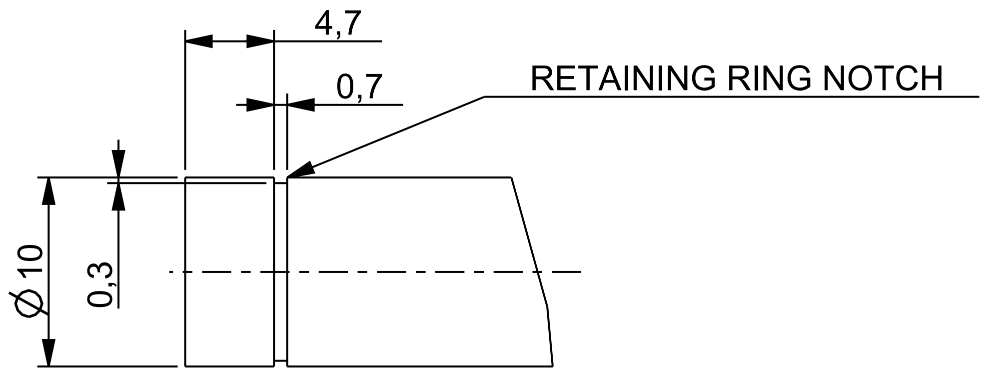
DRAWING NÂº 17
PRT-005-17

REFERENCE:
REF1
REF2
REF3
REF4

DATE:	MAY 2008
UNITS:	mm
DESCRIPTION:	SEPARTOR
GROUP / SUBGROUP:	GENERAL ASSEMBLY
SCALE:	1:1
SHEET:	1/1
FILE:	ARCHIVO
NÂº REV:	0

PRT-006-18
DRAWING NÂº 18





DETAIL D
SCALE 2,500

PART: PINON SAHFT
PART NUMBER: 18
MATERIAL: AISI/SAE 304
QUANTITY: 1 UNT

NOTE:
ALL EDGES SHOULD BE SOFTENED

DANIELA GOMEZ MONTOYA
PRODUCT DESIGN ENGINEERING
EAFIT UNIVERSITY

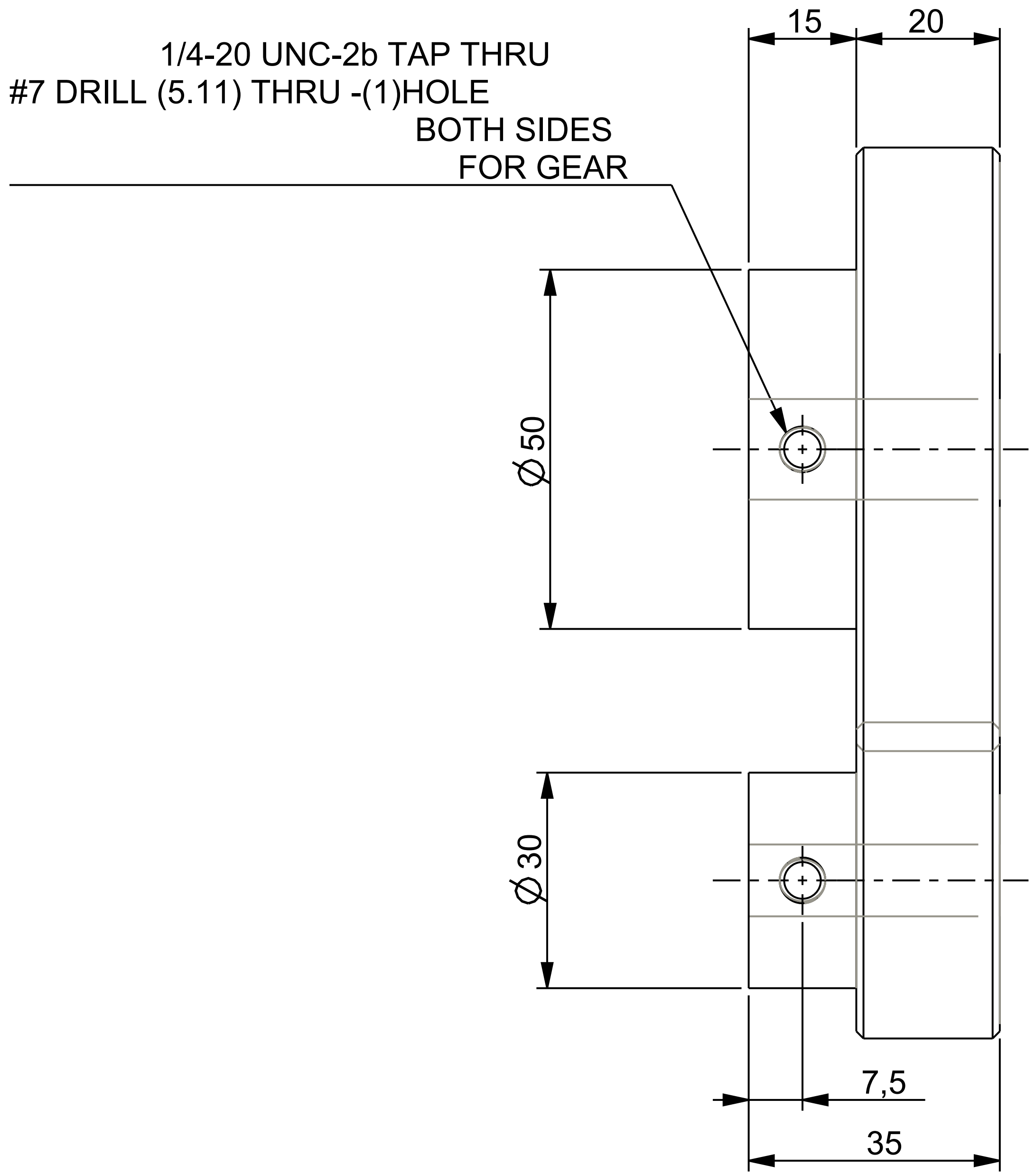
	NAME INITIALS	SIGNATURE	DATE
DESIGN:	DGM		MAYO -2008
DRAW:	DGM		MAYO -2008
APROVE:	VMC		MAYO -2008

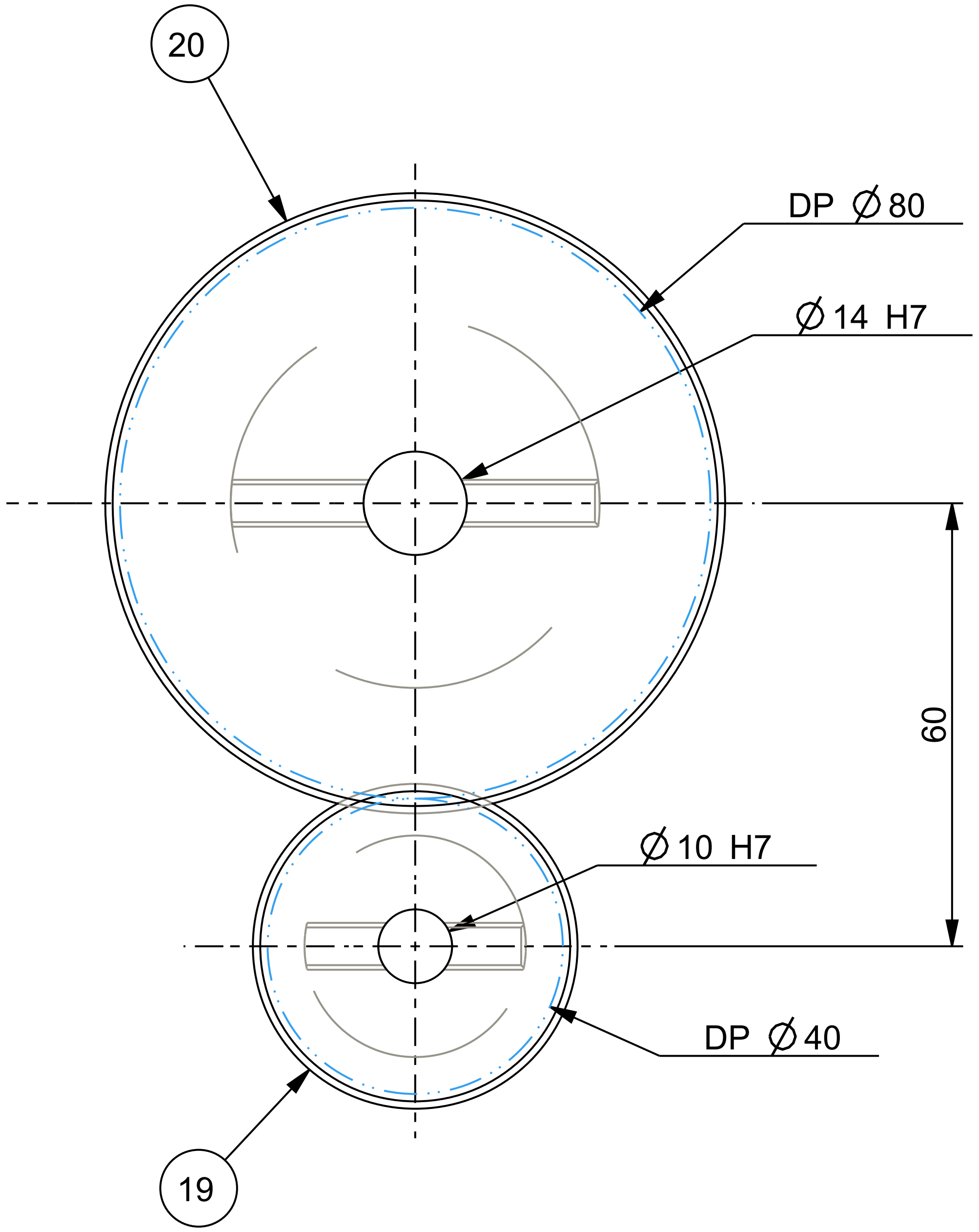
DRAWING NÂº 18
PRT-006-18

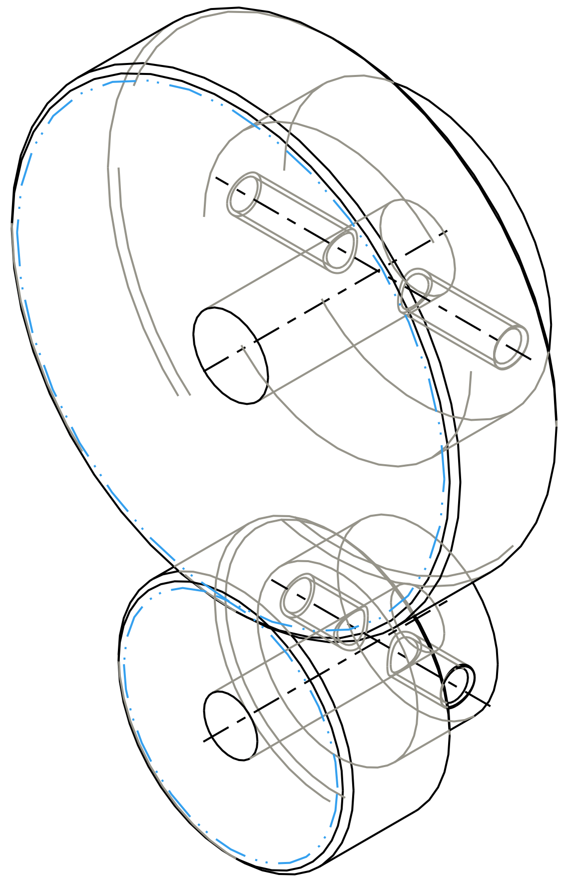
REFERENCE:
REF1
REF2
REF3
REF4

DATE: MAY 2008	DESCRIPTION: PINION SHAFT
UNITS: mm	
	GROUP / SUBGROUP: POWER TRANSMISION

SCALE:		SHEET:
1:2		1/1
FILE: ARCHIVO		NÂº REV: 0







PART: PINON & GEAR
PART NUMBER: 19 & 20
MATERIAL: CAST IRON
QUANTITY: 1/1 UNTS

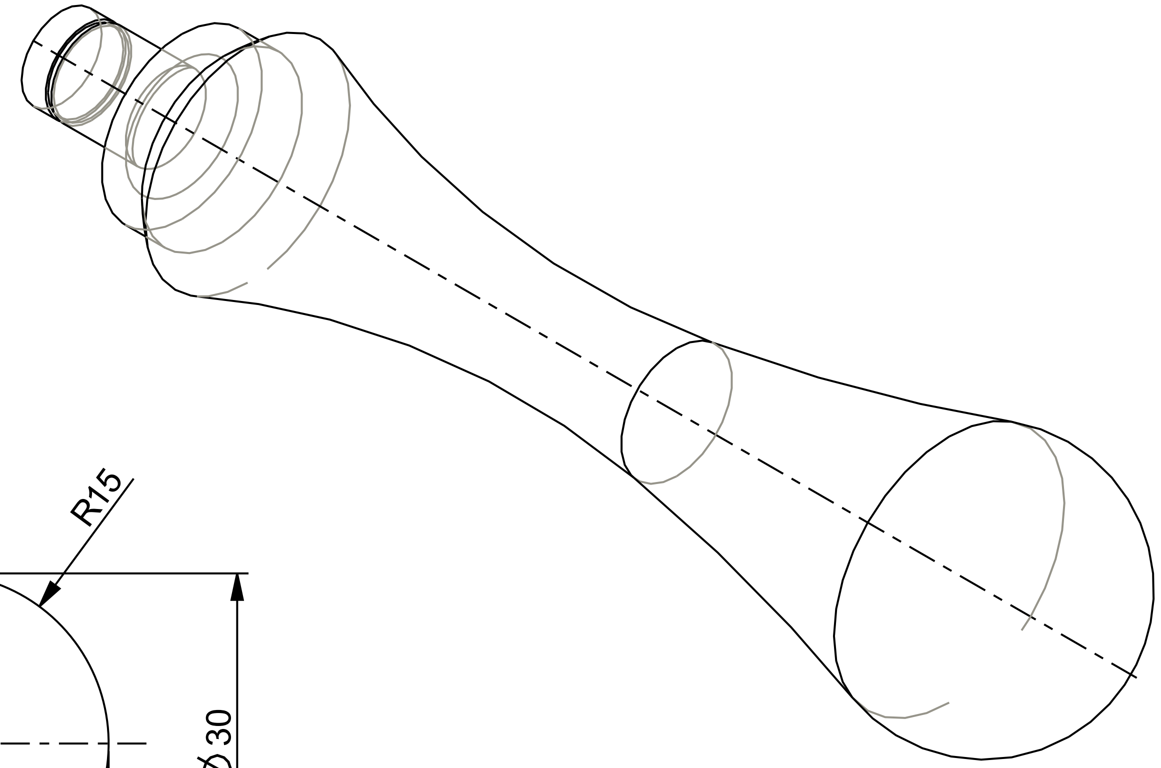
PINON
N - 14 1/2Â° PRESSURE ANGLE
DP - DIAMTRAL PITCH 40 mm
n - No. TEETH 20

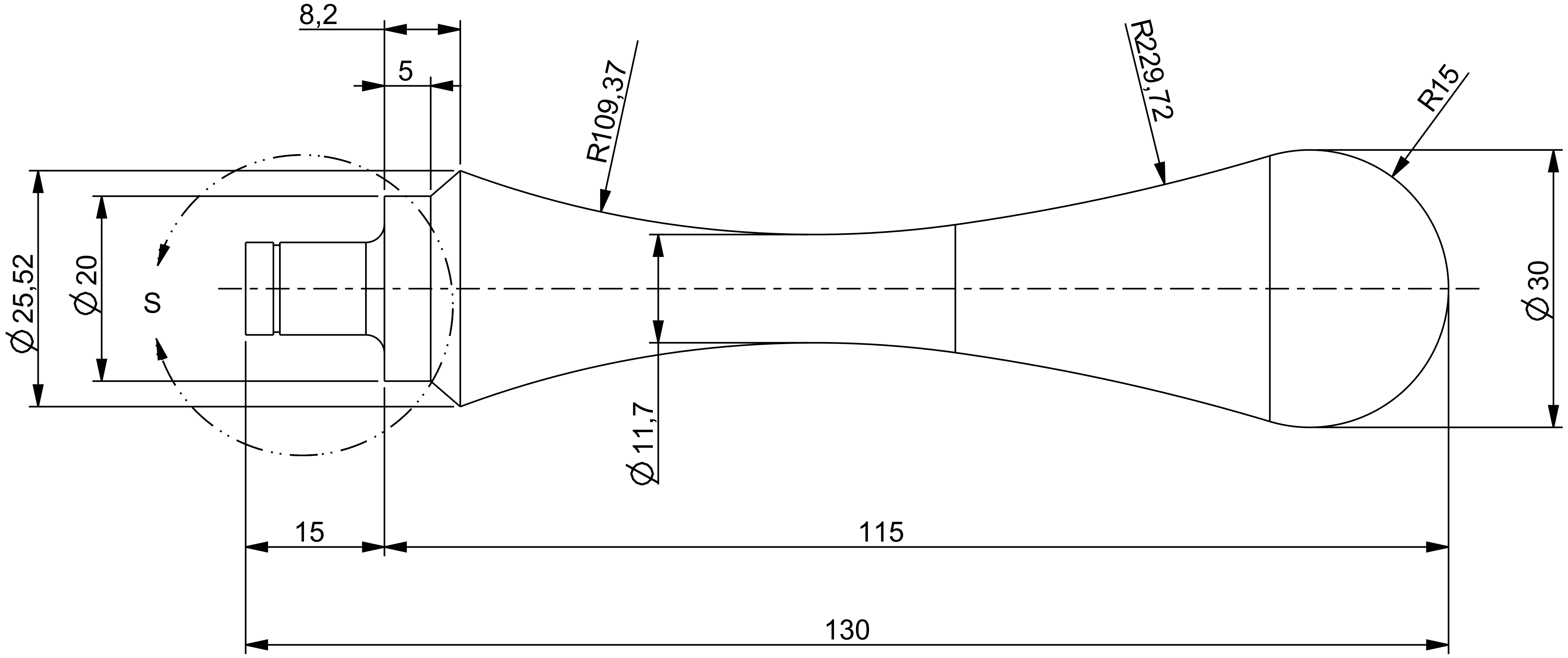
GEAR
N - 14 1/2Â° PRESSURE ANGLE
DP - DIAMTRAL PITCH 80 mm
n - No. TEETH 40

NOTE:
GEAR AND PINON ARE COMERCIAL PARTS
ALL EDGES SHOULD BE SOFTENED

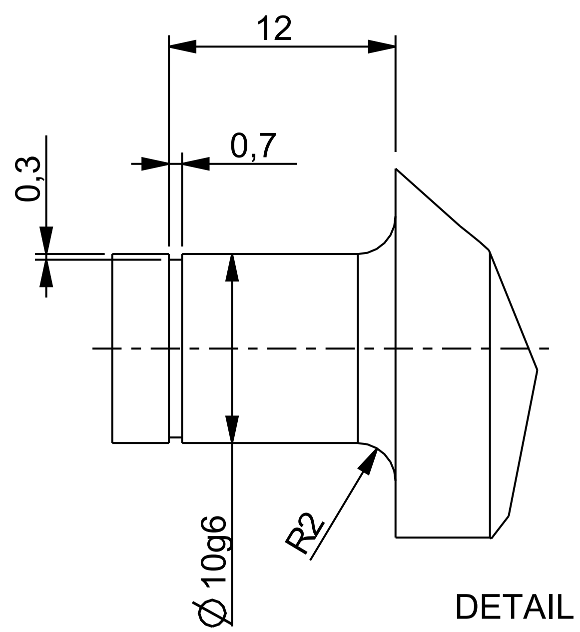
		NAME INITIALS	SIGNATURE	DATE	DRAWING NÂº 19
DANIELA GOMEZ MONTOYA PRODUCT DESIGN ENGINEERING EAFIT UNIVERSITY	DESIGN:	DGM		MAYO -2008	ASM-006-19&20
	DRAW:	DGM		MAYO -2008	REFERENCE:
	APROVE:	VMC		MAYO -2008	REF1 REF2 REF3 REF4
DATE: MAY 2008	DESCRIPTION: PINION GEAR ASEMBLY				SCALE: 1:1 / SHEET: 1/1
UNITS: mm					
	GROUP / SUBGROUP: POWER TRANSMISION				FILE: ARCHIVO / NÂº REV: 0

DRAWING NÂº 20
PRT-006-21





PART: REVOLVING HANDLE
PART NUMBER: 21
MATERIAL: AISI/SAE 304
QUANTITY: 1 UNT



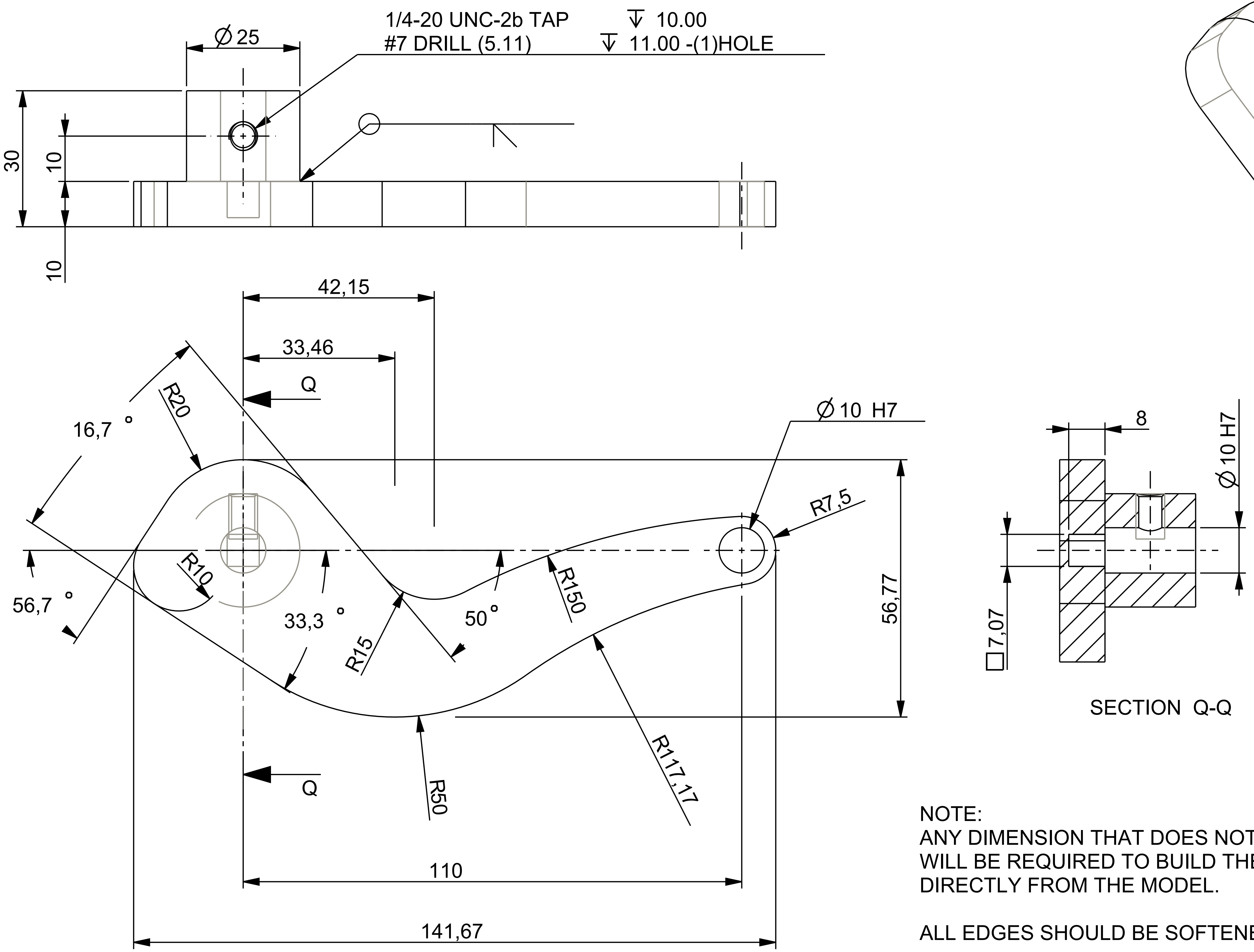
DETAIL S
SCALE 2,500

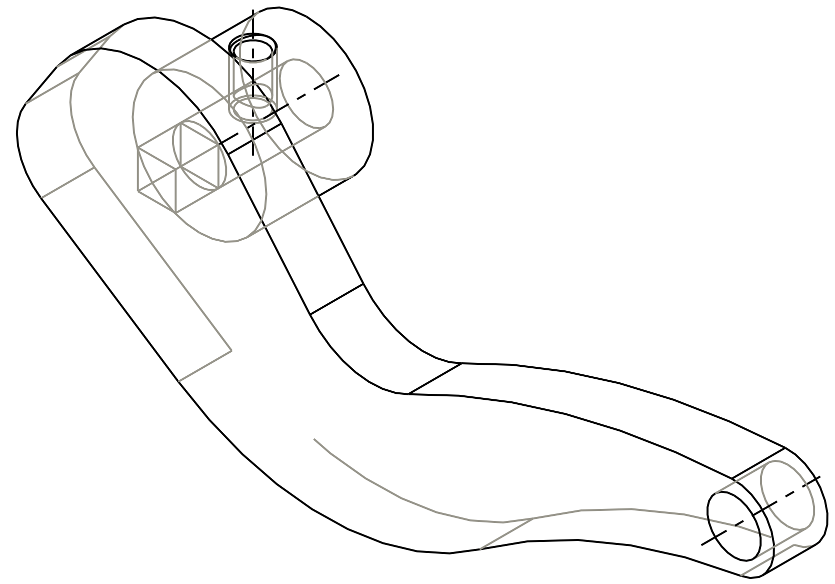
NOTE:
ANY DIMENSION THAT DOES NOT APPEAR IN THE DRAWING AND WILL BE REQUIRED TO BUILD THE PART SHOULD BE TAKEN DIRECTLY FROM THE MODEL.

ALL EDGES SHOULD BE SOFTENED

DANIELA GOMEZ MONTOYA PRODUCT DESIGN ENGINEERING EAFIT UNIVERSITY		NAME INITIALS	SIGNATURE	DATE	DRAWING NÂº 20 PRT-006-21
	DESIGN:	DGM		MAYO -2008	
	DRAW:	DGM		MAYO -2008	REFERENCE:
	APROVE:	VMC		MAYO -2008	REF1 REF2 REF3 REF4
DATE: MAY 2008	DESCRIPTION: REVOLVING HANDLE				SCALE: 1:1 / SHEET: 1/1
UNITS: mm	GROUP / SUBGROUP: POWER TRANSMISION				FILE: ARCHIVO / NÂº REV: 0

DRAWING NÂº1:
PRT-006-22





PART: CONNECTION ROD
PART NUMBER: 22
MATERIAL: ASTM A-36
QUANTITY: 1 UNT

NOTE:
ANY DIMENSION THAT DOES NOT APPEAR IN THE DRAWING AND WILL BE REQUIRED TO BUILD THE PART SHOULD BE TAKEN DIRECTLY FROM THE MODEL.

ALL EDGES SHOULD BE SOFTENED

DANIELA GOMEZ MONTOYA
PRODUCT DESIGN ENGINEERING
EAFIT UNIVERSITY

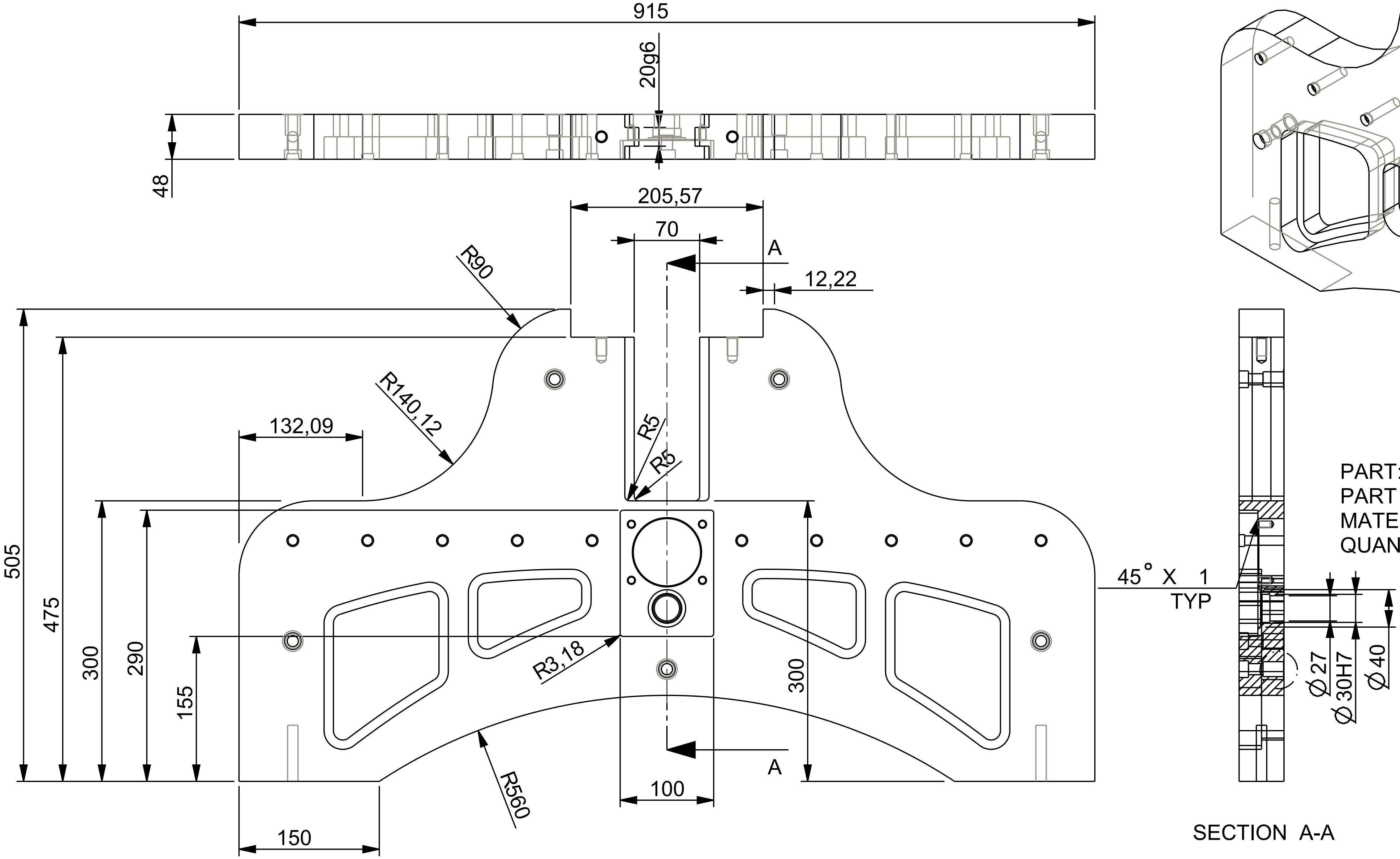
	NAME INITIALS	SIGNATURE	DATE
DESIGN:	DGM		MAYO -2008
DRAW:	DGM		MAYO -2008
APROVE:	VMC		MAYO -2008

DRAWING NÂº 21: PRT-006-22

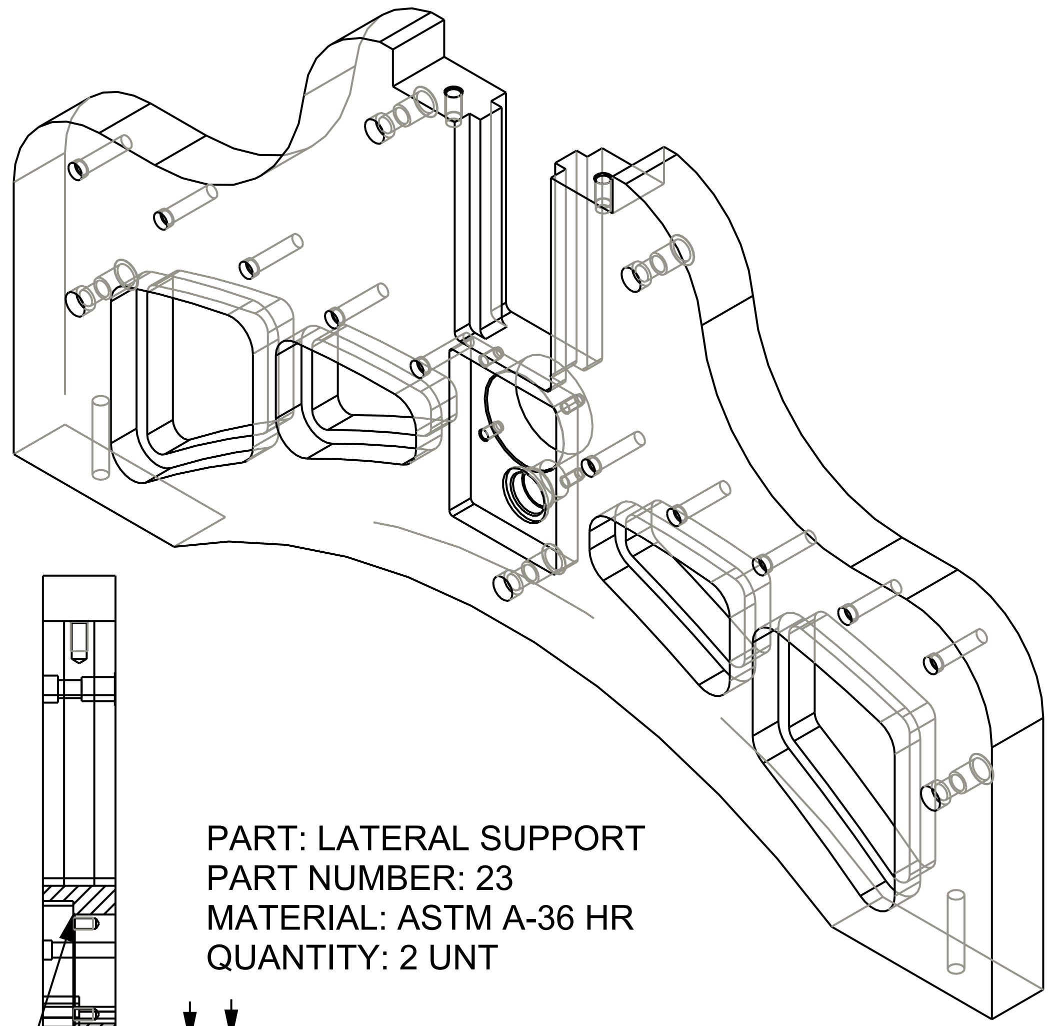
REFERENCE: REF1 REF2 REF3 REF4

DATE:	MAY 2008
UNITS:	mm
DESCRIPTION:	CONNECTION ROD
GROUP / SUBGROUP:	POWER TRANSMISION
SCALE:	1:1
SHEET:	1/1
FILE:	ARCHIVO
NÂº REV:	0

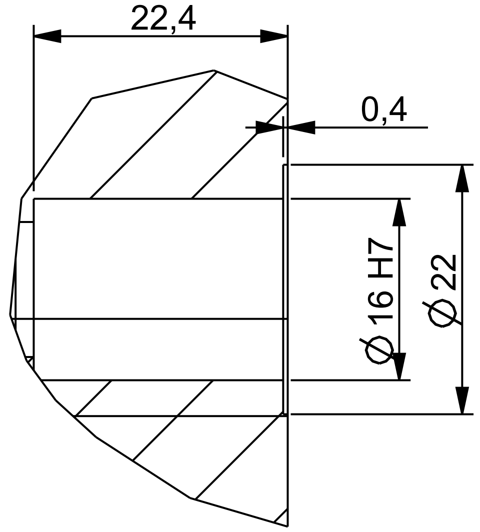
PRT-005-23
DRAWING NÂº 22



SECTION A-A



PART: LATERAL SUPPORT
PART NUMBER: 23
MATERIAL: ASTM A-36 HR
QUANTITY: 2 UNT



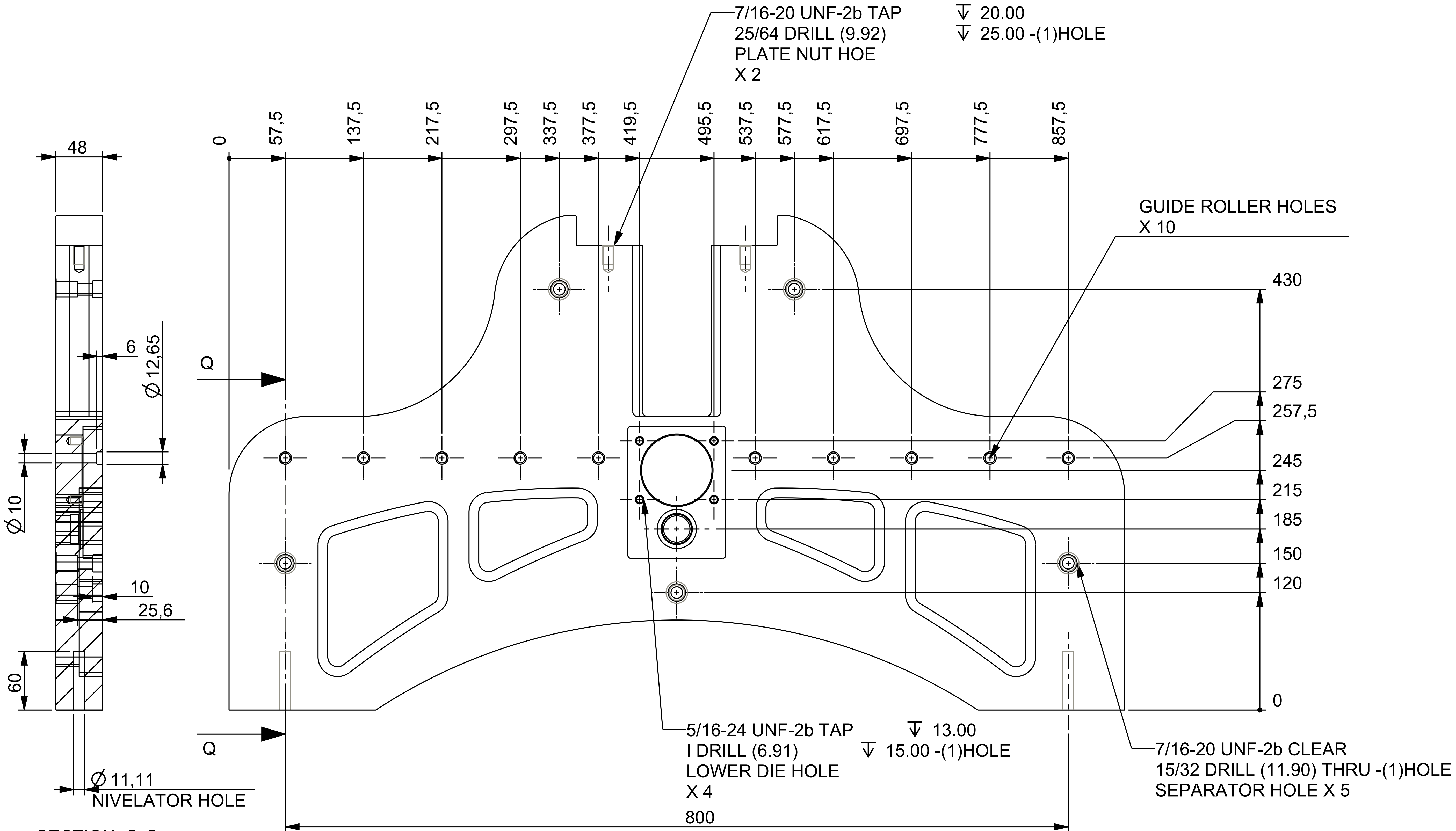
DETAIL U
SCALE 1,500
SEPARATOR HOLE SIT

NOTE:
ANY DIMENSION THAT DOES NOT APPEAR IN THE DRAWING AND WILL BE REQUIRED TO BUILD THE PART SHOULD BE TAKEN DIRECTLY FROM THE MODEL.

ALL EDGES SHOULD BE SOFTENED

		NAME INITIALS	SIGNATURE	DATE	DRAWING NÂº 22
DANIELA GOMEZ MONTOYA PRODUCT DESIGN ENGINEERING EAFIT UNIVERSITY	DESIGN:	DGM		MAYO -2008	PRT-005-23
	DRAW:	DGM		MAYO -2008	REFERENCE:
	APROVE:	VMC		MAYO -2008	REF1 REF2 REF3 REF4
DATE: MAY 2008	DESCRIPTION: LATERAL SUPPORT - GENERAL DIMENSIONS				SCALE: 1:5 / SHEET: 1/1
UNITS: mm	GROUP / SUBGROUP: GENERAL				FILE: ARCHIVO / NÂº REV: 0

PRT-005-23
DRAWING NÂº 23



SECTION Q-Q

NOTE:
ANY DIMENSION THAT DOES NOT APPEAR IN THE DRAWING AND WILL BE REQUIRED TO BUILD THE PART SHOULD BE TAKEN DIRECTLY FROM THE MODEL.

ALL EDGES SHOULD BE SOFTENED

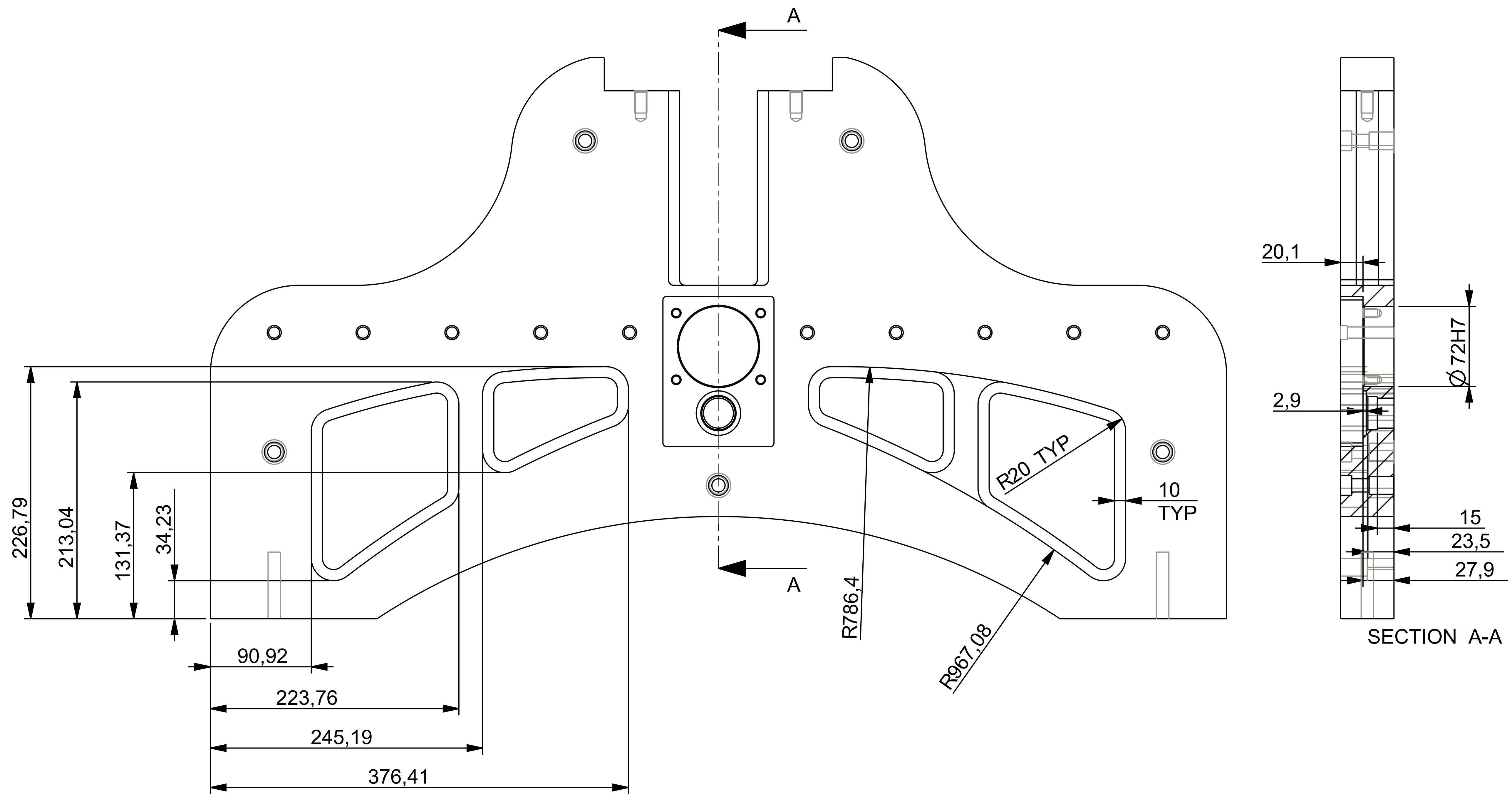
DANIELA GOMEZ MONTOYA PRODUCT DESIGN ENGINEERING EAFIT UNIVERSITY		NAME INITIALS	SIGNATURE	DATE
	DESIGN:	DGM		MAYO -2008
	DRAW:	DGM		MAYO -2008
	APROVE:	VMC		MAYO -2008

DRAWING NÂº 23: PRT-005-23
REFERENCE: REF1 REF2 REF3 REF4

DATE: MAY 2008	DESCRIPTION: LATERAL SUPPORT - ASEMBLE HOLES
UNITS: mm	
	GROUP / SUBGROUP: GENERAL

SCALE: 1:4	SHEET: 1/1
FILE: ARCHIVO	NÂº REV: 0

DRAWING NÂº 24
PRT-005-23



NOTE:
ANY DIMENSION THAT DOES NOT APPEAR IN THE DRAWING AND WILL BE REQUIRED TO BUILD THE PART SHOULD BE TAKEN DIRECTLY FROM THE MODEL.

ALL EDGES SHOULD BE SOFTENED

DANIELA GOMEZ MONTOYA
PRODUCT DESIGN ENGINEERING
EAFIT UNIVERSITY

	NAME INITIALS	SIGNATURE	DATE
DESIGN:	DGM		MAYO -2008
DRAW:	DGM		MAYO -2008
APROVE:	VMC		MAYO -2008

DRAWING NÂº 24
PRT-005-23

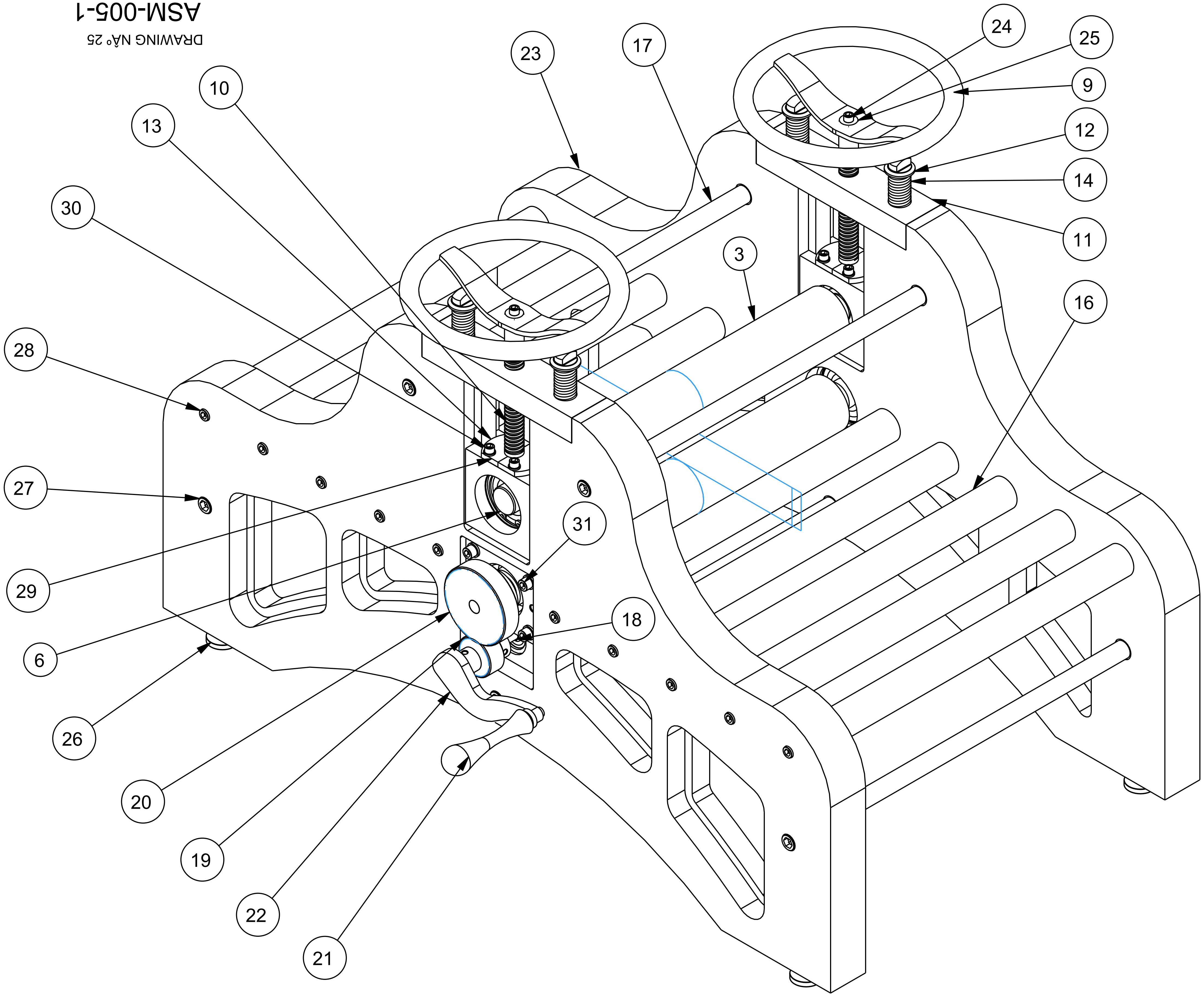
REFERENCE:
REF1
REF2
REF3
REF4

DATE: MAY 2008
UNITS: mm
DESCRIPTION: LATERAL SUPPORT - HOLES AN DETAIL TO MACHINING
GROUP / SUBGROUP: GENERAL

SCALE: 1:4
SHEET: 1/1
FILE: ARCHIVO
NÂº REV: 0

6	5	4	3	2	1

DRAWING NÂº 25
ASM-005-1

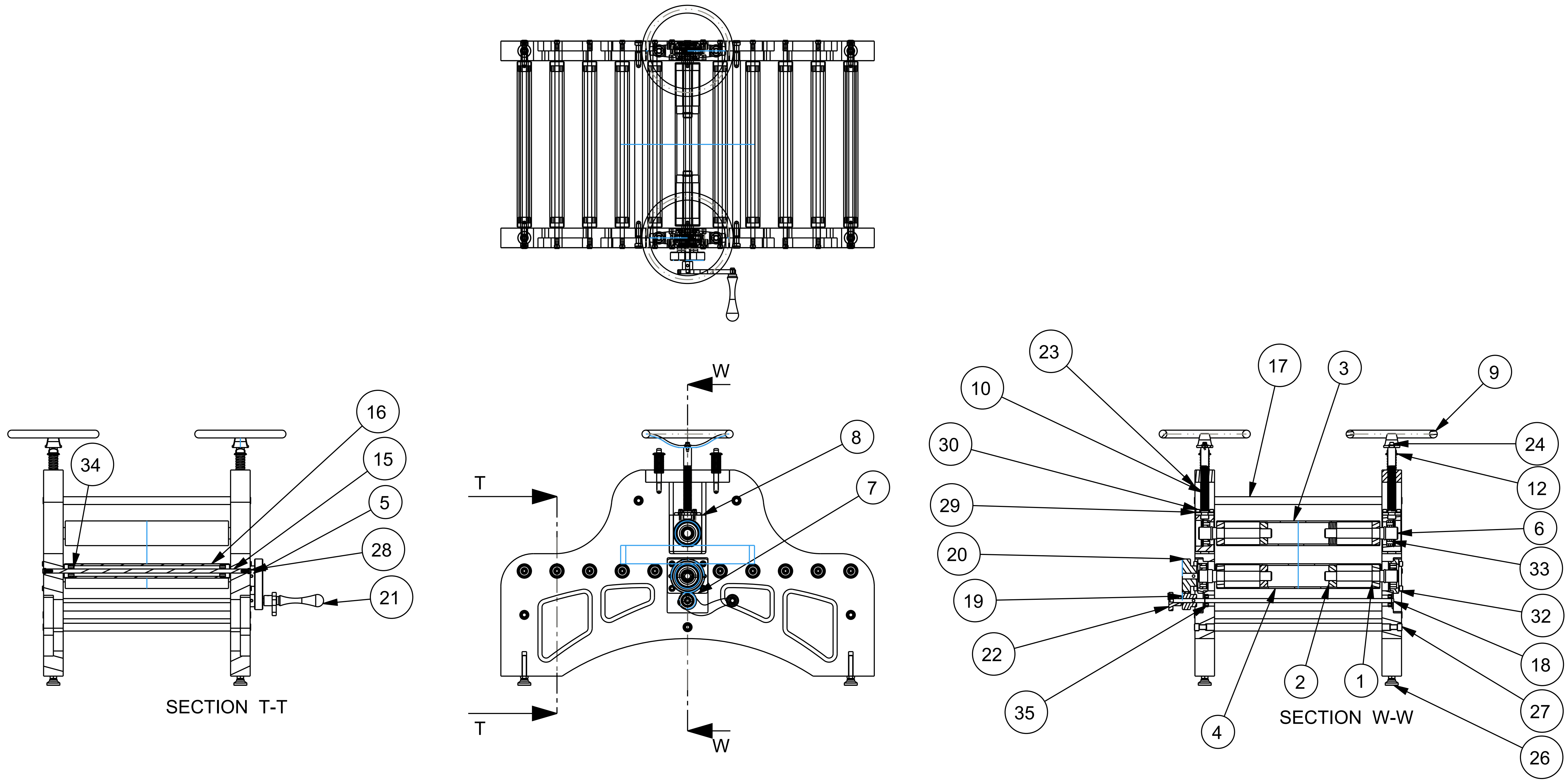


NOTE:
ANY DIMENSION THAT DOES NOT APPEAR IN THE DRAWING AND WILL BE REQUIRED TO BUILD THE PART SHOULD BE TAKEN DIRECTLY FROM THE MODEL.

ALL EDGES SHOULD BE SOFTENED

		NAME INITIALS	SIGNATURE	DATE	DRAWING NÂº 25
DANIELA GOMEZ MONTOYA PRODUCT DESIGN ENGINEERING EAFIT UNIVERSITY	DESIGN:	DGM		MAYO -2008	ASM-005-1
	DRAW:	DGM		MAYO -2008	REFERENCE:
	APROVE:	VMC		MAYO -2008	REF1 REF2 REF3 REF4
DATE: MAY 2008	DESCRIPTION: MACHINE ASSEMBLY				SCALE: 1:4 / SHEET: 1/1
UNITS: mm					
	GROUP / SUBGROUP: GENERAL				FILE: ARCHIVO / NÂº REV: 0

DRAWING NÂº 26:
ASM-005-2



NOTE:
ANY DIMENSION THAT DOES NOT APPEAR IN THE DRAWING AND WILL BE REQUIRED TO BUILD THE PART SHOULD BE TAKEN DIRECTLY FROM THE MODEL.

ALL EDGES SHOULD BE SOFTENED

DANIELA GOMEZ MONTOYA
PRODUCT DESIGN ENGINEERING
EAFIT UNIVERSITY

	NAME INITIALS	SIGNATURE	DATE
DESIGN:	DGM		MAYO -2008
DRAW:	DGM		MAYO -2008
APROVE:	VMC		MAYO -2008

DRAWING NÂº 26
ASM-005-2

REFERENCE:
REF1
REF2
REF3
REF4

DATE: MAY 2008
UNITS: mm

DESCRIPTION: CHASIS - HOLES AN DETAIL TO MACHINING

GROUP / SUBGROUP: CHASIS

SCALE: 1:10
SHEET: 1/1
FILE: ARCHIVO
NÂº REV: 0