# Two hole paper punch engineering essay

The product I have chosen to manufacture is the two-hole paper punch. This product is one which is widely used in homes, schools and businesses all over the world for the purpose of punching holes in paper to allow for attaching multiple sheets together in an organised fashion. Such examples of devices used in conjunction with the two-hole punch include the ring binder folder and treasury tags.

## Component Parts

On close inspection of existing two-hole punch products similar to the one in Fig. 1 it can be observed that there exists six fundamental component parts to the piece. Some of these components are used in matching pairs and for this reason they can be considered as one single part in regards to the manufacturing of the product.

Therefore the component parts can be categorised in four groups as follows:

- Base Plate ( To which everything is attached)
- Lever Handel ( The whole mechanism works from the behaviour of this part)
- Punchers ( Creates the holes in the paper)
- Springs ( Resets the mechanism for next use)
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## Possible Materials

There are countless materials which could be used to make the components of this product but the question is which ones are cost effective and also offer good quality.

At this point I am considering using Perspex for the lever handle and Aluminium for the base plate. Stronger materials will be needed for the puncher heads to ensure a lasting sharpness over repeated use. Stainless steel could be a possibility in this case. And the springs will need to be strong also for the same reasons of repeated use so I would consider using some other variation of steel here too.

## Perspex

The material we now know as Perspex began life, when the first acrylic acid was produced, in 1843. Methacrylic acid was formulated in 1865 and the reaction between methacrylic acid and methanolresults in the coumpound called metyl methacylate. In 1877 Two German chemists discovered the polymerization process that turns methyl methacrylate into polymethyl methacrylate. In 1933 another German chemist named Otto Rohmpatented and registered the name PLEXIGLAS. Then in 1936 the first commercially viable production of acrylic glass began. During World War II acrylic glass was used for submarine periscopes, and windshields, canopies, and gun turrets for airplanes.

From a chemical point of view it is the polymer of methyl methacrylate that is sold under the trade names of Plexiglas or Perspex.

Perspex is frequently used as a light or shatter-resistant alternative to glass. It is often favoured because of its moderate properties, easy handling and processing, and low cost. However when loaded it behaves in a brittlemanner and this is especially the case when subjected to an impact force. Also when compared to glass it is more prone to scratching.

**Aluminium**

Aluminium is a silvery-white andductilemember of theboron groupofmetals. It has the symbolAl and itsatomic numberis 13. Also it is not soluble in water. Aluminium is themost abundant metalin theEarth'scrust, and the third most abundant element therein, next to oxygenand silicon. It makes up approximately 8% of the Earth's solid surface by weight. Aluminium is too reactive chemically to occur as a free metal naturally. Instead, it is found combined in over 270diverseminerals. The chief resource of aluminium isbauxiteore.

Aluminium is remarkable for its ability to resistcorrosiondue to the phenomenon ofpassivationand the metal's low density.

Aluminium is a soft, durable, lightweight, malleablemetalwith visual appearance ranging from silvery to dull grey which depends on the surface texture. Aluminium is non-magnetic and non-sparking. It is also insoluble in alcohol, though in certain forms it can be soluble in water. Theyield strengthof pure aluminium is 7-11MPa, while aluminium alloyshave yield strengths ranging from 200 MPa to 600 MPa. Aluminium has about one-third the densityandstiffnessofsteel. It isductile, and easilymachined, cast, drawnandextruded.

Corrosionresistance can be excellent due to a thin surface layer ofaluminium oxidethat forms when the metal is exposed to air, effectively preventing furtheroxidation. The strongest aluminium alloys are less corrosion resistant due togalvanicreactions with alloyedcopper. This corrosion resistance is also often greatly reduced when many aqueous salts are present, particularly in the presence of dissimilar metals.

Aluminium atoms are arranged in aface-centred cubic(fcc) structure.

## Stainless Steel

Inmetallurgystainless steel, also acknowledged asinox steelorinoxfrom French “ inoxidable”, is defined as asteelalloywith a minimum of 10. 5or 11% chromiumcontent by mass. Stainless steel does not stain, corrode, or rust as easily as regular steel (itstains less, but it is not stain-proof). It is also calledcorrosion-resistant steelorCRESwhen the alloy type and grade are not detailed. There are different grades and surface finishes of stainless steel to suit the environment to which the material will be exposed to in its lifetime. Stainless steel is used where the properties of steel, and resistance to corrosion are both required.

Stainless steel differs from carbon steel by the amount of chromium present. Carbon steel rusts when exposed to air and moisture. This iron oxide film (the rust) is active and accelerates corrosion by forming more iron oxide. Stainless steels contain sufficient chromium to form a passive film of chromium oxide, which prevents further surface corrosion and blocks corrosion from spreading into the metal’s internal structure.

## Carbon Steel

Carbon steel, also calledplain carbon steel, issteelwhere the mainalloyingconstituent iscarbon. Carbon steel is defined as steel that has no minimum carbon content specified. The term “ carbon steel” may also be used in reference to steel which is notstainless steel; in this use carbon steel may include alloy steels.

Steel with a low carbon content has properties similar to iron. As the carbon content rises, the metal becomes harder and stronger but lessductileand more difficult toweld. In general, higher carbon content lowers the melting point and its temperature resistance. Carbon content influences the yield strength of steel because carbon atoms fit into theinterstitialcrystallinelatticesites of thebody-centered cubic(BCC) arrangement of the iron atoms. The interstitial carbon reduces the mobility ofdislocations, which in turn has a hardening effect on the iron. To get dislocations to move, a high enough stress level must be applied in order for the dislocations to " break away". This is because the interstitial carbon atoms cause some of the iron BCC lattice cells to distort.

## Mild and low carbon steel

Mild steel is the most common form of steel because its price is relatively low while it provides material properties that are acceptable for many applications. Low carbon steel contains approximately 0. 05-0. 15% carbonand mild steel contains 0. 16-0. 29%carbon, therefore it is neither brittle norductile. Mild steel has a relatively low tensile strength, but it is cheap and malleable; surface hardness can be increased throughcarburizing.

It is often used when large quantities of steel are needed, for example asstructural steel. The density of mild steel is approximately 7. 85g/cm3(0. 284lb/in3)and theYoung's modulusis 210, 000MPa (30, 000, 000psi).

## Background Research

### Production Process

The Objective of this section is to define the materials and examine the possible production processes for each of my four component parts. There is always more than one way to carry out a job and yet still obtain a successful result. However some methods are more cost effective than others. I wish to present multiple solutions to manufacturing each of my parts and from there choose the best balance of quality, time and economy.

### Base Plate – Aluminium

### Casting

The first production process option to be examined is the idea of the multiple-use-mold casting process In the permanent-mold casting process a re usable mold is machined from grey cast-iron, steel, graphite or other such material. The mold is first pre-heated, and molten metal is poured in under the action of gravity alone. After solidification, the mold is opened and, the product is removed. The mold is then reclosed and another casting is poured. Aluminium is frequently cast by this process.

There are numerous advantages for this process. The mold is reusable. A good surface finish is obtained provided the mold is in good condition. Dimensional accuracy can usually be held within 0. 13-. 25 mm. By selectively heating or cooling various parts of the mold, or by varing the thickness of the mold wall, directional solidification can be promoted so as to produce sound, defect-free castings with the desired mechanical properties.

However there are some drawbacks to this process too. The mold life depends upon a number of factors:

- The allow being cast. The higher the melting point, the shorter the mold life.
- The mold material. Grey cast iron has about the best resistance to thermal fatigue and also machines easily. Thus it is used most frequently for permanent molds.
- The pouring temperature. Higher pouring temperatures reduce mold life, increase shrinkage problems, and induce longer cycle times.
- Mold temperature. If the temperature is too low, mis runs are produced, and high temperature differences form in the mold. If the temperature is too high, excessive cycle times result, and mold erosion is aggravated.
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Mold complexity is often restricted because the rigid cavity has no collapsibility to compensate for the shrinkage of the casting. As a best alternative, it is common practice to open the mold and remove the casting immediately after solidification, thereby preventing any tearing that may occur on subsequent cooling-down. Permanent molds are usually headed at the beginning of a run and are then maintained at a fairly uniform temperature as a means of controlling the cooling rate of the metal being cast. Since the mold rises in temperature as a casting is poured and sufficient time is permitted for solidification, it may be necessary to provide a cool-down delay before another casting is poured. Refractory washes are often applied to the mold walls to prevent the casting from sticking and to prolong the mold life. Mold costs are generally high so that high-volume production is necessary to justify the expense.

## Milling

Milling is a basic machining process by which a surface is generated progressively by the removal of chips from a workpiece fed into a rotating cutter in a direction perpendicular to the axis of the cutter. Sometimes the workpiece remains stationary, and the cutter is fed to the work. In nearly all cases a multiple-tooth cutter is used so that the material removal rate is high. Often the the desired surface is obtained in a single pass of the cutter or work and, because very good surface finish can be obtained, milling is particularly well suited to and widely used for mass-production work. Several types of milling machines are used ranging from relatively simple and versatile machines that are used for general-purpose machining in job shops and tool-and-die work to highly specialized machines for mass production. Unquestionably, more flat surfaces are produced by milling than by any other machining process.

The cutting tool used in milling is known as the milling cutter. Equally spaced peripheral teeth will intermittently engage and machine the workpiece. This is called interrupted cutting.

Milling operations can be classified into two broad categories called peripheral milling and face milling. Each has many variations.

In peripheral milling the surface is generated by teeth on the periphery of the cutter body. The surface is parallel to the axis of rotation of the cutter. Both flat and formed surfaces can be produced by this method, the cross section of the resulting surface corresponding to the axial contour of the cutter. This method is often called slab milling and is usually performed on horizontal spindle machines. In slab milling, the tool rotates at a certain rpm while work feeds past the tool.

## Water Jet Cutting

Awater jet cutter or just waterjetis a machine capable of cutting intometaland other materials by means of a jet ofwaterat high velocity and pressure. The process is, in theory, the same aswater erosionfound in nature however it is greatly accelerated and concentrated. It is frequently used during manufacture of parts for machinery and other such devices. This is the preferred process when the materials involved are sensitive to the extreme temperatures that friction causes in other methods. Water jet cutting has found applications in a wide range of industries. Examples of these are mining and aerospacewhere it is used for operations such as shaping, cutting and carving.

One important advantage of the water jet cutter its function to process material without interfering with the material's inherent structure as there is no " heat-affected zone"/ Haz. Minimizing the effects of heat allows metals to be processed without altering internal charachteristics.

Water jet cutters also have the ability to produce rather detailed cuts in a material. When specialized computer software and 3-D machining tools are used, complex 3-D shapes can be created.

The nozzle can be changed and adjusted to give the required cutting width. Typical abrasive cuts are made with a nozzle in the range of 1. 016 to 1. 27mm, but can be as narrow as 0. 508mm. Non-abrasive cuts are normally 0. 178 to 0. 33mm, but can be as small as 0. 076mm, which is roughly the width of a human hair. Small cutters ike these can make very small detail possible in a broad range of tasks.

Waterjets are capable of accuracy of 0. 13 mm, and repeatability to within a tolerance of 0. 03 mm.

Water jet cutting is a “ green” technology. Nno hazardous waste is produced which reduces waste costs. Large pieces of recyclable scrap material are cut off using this method which would have been otherwise lost using traditional cutting methods. Waste water is usually clean enough to filter and disguard of down a normal drain. The abrasive is non-toxic and can be recycled for many uses. Water jets also avoid airborne fumes, and contaminates from cutting materials such as asbestos and fiberglass. This really benefits the work environment and greatly reduces any health problems arising from operator exposure.

## Lever Handel-Perspex

## Injection moulding

Injection moulding is used to produce more thermoplastic products than any other process. Granules of raw material are fed from a hopper by gravity into a pressure chamber ahead of a plunger. As the plunger advances, the plastic is forced through a heated chamber, where it is preheated. From the preheating segment, it is forced through the torpedo section, where it is melted and super-heated to 200-300°C. It then leaves this section through a nozzle which seats up against the mold and allows the molten plastic to enter the closed-die cavities through suitable gates and runners. The die remains cool, so the plastic solidifies almost as soon as the mold is filled. To ensure proper filling of the cavity, the material must be forced into the mold rapidly under considerable pressure, typically 35-140 MPa. Premature solidification would cause defective products. While the mold is being opened, the part ejected, and the mold reclosed, the material for the next part is being heated in the torpedo. The complete molding process takes typically between 1 and 30 seconds and is very similar to the die-casting of molten metals'.

Because thermosetting plastics must be held at an elevated temperature and pressure for sufficient time to permit curing, the injection molding process must be modified for this type of polymer. In the jet molding process the polymer is preheated in the feed chamber to about 95°C and then is further heated to the temperature of polymerization as it passes through the nozzle. Additional time in the heated mold completes the curing process. Care must be exercised to prevent the material in the nozzle from cooling during this time and clogging the flow. Water cooling is introduced to the nozzle area as soon as the cavity is nearly filled. The water cools the material in this region and retards the hardening reaction. Because of the long cycle time, little injection molding of thermo-sets is performed. The properties can often compete with die-cast metals, provided the lower rigidity of the polymer is not objectionable.

## Milling

The milling process is the same as before when it was discussed in relation to Aluminium. The only difference now is the material, which is Perspex.

## Laser cutting

Laser-aided cutting has brought about a revolution in the manufacturing industries. These high-powered optical beams are used to cut through a variety of materials such as metal, wood, glass and plastic. The laser is directed at the required surface and moved around to cut the material in the desired shape. Laser cutting gives a finer finish to the end product as compared to conventional cutting methods.

A typical laser beam is about 1/5th of a millimeter in width and has an intensity of 1000 to 2000 watts. Most laser cutting machines are integrated into a CAD/CAM system that helps the user design the end product on a computer before implementing it on the work piece.

Laser cutting devices are proving beneficial in a wide array of industries. The plastic industry is no exception. These optic powered devices are used to cut precise shapes into plastic or acrylic sheets. The lasers can be used to cut plastics of varying thickness by simply altering the intensity of the beam. Lasers are not only used to cut through plastics but also help engrave on various surfaces.

Laser plastic cutting machines bring precision and accuracy to the entire process. Since most machines are fully automated, they can perform complex cutting operations at high-speeds. The laser plastic cutting machines can also be used to cut polymers, polycarbonates and other synthetic materials such as polyesters and rubbers.

The laser cutting method uses a non-contact approach when cutting the material. Due to this, the wear and tear associated with conventional methods is absent, preventing the product from any damage and deformation. The laser process also delivers a finish quality unmatched by any other process.

When using laser plastic cutting machines, care should be taken to avoid the use of flammable plastics such as PVCs. These materials cannot cope with the heat generated by the laser and get damaged easily.

### Punches – Stainless Steel

### Extrusion

The process begins by heating the stock material. It is then loaded into the container in the press. A dummy block is placed behind it where the ram then presses on the material to push it out of the die. Afterward the extrusion is stretched in order to straighten it. If better properties are required then it may beheat treatedorcold worked.

The extrusion ratio is defined as the starting cross-sectional area divided by the cross-sectional area of the final extrusion. One of the main advantages of the extrusion process is that this ratio can be very large while still producing quality parts.

Hot extrusion is done at an elevated temperature to keep the material fromwork hardeningand to make it easier to push the material through the die. Most hot extrusions are done on horizontal hydraulic presses that range from 250 to 12, 000 tons. Pressures range from 30 to 700MPa (4, 400 to 102, 000psi), therefore lubrication is required, which can be oil or graphite for lower temperature extrusions, or glass powder for higher temperature extrusions. The biggest disadvantage of this process is its cost for machinery and its upkeep.

There are many different variations of extrusion equipment. They vary by four major characteristics:

- Movement of the extrusion with relation to the ram. If the die is held stationary and the ram moves towards it then its called “ direct extrusion”. If the ram is held stationary and the die moves towards the ram its called “ indirect extrusion”.
- The position of the press, either vertical or horizontal.
- The type of drive, either hydraulic or mechanical.
- The type of load applied, either conventional (variable) orhydrostatic.
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A single or twin screw auger, powered by an electric motor, or a ram, driven by hydraulic pressure (often used for steel and titanium alloys), oil pressure (for aluminum), or in other specialized processes such as rollers inside a perforated drum for the production of many simultaneous streams of material.

Typical extrusion presses cost more than $100, 000, whereas dies can cost up to $2000.

## Springs – Steel

The following description focuses on the manufacture of steel-alloy, coiled springs.

## Winding

### Cold winding

Wire up to 0. 75 in (18 mm) in diameter can be coiled at room temperature using one of two basic techniques. One consists of winding the wire around a shaft called an arbor or mandrel. This may be done on a dedicated spring-winding machine, a lathe, an electric hand drill with the mandrel secured in the chuck, or a winding machine operated by hand cranking. A guiding mechanism, such as the lead screw on a lathe, must be used to align the wire into the desired pitch (distance between successive coils) as it wraps around the mandrel.

Alternatively, the wire may be coiled without a mandrel. This is generally done with a central navigation computer (CNC) machine.

Examples of different types of springs.

Examples of different types of springs.

The wire is pushed forward over a support block toward a grooved head that deflects the wire, forcing it to bend. The head and support block can be moved relative to each other in as many as five directions to control the diameter and pitch of the spring that is being formed.

For extension or torsion springs, the ends are bent into the desired loops, hooks, or straight sections after the coiling operation is completed.

## Hot winding

Thicker wire or bar stock can be coiled into springs if the metal is heated to make it flexible. Standard industrial coiling machines can handle steel bar up to 3 in (75 mm) in diameter, and custom springs have reportedly been made from bars as much as 6 in (150 mm) thick. The steel is coiled around a mandrel while red hot. Then it is immediately removed from the coiling machine and plunged into oil to cool it quickly and harden it. At this stage, the steel is too brittle to function as a spring, and it must subsequently be tempered.

## Assembly

## Procedure

## Methods

## Quality Control

Qulaity control is defined as the maintenance of standards of quality of manufactured goods. With this in mind there are a few methods i could employ in the upkeep of quality in the product choosen.