



University of Wales Trinity St David



Engineering Design

Drill Press Redesign and Reflective Report

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1. Executive Summary

This report will be looking into the modification and redesign of an already functioning part. It will show the different stages of explaining the function of the part, designing a new and improved part, selecting the material that would be best for creating the new part and finally an explanation of the manufacturing process that will be used to mass produce the part.



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2. Introduction

This report will consist of a description of a drill press and the different types that are available in industry, outlining the different functions. The report will then focus on a main sliding unit of an already assembled drill press and highlight the characteristics that make it function correctly and how it can be improved for mass production.

The report will then focus on a new and improved main sliding unit, comparing different materials that can be used to make it, along with the method that the part will be made if it were to be mass produced. This method will have to be able to provide 500 units per week once it goes out on mass production



3. Findings

3.1.1 Drill Presses

The drill press is the standard machine tool that is used for drilling. There are different types of drill press' that are suited to certain jobs, depending on what type of hole is required. The most basic type of drill press is the upright drill press. This tool stands on the floor and consists of a table for holding the work part, a drilling head with powered spindle for the drill bit and a base and column for support.

A similar type of drill press is the bench drill. This tool is mounted on a table or bench rather than the floor. In addition, CNC drill presses are available to control the positioning of the holes in the work parts. These drill presses are often equipped with turrets to hold multiple tools that can be indexed under control of the CNC program. The term CNC turret drill is used for these machine tools. Work holding on a drill press is accomplished by clamping the part in a vise, fixture, or jig. A vise is a general-purpose work holding device possessing two jaws that grasp the work in position. A fixture is a work holding device that is usually custom-designed for the particular work part. The fixture can be designed to achieve higher accuracy in positioning the part relative to the machining operation, faster production rates, and greater operator convenience in use (Groover, 2010).

3.1.2 The Original Design

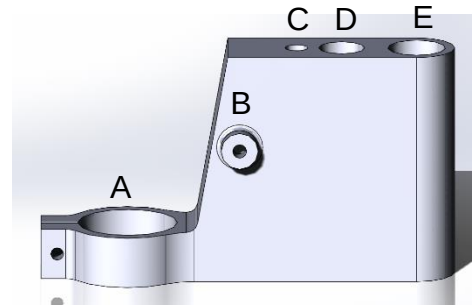


Fig 3.1.2.0 shows the design features A-E labelled.

See figure 3.1.2.0 for the original drill press main slide unit that was included in the drill press that I was given to modify both on its own and as part of the fully assembled drill press. This part is designed to hold a drill so that the spindle is held perpendicular to the base plate. This allows accurate, vertical drilling for hole-producing operations required in the manufacturing process. Materials can be hand fed to this type of drill press.

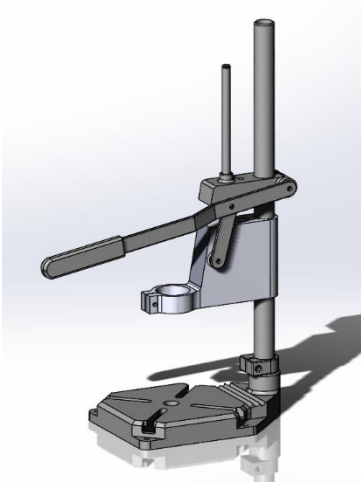


Fig 3.1.2.1 shows the slider unit as part of the drill press.

The main sliding unit of the drill press that I was given to improve consists of 5 holes and a clamp. According to Fig 3.1.2.0, the clamp is located on the left side of the part at point A. Its location allows enough room for the neck drill to be attached without conflicting with the rest of the drill press. The largest of these holes, located on the right side the image at point E, is fitted on to the main shaft of the press. The radius of this hole is machined so that it is slightly larger than the radius of the shaft to allow little



movement, but also allowing enough room so that the part can slide up and down with little resistance.

To prevent any side to side movement, a secondary guide hole had been included. This is the hole located at point C on the unit. This hole is vital as it ensures that the drill stays central during the process. The guide shaft part of the drill press can be altered to control the depth of the drilling. This is a practical feature as it expands the variety of holes that this type of press will be able to drill, making it available to carry out different jobs.

The up and down motion of the main sliding unit is controlled by the main lever arm. This arm is connected to the top brace and uses a smaller link arm which is attached to point B of the main sliding unit to move the drill up and down. It is important that the link arm hole is positioned appropriately to allow a good range of movement. These components work together to transfer the downward vertical force applied on the lever arm into the downward vertical movement of the drill. The lever arm is fitted with a spring return so that the drill is returned to its original position when the force is removed from the lever.

When designing the new sliding unit, it was vital that it contained these features so that its function would be the same.

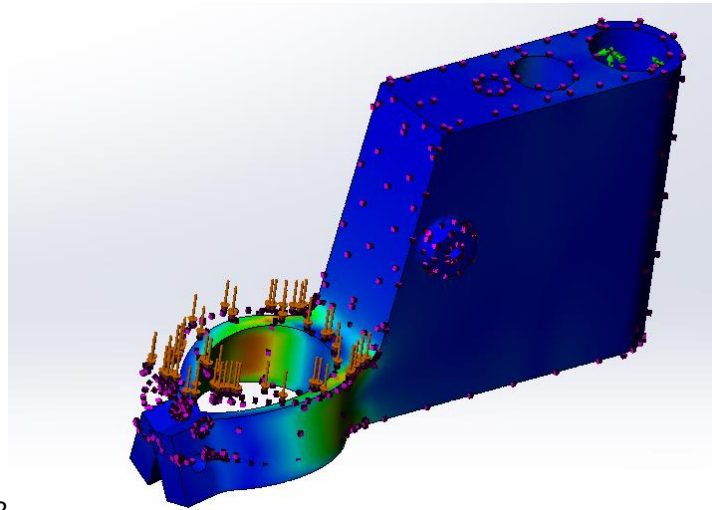


Figure 3.1.2.2

Figure 3.1.2.2 is a simulation from SolidWorks showing what would happen to the main sliding unit if a force of 50N (5 kg drill) was applied to it. There is clearly a weakness around the clamp area. This could be due to the fact that it is not a solid design and the space left between the clamping point has caused the material to buckle. When designing the new part, caution will be taken to ensure that this same problem does not occur.

3.1.3 New Design

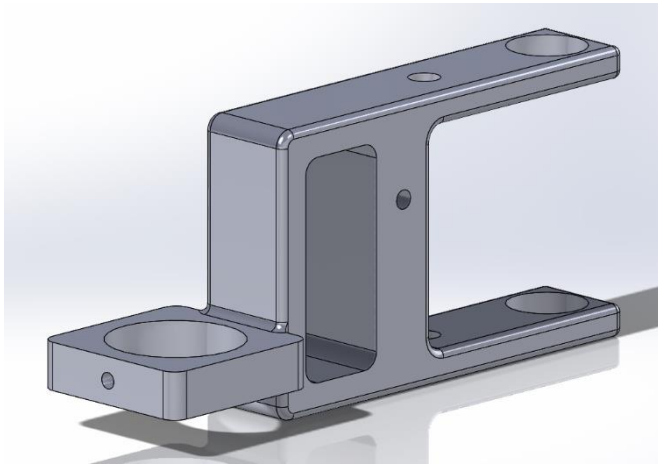


Fig 3.1.3.0 shows the new and improved main slider unit.

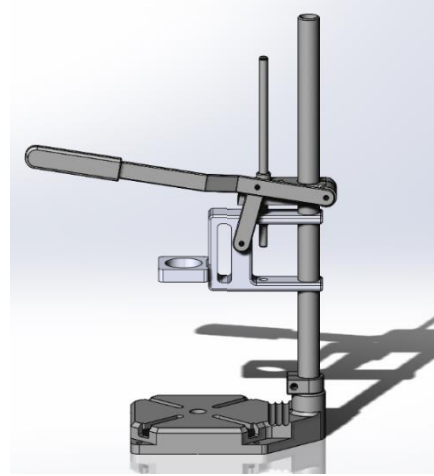
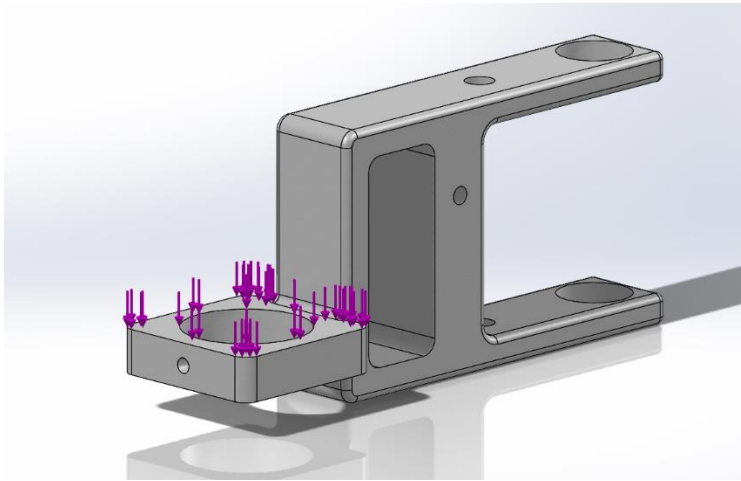


Fig 3.1.3.1 shows the new component as part of the assembly

The above images show the improved version of the main sliding unit. This component is a lot lighter than the previous one as a lot of the excess material had been left out. Although the new part looks completely different, a close visual inspection will show that the majority of the points that were highlighted in fig 3.1.2.0 are very much the same. The fact that there is less material will bring the cost of material right down and should still be sturdy enough to carry out its function. There are several other changes that have been made to the component including the location and type of drill clamp. The clamp has been raised slightly and includes a hole for a grub screw to fit into the drill to hold it in place. The clamp on this new part was noticeably different. This was due to how the clamp on the initial part buckled during the simulation shown in fig 3.1.2.2. In an attempt to avoid this, a solid square shape was used.



Fig 3.1.2.3 shows the new part prior to a simulation run



Due to issues with the SolidWorks software, a simulation run was not available for this part.



3.1.4 Material Selection and Manufacturing Process Selection

Material Selection

To meet the manufacturing demands for the new and potentially improved drill press main sliding unit, it is vital that the appropriate material is selected. This material will help determine the best outcome for the finished product. When selecting the material, the different properties and characteristics will be taken into account, along with the cost of the selected material. To ensure that the best material is selected for the part, research was carried out comparing a variety of different polymers that could be used.

Resin Generic Name	Some brand names	Mechanical Properties			Moldability Characteristics						Relative Cost
		Strength	Impact Resistance	High Temp. Strength	Warp and Dimensional Accuracy, Molded	Fills Small features	Voids in thick sections	Sink in Thick Sections	Flash	High Temp. hard on Mold & Ejectors	
Acetal	Delrin, Celcon	Medium	Medium	Medium-Low	Fair	Fair	Poor	Good	Good	Fair	Medium
Nylon 6/6	Zytel	Medium	High	Low	Fair	Excellent	Good	Fair	Poor	Fair	Medium
Nylon 6/6, glass filled	Zytel	High	Medium	High	Fair	Good	Excellent	Good	Fair	Fair	Medium
Polypropylene	Maxxam, Profax	Low	High	Low	Fair	Excellent	Poor	Poor	Poor	Good	Low
High Density Polyethylene (HDPE)	Dow HDPE, Chevron HDPE	Low	High	Low	Fair	Excellent	Unknown	Poor	Poor	Good	Low
Polycarbonate	Lexan, Makrolon	Medium	High	Medium-High	Good	Fair	Fair to Good	Fair	Good	Good	Medium - High
Acrylonitrile Butadiene Styrene (ABS)	Lustran, Cycolac	Medium-Low	High	Low	Good	Fair	Good	Fair	Good	Good	Low
Polycarbonate / ABS Alloy	Cycoloy, Bayblend	Medium	High	Medium	Good-Excellent	Fair	Good	Fair	Good	Good	Medium
Polyetherimide	Ultem	High	Medium	High	Good-Excellent	Fair	Fair	Good	Good	Poor	High
Polyetherimide, fiber reinforced	Ultem	Very High	Medium	High	Good	Fair	Fair	Good	Excellent	Poor	High
Polybutylene Terephthalate	Valox, Crastin	Medium	High	Low	Fair	Fair	Unknown	Fair	Fair	Good	Med-High
Polystyrene	Styron	Medium-Low	Low	Low	Good	Good	Unknown	Fair	Fair	Good	Low
Thermoplastic Elastomer	Isoplast, Santoprene	Low	High	Low	Poor	Excellent	Excellent	Good	Poor	Excellent	Low-Med
Acrylic	Plexiglass, Acrylite	Medium	Low	Low	Good	Fair	Excellent	Good	Good	Good	Medium

(Protomold, 2016)



After reviewing the above table and comparing the different aspects of each material, the selection process for the material that would be used for the part was narrowed down to two types of plastic. The final two materials, ABS and Nylon 6/6 glass filled were then analysed further to ensure the correct material was chosen. Each of the materials had their advantages as Nylon 6/6 glass filled is stronger than ABS. However, ABS is cheaper, has better mould accuracy and deals with flash than the Nylon. This will mean that the final product would have a better finish if injection moulding was to be selected as the manufacturing process.

Due to the type of part that the material is required for, it was not vital that the material; had to be very strong. As both of the materials were rated at least medium strength, the focus was then turned to the cost of each material. The cost of each material could be compared on Alibaba as it is a trade site and would be the provider of the material for the actual manufacture of the part.

Product Features	Nylon 6/6 Glass filled	ABS
Min.Order Quantity	500 Kilograms	1 Kilogram
FOB Price	US \$ 3.1-11/Kilogram	US \$ 2.99-3.43/Kilogram

(Alibaba, 2018)

After comparing the costs of each of the materials, it was decided that the polymer that was going to be used to create the part would be ABS plastic. This being as it was less than half the price per kilogram as the average price of Nylon 6/6.

Another factor in the selection of this material was that the minimum order quantity was only 1kg as oppose to the 500kg minimum order quantity of the nylon. This low minimum order quantity could come in handy if material is ordered in quarterly. Ordering the required material in every 3 months will ensure that there is not too much excess



material being stored away. Annual deliveries would also cause problems with storage as it may be difficult to come by for a years' worth of material. An issue with ordering materials in quarterly would be the risk of a material shortage. This could occur if a batch of parts were to fail the next stage of development. To

Overall ABS was the more practical option when it came to costs and storage purposes. According to certain material comparison sites, ABS comes off well against both impact force and corrosive chemicals. Despite this strength however, the material is relatively easy to machine. This material is also a good material to use for injection moulding as it has a low melting point. ABS is also ideal for 3D printing due to its melting and setting properties. These factors will be very effective if injection moulding or 3D printing were to be used as the manufacturing process.

(Mechanisms, 2017)



Manufacturing Process

Before diving straight in to mass production, a prototype of the part should be made to ensure that it functions correctly and can undergo further testing. There are several ways of doing this including CNC machining and 3D printing.

The method being used for this part will be 3D printing as the part can be created very accurately and will only take several hours as oppose to months. This part will also be completed by the printer, eliminating the need for manual labour. 3D printing is also good as it does not cost extortionate amounts and does not take a ridiculous amount of time to build the part. This means that the design can be verified by the printer before mass production to ensure the ergonomics and fit of the product are appropriate. (Innovation, 2015).

Using SolidWorks, an estimate for the costings of a 3D printed prototype could be found. Printing off an ABS part weighing in at 0.46lbs came to an estimated £62.65 per part. This one off cost would be worth the investment as the prototype will be required instead of mass producing straight away. If there are any errors with the prototype, then amendments can be made and production will be put on hold (SolidWorks, 2017).

Once the prototype part has been obtained, it can then be mass produced via injection moulding. This mould is essential when it comes to moulding as once the custom design is fabricated, thousands of moulds can be made. The life of an injection mould tool can be anything between 500,000 and 1,000,000 parts per tool. This means that one tool is more than enough to provide the 500 parts per week demand for the main sliding unit. However, the tool will need refurbishing/maintenance like all things (BASF, 2016).

Due to the high thermal expansion coefficients in polymers, when the part cools it can be affected by shrinkage. This occurs when the plastic cools suddenly from the moulding temperature to room temperature. To ensure that shrinkage does not affect the final product, molds are made slightly larger than the part should be to compensate for any shrinking material. The shrinkage of ABS is the smallest when it comes to



moulded thermoplastics. This plastic will only shrink by 0.006mm, meaning there will be little issues with freshly moulded parts being affected. Weld lines, flash, voids and warping can also occur during the injection moulding purpose. Parts affected y any of these would have to be scrapped (Groover, 2010).

While the mould itself is not cheap to make, once it has been made it can produce thousands of parts making it well worth the investment.



4. Conclusion

This report focuses on the modifications and improvements made to a standard drill press sliding unit. While this original was perfectly capable of carrying out its purpose, changes were made to ensure it was eligible for mass production. These changes included getting rid of any material that was not deemed important in an attempt to keep the cost of materials required to build the part at a minimum. The new and improved main sliding unit was a different shape to try and avoid it from buckling due to the force applied when the lever is pulled down, starting the drilling. It is not known yet whether or not the new part will suffer the same problem as the simulation was not available due to technical issues with SolidWorks. Overall this



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