

*Project Title: Drill Guide with
Residue Extraction*

Adrian Escartin
Centre No: 71526
Candidate No: 9056
Teacher: Mr Maguire



Product Research and Identification

Big Gator Tools V-DrillGuide

<https://www.shop.biggatortools.com/Standard-V-DrillGuide-3-8-1-2-STD2000DGNP-STD2000DGNP.htm>

1 - Function and Purpose

This product's intended function is to quickly and simply let the user drill angles 90° to the intended surface. It achieves this by being a single solid piece (for ease of use and durability) with one slot the user inserts their drill into. It comes with several drill brushes (6) to accommodate a variety of drill diameters that the user may use with the product (6mm up to 10mm) and each can be removed with the included hex wrench. The circular base of the product is meant to help keep the drill stable and it does this by both being large, and being very rigid (manufactured as one, solid aluminium piece). Being a small product, it is able to be moved about and used quickly by the user.

2 - Design Features

This tool is designed to be a small handheld drill aligning tool. Due to its fixed 90° angle, limited capabilities and low cost, it is intended for use in a home environment. The drill slot is attached to the base with 3 support arms to ensure the product can withstand the large forces that are involved with drilling. These support arms are attached to a large circular base and this ensures the entire drilling apparatus remains steady – ensures the user is able to accurately drill a straight hole. Having swappable drill brushes as a design feature makes the product adaptable to the user's needs if they have drills of differing diameters.

3 - Industrial Production Methods

The AIBER drill guide - being made of aluminium alloy 6061 – is industrially produced by a casting method. It is able to be done in one mould due to the unibody design the product accompanies. The individual drill brushes are all also made by casting. Each cast is different and this ensures that each drill brush has a unique diameter to accommodate different drill bits. It also has an anodized finish due to it being aluminium

4 - Ergonomic Suitability

Ergonomically, due to the product's small size, it is easy for the user to hold and transport about. To ensure that the drilling area stays the same, the product has a large circular base that the user can hold on to. The product's smooth anodized aluminium finish also ensures that the product is pleasing to hold. The smooth finish also makes sure that the product is not able to cut the user – as would happen if the product had a rough surface.

5 - Aesthetic Suitability

The aesthetic property that stands out the most is the product's bright red anodized finish. This ensures that it stands out amongst other similar products (ones that have the purpose of being a drill guide) and as a result makes the user more likely to buy and use. This is very suitable due to the target demographic of the product being people using it in a home environment.

6 - Materials

Aluminium alloy 6061 is the material used in this product. Being an aluminium alloy that contains magnesium and silicon, it possesses the ideal properties to be used in this product. It has great mechanical strength (to make it withstand drilling forces and for great general durability), high strength to weight ratio (ensures that the product is light) and ease of moldability (this ensures the product is easy and cheap to manufacture). Being aluminium, the product will not rust (and hence have a longer expected product lifespan) and it is able to have an anodized finish.

7 - Fitness for Purpose

The product is fit for its purpose as a simple drill guide. It is able to ensure the drill is aligned perpendicular to the drilling surface (with its large flat circular base) and it does this whilst taking up a small footprint. The aspect that limits this product is its limited functionality - if the user wants to do more elaborate drilling, they need to consider a different drill guide product that has more functionality. The fixed angle makes it so that 90° is the only angle the user can drill into their desired surface – this limits them if they want to do 70° angles for example. The product can be only ideally used on flat surfaces, if they want to drill a tubular or edged surface, they need to also use a different product.

8 - Product Sustainability

The product is designed to be frequently used due to its small size and simple design. Even though it is limited in angle choice in comparison to other drill guides, it offers the advantage of ensuring the user accurately drills 90° to the intended surface over just using the drill handheld by itself. Due to these features and its relatively quick set up time, it is most suitable if the user wants to drill several 90° holes (the most common for home use) on a surface in quick succession.



Attribute	1	2	3	4	5	6	7	8	Total/40
Rating/5	2	2	4	4	5	4	2	2	25



Attribute	1	2	3	4	5	6	7	8	Total/40
Rating/5	3	3	4	3	4	4	3	2	26



Attribute	1	2	3	4	5	6	7	8	Total/40
Rating/5	4	3	3	4	3	3	5	5	30



AIBER Woodworking Tool Drill Guide

<http://woodworkingprojectsyoucanbuild.com/6-7-8-9-10mm-woodworking-tool-drill-guide-vertical-drilling-fixture/>

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1 - Function and Purpose

This product's function is to allow the user to drill holes 90° to their desired surface. Unlike the other drill guides, it accommodates all of the different drill brushes into one piece so a wide variety of drill sizes can be used with the product right out of the box. However to actually use the product, a clamp is needed to secure the V-DrillGuide to the drilling surface since without it, its small base makes it so that it is very unstable otherwise.

2 - Design Features

The most obvious design feature that this product has is its 9 drill brush holes. This is to allow the user to quickly and easily use a wide variety of drill sizes without having to setup the product to accommodate the drill bit size they wish to use. It also features an angled bottom side ("V-groove design") that allows the user to drill perpendicular holes on round and cornered surfaces. The product's body also features alignment lines to help the user to precisely line up the drill guide onto the exact area they wish to drill through.

3 - Industrial Production Methods

Being made out of hardened steel – this product is made from a permanent mould casting method. This is to ensure the product is able to be manufactured at a low cost since the entire product is only one piece and hence only one mould is needed to cast the product. The steel is hardened by being heat treated and what this does is increase the durability of the product.

4 - Ergonomic Suitability

This product has an adequate ergonomic shape for its purpose. The steel edges of the product are all filleted and to make it pleasing to hold, it has a nice smooth finish. Another ergonomic feature that the product has are drill alignment lines to tell the user where exactly the centre of their drill will burrow. This drill guide also has text beside drill brushes to tell the user what size of drill fits in what drill brush.

5 - Aesthetic Suitability

The V-DrillGuide does not have aesthetics as one of its main priorities – as evident from its simple, "natural steel" finish. It does have functional aesthetics that are from the text that is engraved onto the product giving information on drill brush size and how to maintain the product. Overall the aesthetics are suitable for this product as it is meant to be used as a working tool, where function comes first and form comes second. The function of the product makes up for its dull utilitarian aesthetics.

6 - Materials

The product is made out of steel to allow it to be manufactured cheaply at a large scale whilst still retaining high strength. However, being made out of steel it is prone to rusting. As advised on the text that is engraved on the product, it needs to be oiled frequently to prevent rust. Being highly durable is a requirement with this product as it has to simultaneously withstand frequent forces that are associated with drilling and compressing when held with a vice. Steel, although not being perfect (due to it being able to rust), is still however a suitable material for this product as it addresses the mechanical requirements that a drill holder needs.

7 - Fitness for Purpose

The diameter of the product is large enough to accommodate 9 drill brush sizes (from 3/8" to 1/2") which makes it fit for its purpose as a drill guide as it lets the user use 9 different drill sizes with the product without any prior setup. It also features a "V-groove design" to let the user drill on surfaces that are not completely flat – making it even more fit and adaptable for its purpose as a drill guide. However, a clamp is necessary to use this product to ensure that it keeps itself steady over a drilling surface. As a result, without a clamp being used in conjunction with this product, it is less useful than other drill holders that I researched.

8 - Product Sustainability

The V-DrillGuide is designed for easy and quick use due to its simple to understand design. This is due to the engraved text telling the user what diameter drill the drill brushes will accept along with hole alignment marks so that the user will be able to drill exactly on their desired drilling area. It however still does not allow the user to drill other drilling angles other than 90° and it is necessary to use a clamp in conjunction with this product, so it is limiting in these aspects, nevertheless having 9 drill brush sizes quickly available in addition with the ability to drill holes on surfaces that are not flat does give the product high utility.

RX Drilling Dust Nozzle

https://www.amazon.co.uk/dp/B07FQFH8R/ref=cm_sw_r_tw_dp_U_x_2v6KDb6ANF2FQ

1 - Function and Purpose

The RX Drilling Dust Nozzle is meant to remove dust whilst the user is drilling onto a surface. It accomplishes this by being a medium between the drilling surface and a vacuum cleaner, where a vacuum cleaner will do the dust extraction. The product holds the vacuum cleaner tube and ensures all the residue from the user's drilling is guided into the vacuum. The attached vacuum cleaner's suction force is also intelligently utilised by this product - it is able to use this force to allow the product to stick onto walls – making it so that the user does not have to hold onto the product at all whilst drilling.

2 - Design Features

The product comes with a nozzle attachment that allows the user to attach vacuum cleaner hoses with various diameters - from 26mm up to 39mm. It also accepts drill bits with a diameters of up to 12mm. With both of these specifications, this ensures the product will work with a wide range of drill-bits or vacuum hose diameters. The extraction nozzle where the vacuum attaches to is angled downwards out of the way of the user – improves ergonomics whilst the user is drilling. It also utilises the suction force from a vacuum to hold the product against a wall – improving its ease of use.

3 - Industrial Production Methods

The majority of the product's construction is plastic and as a result this lowers its production cost. It is made of a plastic that has high toughness characteristics, such as ABS and because of this, it is made by an injection moulding process. Since the product is made of multiple components, the orange nozzle is injection moulded separately from ABS with a different colour for aesthetic purposes. To ensure airtight fits between the wall and a vacuum cleaner, the product also features rubber seals which are glued onto the main body of the product to ensure they do not loose whilst the product is under operation.

4 - Ergonomic Suitability

This product's most significant ergonomic feature is that it is able to stick onto walls. This frees the users hands when they are drilling a surface and as a result it makes it more useful than other drill extractors that the user has to hold on to. To further improve ergonomics, the product directs the vacuum nozzle downwards as to not get in the way of the user's work. To make the product easier to grip onto for the user, small shaped grooves are present as seen on the



Product Research and Identification

Zerone Drill Bench Press Stand

https://www.amazon.com/dp/B07C5VJSHV/ref=cm_sw_r_tw_dp_U_x_Mg8KDbFWH7NB9

1 - Function and Purpose

This product's function is to hold a drill and in addition to this, provide the user with the ability to drill different depths with high accuracy. It fulfils this goal as this specific drill holder comes with a large lever and depth measuring tool to give information on how deep the user has drilled their hole. The product also features a large base to make sure that the drilling operation remains centred on the desired area.

2 - Design Features

The lever is the most prominent design feature of this stand and it increases drilling depth accuracy to the user by leveraging a class 2 lever. This step down velocity ratio – in conjunction with the measuring tool – makes it so that the user is able to know exactly how far they have drilled down. The base of the product also features several holes to accommodate vice. This further improves the stability of the product if utilised and as a result the Zerone Drill Bench is suitable for heavy duty applications.

3 - Industrial Production Methods

The aluminium that is used for the base is cast moulded. This is because this process enables the manufacturing of complex shapes that are found in the base – such as the various alignment holes and the vice holder holes. The column and lever are made of high carbon steel and are of a much simpler shape in comparison to the base. As a result, these parts are extruded. The rubber grip that is on the handle is glued to make sure it does not detach.

4 - Ergonomic Suitability

The press' end features a rubber handle to improve the ergonomics of the product. This is due to rubber being a soft pleasing material to hold on to and it also provides utility due to its grippy nature – making it suitable for a handle. The depth measurement tool is angled towards the user to make sure it is visible during operation – which is another positive ergonomic feature the product has.

5 - Aesthetic Suitability

Aesthetically, this product looks utilitarian. The integrated measuring tool and various drill alignment moulds that are in the base of the product all serve to give extra information to the user to make sure that they get a more accurate and precise drilling experience with this product. The part that holds the drill itself is in black – to make it stand out to the user. The product also has a large yellow warning sticker on the base. This is to make sure that the user is able to easily notice and read the instructions on how to use the product – making the product more safe to operate. What all these aesthetic decisions do is make the product more intuitive and safe to use.

6 - Materials

To reduce the weight of the large base, aluminium is utilised and the use of this material prevents this portion of the project from rusting. This improves the product's lifespan as rust would otherwise reduce the base's strength over time. The column and lever of the product are made of high carbon steel for its higher hardness and toughness value. This is to withstand the moment and vibration forces from a power drill and the user using the lever.

7 - Fitness for Purpose

The Zerone Drill Bench Stand's many features that make it fit for its purpose of letting the user drill large diameter holes with great precision – especially in terms of depth. It accomplishes this by having features such as a large lever, which in conjunction with the depth measuring ruler, give the user more granular control on how deep they drill. The vice holes make it so that this product is able to stay steady even under heavy forces that may come with a large diameter drill – ensuring the user is able to reliably drill several identical holes in quick succession.

8 - Product Sustainability

This product has many features that contribute to its sustainability. The large aluminium base ensures that the product remains stable whilst in use or if this was not enough – for larger drilling operations – a vice can be attached to the product's base for even more stability. The alignment moulds and depth measuring ruler serve to give the user information on the exactly alignment and depth that the user is drilling into – giving them greater accuracy in terms of drilling depth. Due to its large size, this product is not ideal for most home drilling applications and instead, its operation is most sustainable when used with large diameter drilling operations.

Attribute	1	2	3	4	5	6	7	8	Total/40
Rating/5	4	5	3	4	3	5	5	4	33

Attribute	1	2	3	4	5	6	7	8	Total/40
Rating/5	4	5	4	4	3	4	5	5	34

Attribute	1	2	3	4	5	6	7	8	Total/40
Rating/5	3	5	3	4	4	4	3	2	30

Wolfcraft Multi-Angle Drill Guide

https://www.amazon.com/dp/B000JCIMEA/ref=cm_sw_r_tw_dp_U_x_tr8KDbWZ716YW

Due to it having the highest total attribute score and its high suitability for purpose, I am choosing this product as the one I will modify to improve.

1 - Function and Purpose

The Wolfcraft Multi-Angle Drill Guide allows the user to drill holes on flat surfaces at differing angles, from 45° to 90° to the intended surface. It also lets the user precisely choose how deep they drill with the adjustable guide bars which also serve to return the drill to its neutral position above the surface (which improves the product's ease of use). It is also able to drill holes onto pipes with its "V-Groove" shape that is centred on the product's base to ensure that the drilled hole is centred.

2 - Design Features

This product features its own embedded drill chuck to improve the product's efficiency. This is because having a drill chuck that the user can insert their own drill and drill bit into eliminates the risk of the user's spinning drill bit damaging the drill guide of the product. It also features a "V-Groove" shape that is embedded into its base to allow for the drilling of tubular products. Also, the base has a handle that the user can hold on to which is able to improve the stability of the product when drilling – makes sure the drilling apparatus stays perfectly aligned on the target.

3 - Industrial Production Methods

For the aluminium portions of the product, casting is used due to its complex shape and design. Using this production method enables the manufacturer to put fine details into the product – such as the small text in the embedded protractor. The steel guide bars of the product are made of extruded steel due to its high resistance to mechanical forces. The small plastic parts such as the included chuck and handle are all injection moulded due to the small complexities in their shape. The base does feature rubber to improve product stability and this is glued onto the base of the product to make sure it does not detach.

4 - Ergonomic Suitability

The springs in the guide bars heavily contribute to the ergonomics of this product. They not only add function by letting the user choose how deep they drill, but they also return the drill above the drilling surface – saving the user the effort of pulling back the drill after drilling a hole. The base of the stand also features a smooth plastic handle that the user holds on which improves the stability of the product when drilling.

5 - Aesthetic Suitability

The aesthetics of this product help tell the user how to operate it. The large black handle that stands out from the frame suggests to the user that they must hold on to it for ideal operation of the drilling apparatus. The product also has green plastic accents on the plastic knobs which catch the reader's attention. This tells them that these parts of the product are able to be user adjustable. The "V-Groove" shape on the base of the product also tell the user that they are able to drill into tubular objects. As a result of all of these factors, the aesthetics of this product suits its needs as it intuitively tells the user of the product's features.

6 - Materials

The Wolfcraft tool features a variety of different materials – all to increase the product's utility. Rubber is featured on the underside on the base to improve stability when drilling, and ABS plastic is utilized for the handle and tightening knobs to reduce cost. Aluminium is utilised for the base and top portion of the product. What this does is reduce the product's weight and it also prevents the product from undergoing corrosion due to rust. The guide bars (which support the drill) are however made of steel for strength. This is to make sure the product is able to withstand the heavy vibration forces that it will undergo whilst the product is drilling in its lifetime.

7 - Fitness for Purpose

This product is highly fit for its purpose as a drill guide. The "V-Groove" shape in the base allows the product to not only drill into flat surfaces, but into tubular ones such as small pipes. The ability to change the drilling angle of the drill guide (so the user is able to drill holes that are 45-90° to the product's surface) are another feature that improves the product's fitness for purpose. Add to that, an integrated protractor on the base gives specific information on the drilling angle that the user is doing.

8 - Product Sustainability

This product is highly adaptable to the user's needs and as such it has a high sustainability. The large handle of the product lets the user hold the drilling apparatus down for a steady drilling experience. If the user wants to drill into small tubular structures, they can do that since the "V-Groove" shape that is on the base holds parts of this shape in place. Even if the user wants to drill at angles other than 90°, the Wolfcraft multi-angle drill guide's drilling angle is able to be changed by the user to drill at angles from 45-90°.

Attribute	1	2	3	4	5	6	7	8	Total/40
Rating/5	4	5	4	4	3	4	5	5	34

Attribute	1	2	3	4	5	6	7	8	Total/40
Rating/5	3	5	3	4	4	4	3	2	30

HERZO Drill Dust Collector

https://www.amazon.co.uk/dp/B07N7DT12W/ref=cm_sw_r_tw_dp_U_x_pBpLDb62WEE85

1 - Function and Purpose

The purpose of this product is to collect residue whilst the user is drilling on a surface. It accomplishes this task on its own without any vacuum as the dust is collected within the transparent part of the product's body. It is then disposed of when the user open and emptys the product. It also has 2 integrated levels as well as a laser to help the user align objects perfectly horizontally or vertically without an external level. In a sense it makes this product a multi-tool. It can also stick on the wall by itself as it has a battery powered suction mechanism that ensures the product sticks tight to a wall.

2 - Design Features

The main design feature that this product has is its ability to collect dust on its own. As dust is produced by the user's task, it falls down (due to gravity) and stays within the transparent part of the product, where it can be emptied later by the user. The product also needs batteries to function since it features a suction mechanism that keeps the product on the wall by use of negative air pressure and addition to this, it also powers the integrated laser that the user can use if they want to align objects completely flat onto a surface.

3 - Industrial Production Methods

The majority of this product's body is constructed from polyethylene due to its low cost, great mould-ability and high durability. As a result, this part of the product is injection moulded with hollow portions left to accommodate the levels and electronics. The transparent part of the object is also injection moulded but this time with acrylic. Rubber is also glued on to the underside of the product to ensure an airtight fit between this product and a surface.

4 - Ergonomic Suitability

The product's general shape resembles a circle and as a result – it ergonomically fits within the user's hand whilst they are moving the product about. The fitting between the transparent and red portion of the product is removable and to improve the ergonomics, when fully closed, the product makes an audible and tactile snap – intuitively telling the user both parts of the product are securely in place.

5 - Aesthetic Suitability

Aesthetically, the red colour of the product stands out to potential buyers – making the product more enticing to purchase. The levels of the product are positioned towards the user to improve readability when they are used and also the face that the laser is on has a distinct warning label – reminding the user of the safety considerations they should think of when using the laser. The dust collecting portion of the product is transparent to give the user information on how full the dust chamber of the product is. With these functional considerations, the product is aesthetically suitable for its task.

6 - Materials

Polyethylene is utilised for the majority of the product's red body due to its ease of mould-ability – as well as its high durability. The transparent part of the product is however made of acrylic due to its ability to be fully transparent. Rubber is utilised on the underside of the product to ensure that the fit between the product and a wall is airtight – enabling the product to stick onto a wall by itself. The part where the user inserts their drill is made of steel. This is to protect the soft plastic of the body from potential damage if the user accidentally hits the plastic with a hard drill bit.

7 - Fitness for Purpose

For small hole drilling operations, this product is perfectly fit for this purpose. Sticking onto a surface and collecting dust on its own makes it much quicker and easier to use in comparison to dust collectors that need an external vacuum to function. The bottom half of the product with the levels are a nice addition to the product's function – however a dedicated level would be better at this function due to its smaller size and larger level. The product does function well for its primary purpose however for its secondary function of being a level – it could be easily outclassed in terms of ease of use and accuracy.

8 - Sustainability

The ability of the product to collect dust on its own without an external vacuum cleaner makes the product suitable for small drilling operations – however – for more sustained drilling operations (where a large number of holes are being drilled) the product is not sustainable as frequent emptying of the dust collector would be needed. In addition to this, the max diameter of drill-bit the user can use with the product is only 3/8". This product is however perfectly suitable for smaller drilling operations and the fact that a vacuum is not needed to be used with this product makes it even simpler to use.



Specification



Function

- Product must effectively combine the function of being a drill guide and a dust extractor simultaneously.

- For my adaptation to be a successful drill guide, it must be able to hold a drill in place and let the user drill identical holes in quick succession. To achieve this it must be manufactured with precision to make sure if the product is used – it will perform the consistently every single time.

- Measurement devices will also be part of my product, as it will improve its utility and ease of use.

- An integrated protractor and ruler will be included to help the user both know; what angle they are going to drill at and how deep they have drilled.

- The product must be able to change its drilling angle. After this is done, it must also be locked into place to ensure the drilling angle is constant and maintained.

- A user adjustable depth limiter should also be included in the product – makes drilling multiple identical holes in quick succession easier for the user.

- The drill guide should feature springs – saves the user effort as the product will return to its neutral position after drilling.

- My product should also be ergonomic to use. Rubber fitted where frequent hand contact will be - improves the physical feel of the product and measurement devices angled towards the user for ease of reading.

- Product must be able to catch >95% of all residue made when the user is drilling a hole.

- My product needs to be able to attach vacuum cleaner hoses of various sizes (via an airtight adaptor) to make it much more accessible to use with different vacuum cleaner models.

- Brushes should be present where the user inserts the drill bit into the wall. This is to ensure the suction force from the attached vacuum cleaner is sufficiently maintained and this also prevents any residue from escaping whilst the reader is drilling.

- Brushes should be user replicable since they will be worn down when the product is under constant use.

- Drills of many different sizes must be able to be used with the product's integrated chuck. The goal would be to be able to attach most standard drill bit diameters.

- Each drill brush must be able to be user removable and attachable to the product, but also very securely attached whilst under use (by use of a chuck and chuck key). The chuck and chuck key must be both made of appropriate materials to prevent them from quickly wearing out the other.

- The product itself must not have any risk of damaging an attached drill or vacuum cleaner. To do this, every component must be secured into place to prevent it from getting either; sucked into a vacuum or get in the way of a drill bit.

- Under nominal operation, the product must be able to withstand the various forces it will encounter in its task. Suction forces from a vacuum, vibration forces from a drill, and the constant reciprocal action of the user raising and lowering the drill holder.

- The build quality of the product must be of high standards to enable the user to use the product for at least 3 years.

- The product must be able to be easily and quickly assembled for use and disassembled to decrease its footprint whilst in storage.

- The product must be able to remain steady and stable above the intended drilling surface. A vice should be able to be attached to the product's base to significantly improve its stability. A handle should also be attached to the product's base if the user wants to improve the drilling apparatus' stability that way.

- A base must feature a grooved shape on its top surface to accommodate small tubular or edged objects. This is to securely hold them into place whilst the user is drilling.

- The bottom of the base should also come with a grooved shape to allow the user to place the whole drilling apparatus on top of a large tubular or edged surface. This allows them to drill on surfaces with said shape.

- The product's aesthetics should suggest information to the user on how the product functions. One colour will be used for the adjustable knobs, and the text that is moulded into the product must be highly visible.

- High safety is one of the most important functions this product should have. To do this, the product must have smooth edges (to prevent cutting the user) and be solidly built (so no parts fall out of the product whilst under normal operation). Text giving user instructions and advising safe practice should also be part of the product body.

Materials

- The majority of the product will be comprised of a high strength and durability plastic. This would include ABS or High-density polyethylene (which also is a commonly recycled plastic).

- Rubber should be used as the handle's cover material. Not only its softness ergonomically pleasing, it also provides extra grip to the user whilst they are using the product.

- Chuck and chuck key should be made of the same plastic (i.e. ABS) so one does not excessively wear out the other.

- The brushes that prevent dust from escaping should be made of nylon or polyester.

Manufacturing Process

- A detailed and labelled concept sketch of my product will be first made. This is to give me a rough idea on how the product will look and function.

- Every single part will be then designed and modelled as a CAD drawing (with the use of Solid Works). This is to allow me see my design in a 3D view and to be able to send the CAD file to a CNC machine for much more precise manufacturing (in comparison to manual hand fabrication).

- The most complex parts (such as the chuck key) need to be 3D printed as this manufacturing process offers the highest precision and low chance of user error if configured correctly.

- After manufacturing, the product should be tested so see if it works as intended and is of sufficient build quality to make it very durable.

Aesthetics

- The general colour scheme of the product must be eye catching. This is to increase the chance of a potential buyer noticing and purchasing the product. It must also be appropriate for a workshop setting (the colours not being too vibrant so that it irritates the user).

- The general shape of the product must have a lot of utility, but also a modern, sleek design to signify to the user that the product is not an outdated and old design.

- All measurement tools (the integrated ruler and protractor) but all be highly visible to the user while the product is in use.

- The finish of the product will be matte. This is to hide scratches that the product may receive whilst it is in use.

Ergonomics

- Plastic knobs should have small grooves on them – improves the user's grip on them.

- The product's grip should have a shape that moulds into the user's hands. This is to ensure the user's fingers do not slip whilst they are using the product

- The handle should have a rubber covering, this also improves the user's grip on the product but it also makes it more pleasing to hold on to.

- The product must be of an appropriate size so that the majority of the population are able to easily use and transport the product with ease.

Portability

- The product needs to have a light weight (<500g) to ensure that it can easily be moved about by the user.

- The product should feature at least one handle for the user to hold on to whilst they are moving the product (improves ergonomics as well.)

- The whole product must be able to be disassembled if it is not in use. This is to significantly reduce the product's footprint when it is transported about (for example, when the product is being shipped to the user.)

Maintenance

- Most of the product must be user removable and interchangeable (allows simple repair by replacement).

- The product should be disassembled and stored easily to ensure it does not get damaged by accident. It also needs to do this quickly so the user is able to use the setup the product and start they work in a short amount of time.

Specification



Storage

- When the product needs to be put into storage, it must be easily disassembled to significantly reduce its footprint.

- Several small components of the product must still be attached to larger ones whilst in storage. This is to reduce the chance of these small components from getting lost.

- Any attachments to the product (drill or vacuum cleaner) must be easily removed so to make the process of storing the product faster.

Weight

- The product must be light (>500g) to make it much easier to move around. It however must still have sufficient enough strength so that it does not break under normal use. As a result, the strength to weight ratio of the product must be very high.

- To achieve this goal, plastics with a high strength to weight ratio will be used (I.e. ABS).

- The shape and design of the product is also another major factor on how much strength the product can withstand. As a result, to maintain a high strength to weight ratio, the product must have a good design.

Durability

- To ensure the product remains intact during normal use, it has to both simultaneously withstand both the vibrations from a drill, the drill bit's contact with the wall, and the suction force that is from the extraction vacuum.

- The product should have a matte finish as opposed to a glossy one. This is to ensure the surface is more scratch resistant so it would continue to look like in good condition as the matte finish will hide scratches better than a glossy finish

- The drill support should be able to withstand the force of a drill's vibrations, whilst the user is sliding the drill up and down the said drill support. It must also be able to do this no matter what angle the user is drilling a hole. To achieve this, the drill support needs to be of a sufficient thickness to ensure it can withstand the mentioned forces.

- The measurement information (protractor and ruler) both need to be scratch resistant. This is to ensure that, after long term use of the product, all measurement instruments are still readable.

- The product – being in a workshop environment – must be able to withstand accidental drops. To accomplish this, the body of the product must not fracture when subject to the forces involved with an accidental drop.

Storage

- When the product needs to be put into storage, it must be easily disassembled to significantly reduce its footprint.

- Several small components of the product must still be attached to larger ones whilst in storage. This is to reduce the chance of these small components from getting lost.

- Any attachments to the product (drill or vacuum cleaner) must be easily removed so to make the process of storing the product faster.

Cost

- The product's material and manufacturing process should be of the lowest cost as possible, whilst still maintaining sufficient durability.

- The MSRP of the product should be <£30. This is to make it competitive with existing products that have the same function.

- In its price bracket, it should offer more features than its competitors (e.g. integrated vacuum hose adapters or drilling angle changer. – making the project an intriguing buy for consumers looking for drill holders.

Expected Product Lifespan

- The product should last at least 3 years. This is to ensure to the user they are buying a durable and highly functional product. It needs to be able to withstand a wide range of forces over the course of these 3 years. These would include; vacuum cleaner suction forces, accidental drops and vibrations caused whilst the user is drilling into a wall.

- To accomplish this specification goal, the product must be made of a durable material (ABS plastic) and it has to be well constructed during manufacturing.



Design Page 1



Measurements

This feature gives information to the user on how far they have moved the drill holder apparatus.

The primary purpose of this is to tell the user how far they have drilled into their target drilling surface.

Springs

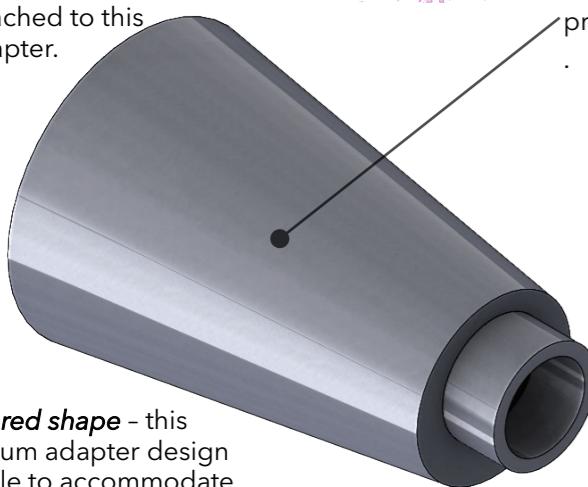
After the user drills a hole, the springs (inserted between the ball and the head) will automatically return the drill holder to its neutral position at 0mm.

This makes the product easier to use repeatedly and continuously.

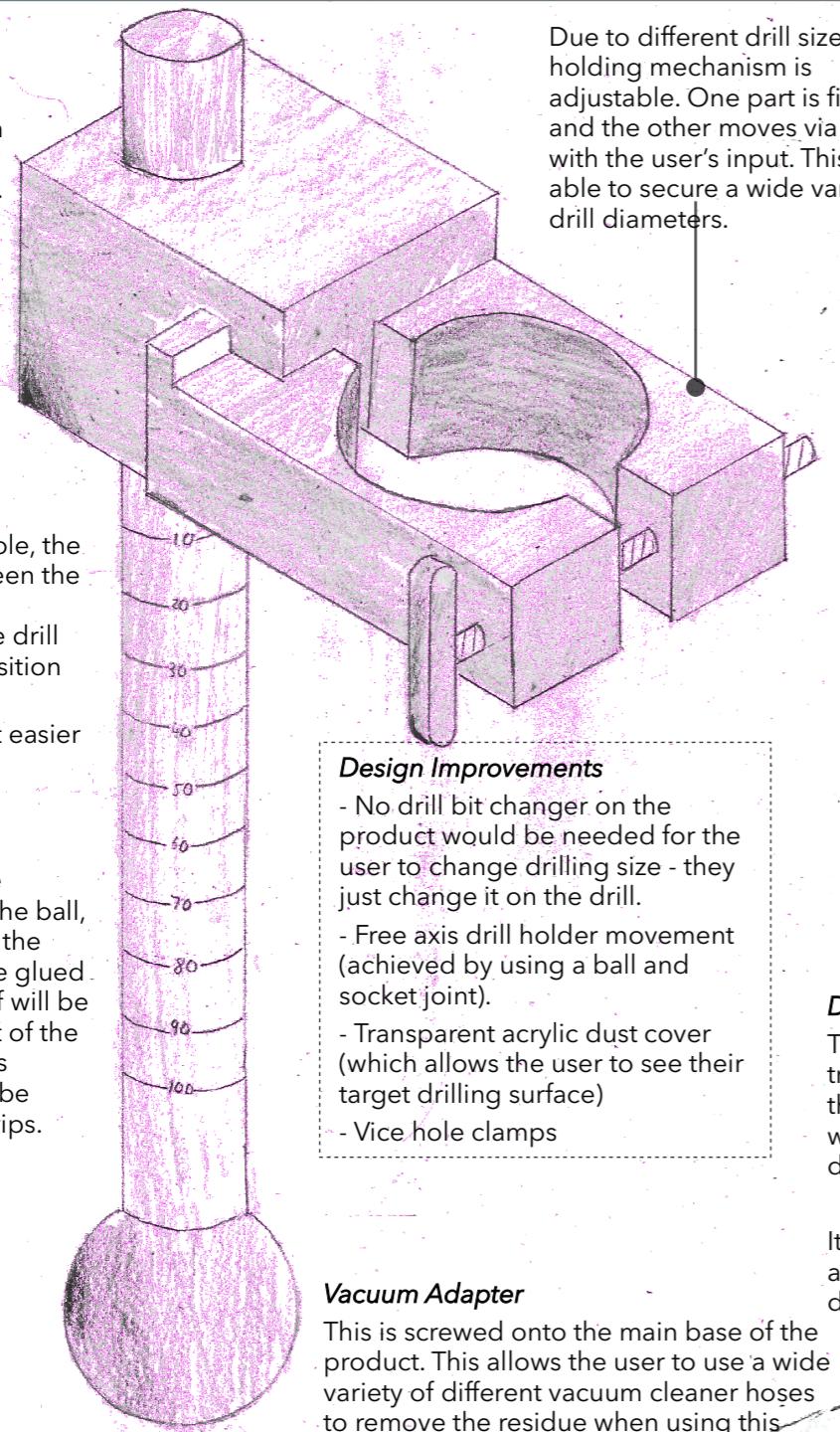
Fabrication

This component will be comprised of 5 parts. The ball, shaft, head, and one of the drill holder grips will be glued together. The other half will be free to move in and out of the head and to control this movement, screws will be inserted through the grips.

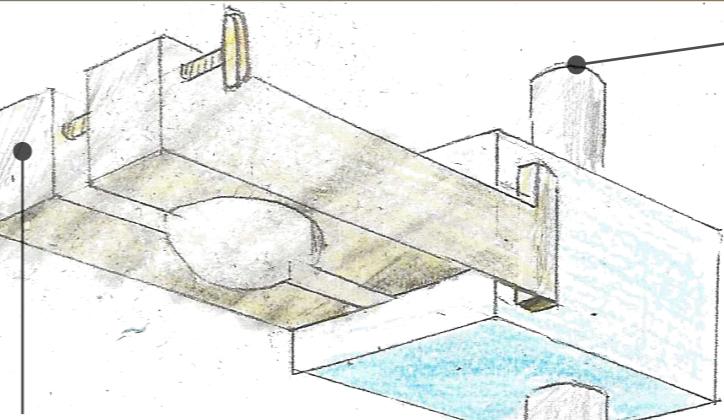
Finish - a matte finish would be suitable for the vacuum adapter since a glossy finish would quickly get scratches from when this a vacuum hose is attached to this adapter.



Tapered shape - this vacuum adapter design is able to accommodate vacuum hoses from 20mm - 40mm.



Due to different drill sizes, the holding mechanism is adjustable. One part is fixed and the other moves via screw with the user's input. This is able to secure a wide variety of drill diameters.



Drill Holder

This design is able to accommodate drill diameters ranging from 25mm, up to 40mm. This is accomplished due to the grips able to change their distance from one another. This is done by a screw which the user is able to adjust while they are using the product.

Material

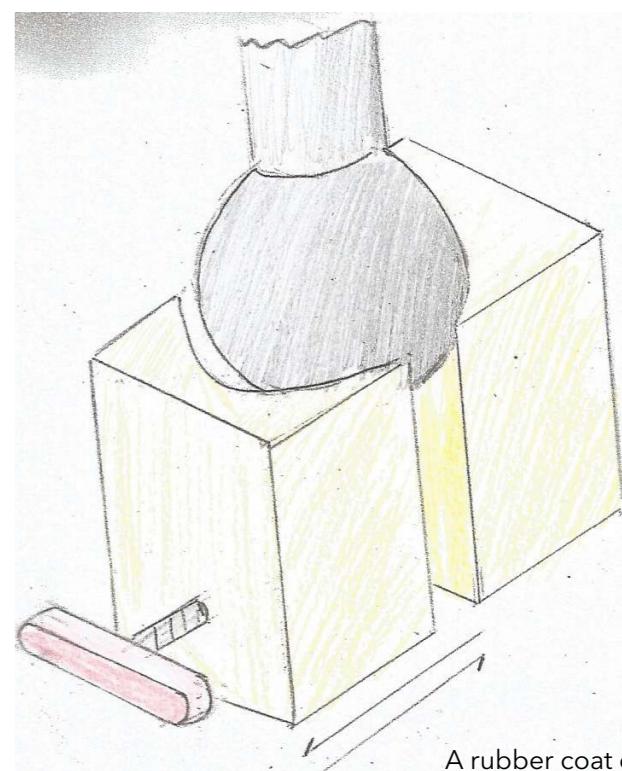
ABS will be the primary plastic for the project's construction. This ensures the product is easy to manufacture, light weight but also still retaining sufficient durability.

Ball and Socket joint

By using this joint - it allows the user to move the drill holder about many different axis.

The tightness of the drill holder will depend on how much the user screws the two sockets together. Fully tightening the socket locks the drill holder's drilling axis which allows for a stable drilling experience.

The user will be able to open the socket fully and remove the drill holder from the base of the product. This is to reduce the volume the product takes up when in storage.



Clamp Holes

These allow clamps to be easily attached to the base of the product. This is more important for larger drilling operations as it is harder to keep the drilling apparatus steady - something clamps will help to achieve.

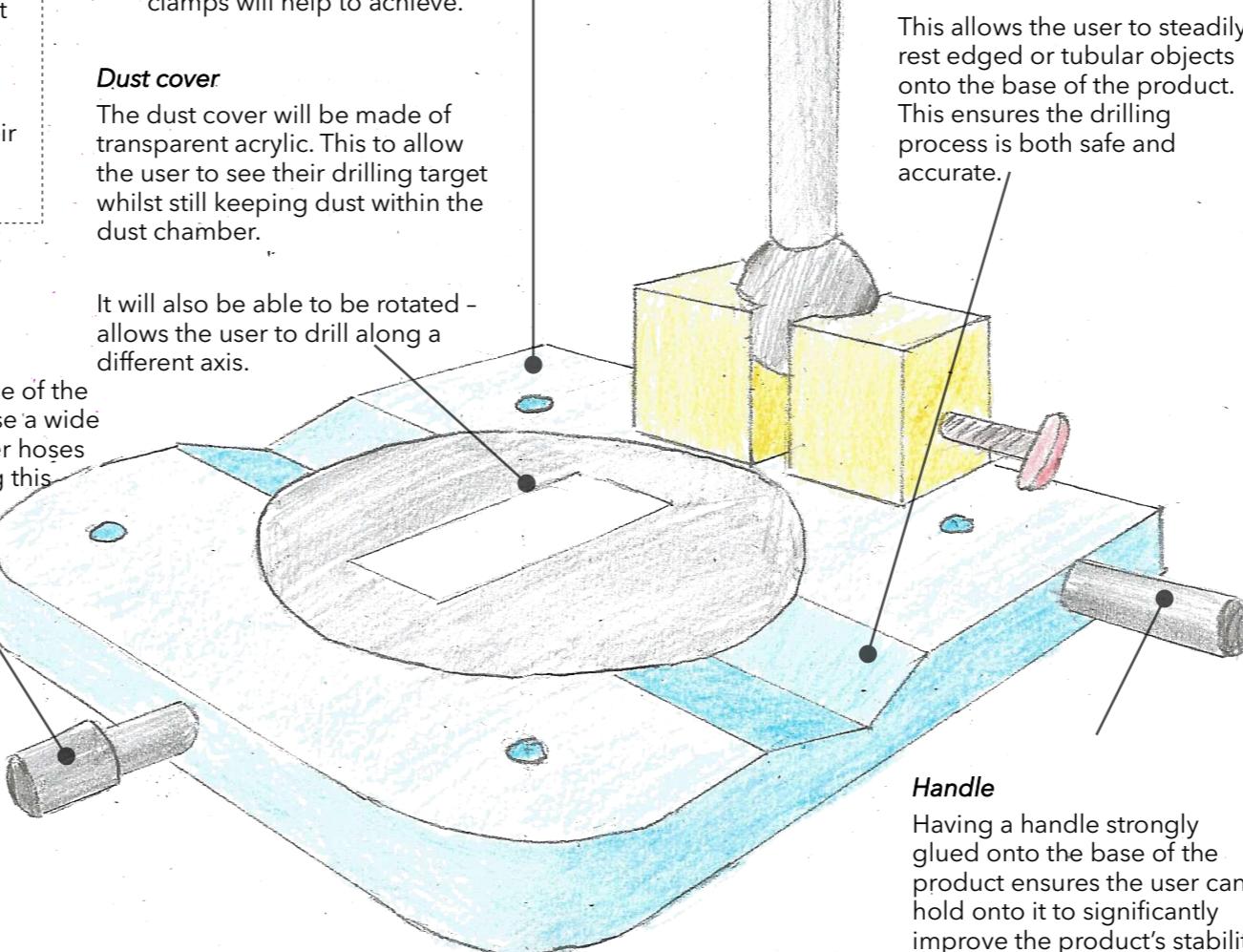
Grooved Surface

This allows the user to steadily rest edged or tubular objects onto the base of the product. This ensures the drilling process is both safe and accurate.

Dust cover

The dust cover will be made of transparent acrylic. This to allow the user to see their drilling target whilst still keeping dust within the dust chamber.

It will also be able to be rotated - allows the user to drill along a different axis.



Vacuum Adapter

This is screwed onto the main base of the product. This allows the user to use a wide variety of different vacuum cleaner hoses to remove the residue when using this product.

Like the handle, this can be fabricated using a solid ABS cylinder and a lathe.

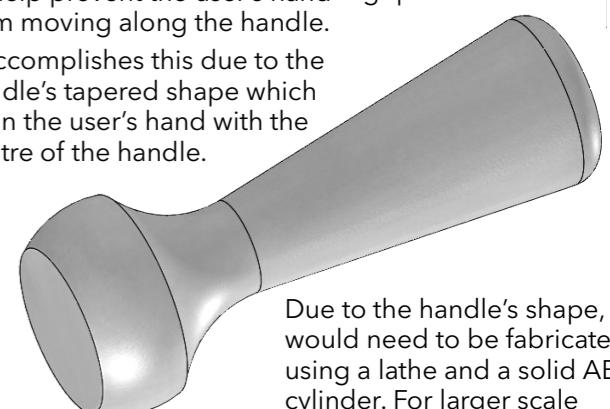
For larger scale manufacture, it could be injection moulded since this would remove the waste factor associated with using a lathe process.

A rubber coat can be applied onto the surface of the handle which would improve the ergonomics and grip for the end user.

Handle

Having a handle strongly glued onto the base of the product ensures the user can hold onto it to significantly improve the product's stability when drilling.

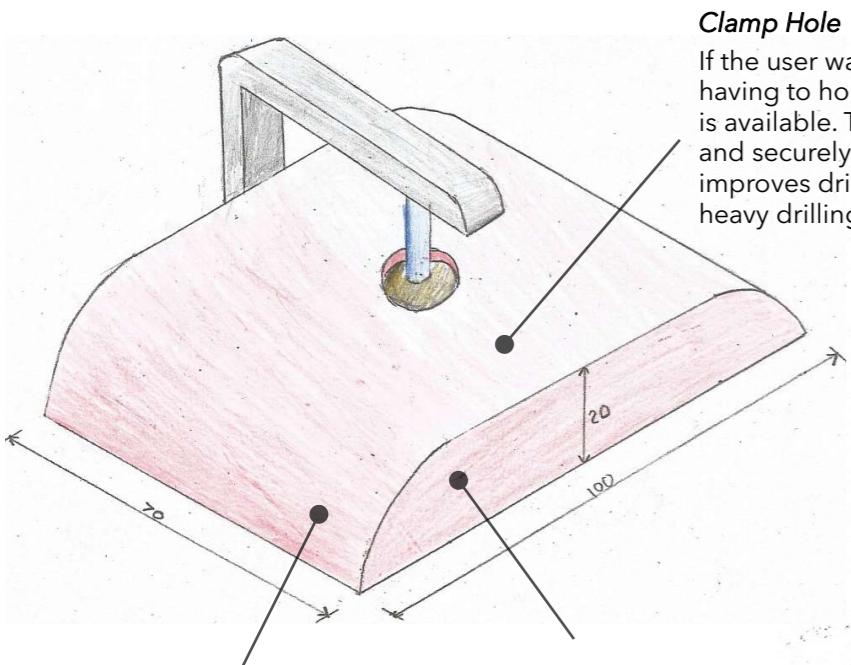
The shape of the handle is able to help prevent the user's hand from moving along the handle. It accomplishes this due to the handle's tapered shape which aligns the user's hand with the centre of the handle.



Due to the handle's shape, it would need to be fabricated using a lathe and a solid ABS cylinder. For larger scale manufacture - it could be injection moulded.



Design Page 3



Clamp Hole

If the user wants to use the product without having to hold onto the hand rest, a clamp hole is available. This allows clamps to be quickly and securely attached to the product and this improves drilling stability - more suited for heavy drilling operations.

Domed Support Arms

This shape makes the process of switching drill plates easier and quicker.

Ergonomics

The hand rest's dimensions (70x100x20) and rounded edges are meant to accommodate a wide variety of hand sizes comfortably. This is important as it allows as many people as possible to use this part of the product effectively.

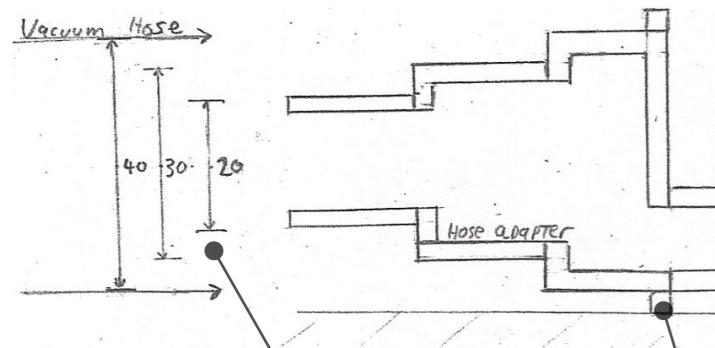
Hand Rest

Instead of using a handle to improve the product's stability during a drilling operation - this concept uses a hand rest.

This allows the user to rest their hand and put down their weight onto the product which can significantly improve drilling stability. It also increases the base area of the product - making it overall more stable.

Hose Adapter

This vacuum hose adapter design allows the product to rest flat on the floor (large diameters are raised above the ground as seen in the 2D diagram) and this is essential as it ensures the product is able to maintain a successful seal onto its drilling surface (as to remove drilling residue effectively).

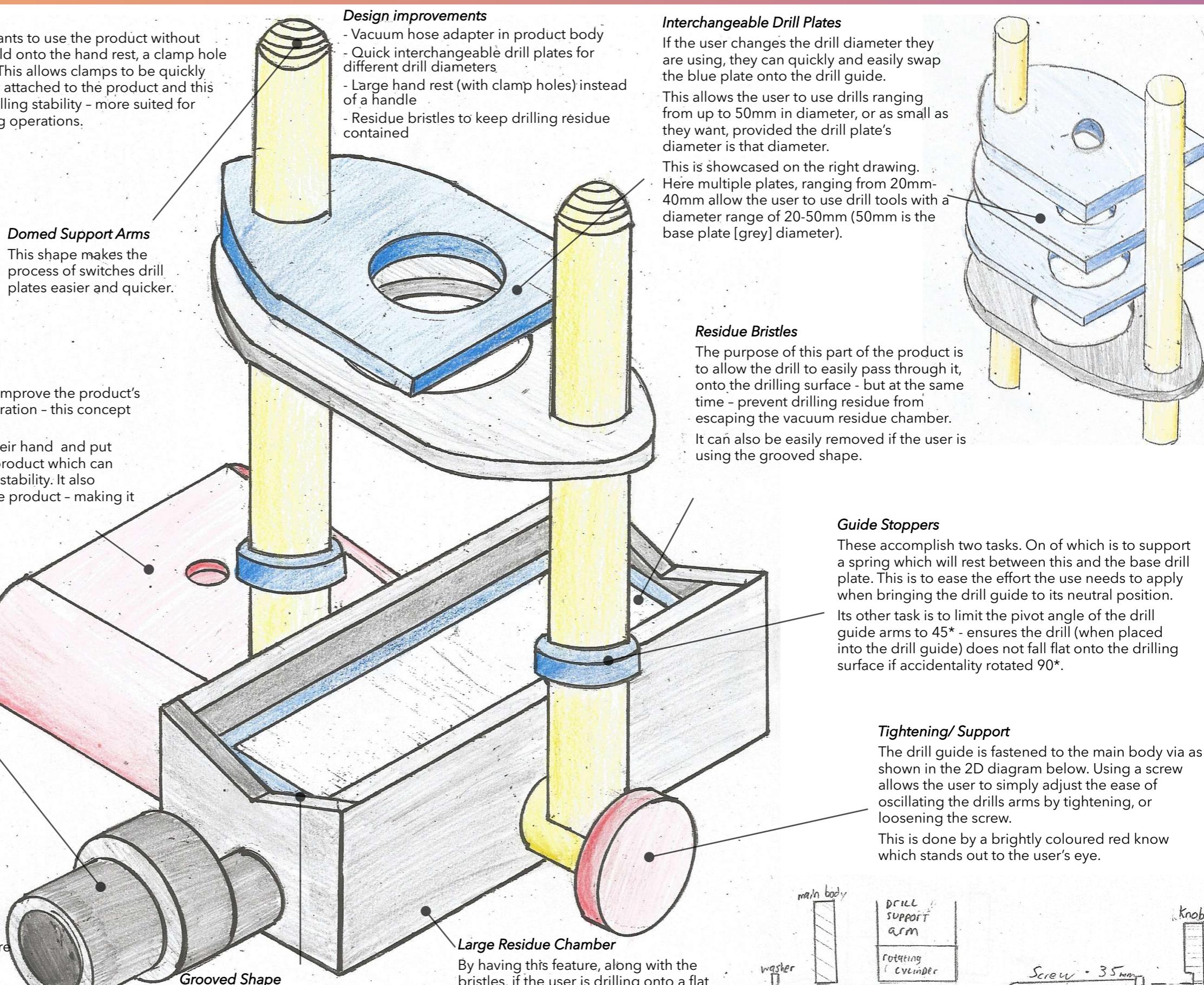


Compatible Vacuum Dimensions

This design is able to let the user use various different vacuum cleaner hose diameters - ranging from 20mm, up to 40mm. If larger diameters are required, the adapter design can be simply altered by increasing the diameter to accommodate larger vacuum cleaner hoses.

Stoppers

These serve to ensure that the user's vacuum hose does not slip too far from its intended place.



Design improvements

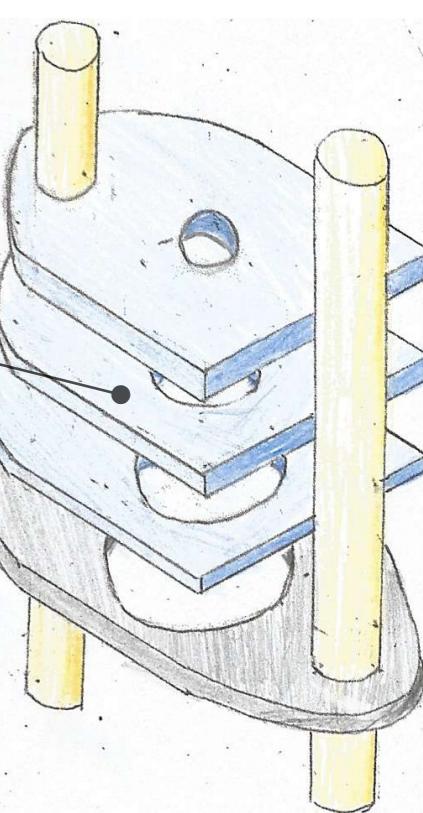
- Vacuum hose adapter in product body
- Quick interchangeable drill plates for different drill diameters
- Large hand rest (with clamp holes) instead of a handle
- Residue bristles to keep drilling residue contained

Interchangeable Drill Plates

If the user changes the drill diameter they are using, they can quickly and easily swap the blue plate onto the drill guide.

This allows the user to use drills ranging from up to 50mm in diameter, or as small as they want, provided the drill plate's diameter is that diameter.

This is showcased on the right drawing. Here multiple plates, ranging from 20mm-40mm allow the user to use drill tools with a diameter range of 20-50mm (50mm is the base plate [grey] diameter).



Residue Bristles

The purpose of this part of the product is to allow the drill to easily pass through it, onto the drilling surface - but at the same time - prevent drilling residue from escaping the vacuum residue chamber.

It can also be easily removed if the user is using the grooved shape.

Guide Stoppers

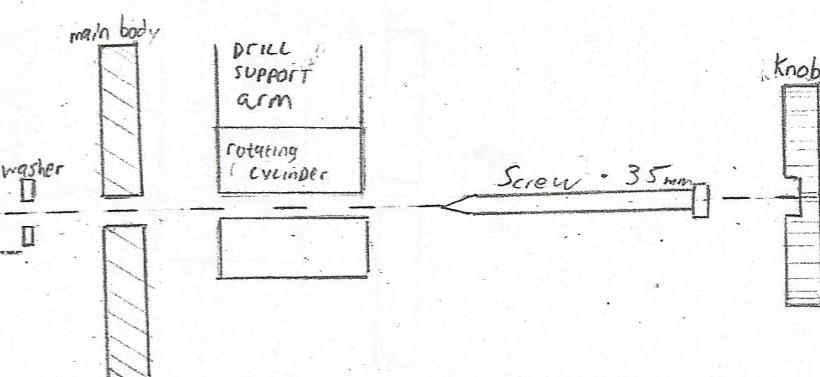
These accomplish two tasks. One of which is to support a spring which will rest between this and the base drill plate. This is to ease the effort the user needs to apply when bringing the drill guide to its neutral position.

Its other task is to limit the pivot angle of the drill guide arms to 45° - ensures the drill (when placed into the drill guide) does not fall flat onto the drilling surface if accidentally rotated 90°.

Tightening/Support

The drill guide is fastened to the main body via a screw as shown in the 2D diagram below. Using a screw allows the user to simply adjust the ease of oscillating the drill arms by tightening, or loosening the screw.

This is done by a brightly coloured red knob which stands out to the user's eye.





Design Page 3



Domed Support-Arms

Like the previous design page, this feature is included. This reduces the effort and assists the user when they are removing the *drill-rest platform* by guiding the platform's holes to the centre of the support-arm's cylindrical shape.

Manufacture

The majority of this design will be able to be made from extrusion moulding acrylic plastic. Some components, such as the support arms, would be more suitable made by just regular extrusion.

The shaft and gears would be ordered from an external firm and would be made of steel, to ensure high durability.

Main Product Body

Using a circle shape, the product has a reduced profile as to opposed to a rectangular shape, it also enables the screw-on mechanism for the residue blocker. In inside of the body has a hollow shape, to allow the handle and gears to fit inside and to reduce the overall product mass.

Other various features are also integrated into the body, the v-groove shape to enable the user to drill edged/tubular objects on top of the body, a clamp/hand-rest permanently attached, and an attachment hole to enable the dust-extractor attachment to be easily removed and attached.

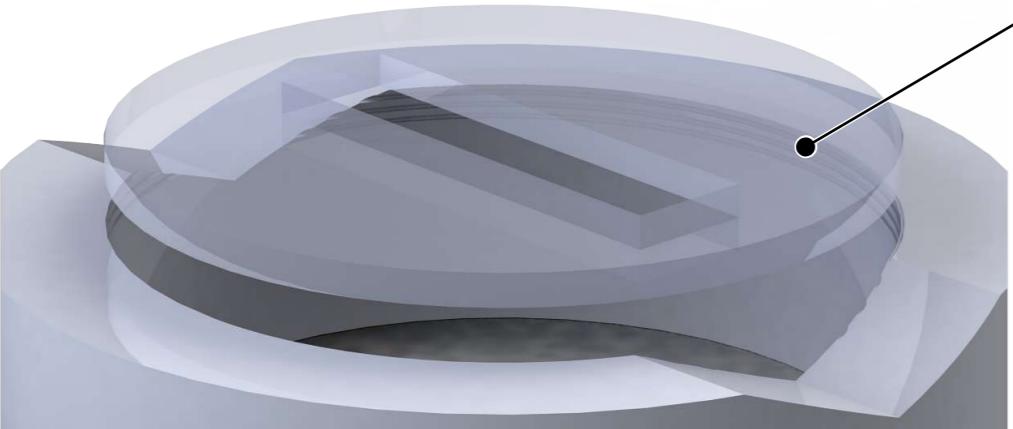
The underside of the product is completely flat, coupled along with the flat clamp/hand-rest, the underside of the product, if placed on to a flat surface like a table or a wall, is extremely stable.

Clamp/Hand-rest

This part of the product is permanently attached to the main product body - this increases the strength of this part as high strength permanent attachment methods (etc. glue) can be used.

The hole in this part allows the user to dig-in a clamp and hence increase the effective clamp strength, making the drilling apparatus more secure if a clamp is chosen to be used with the product.

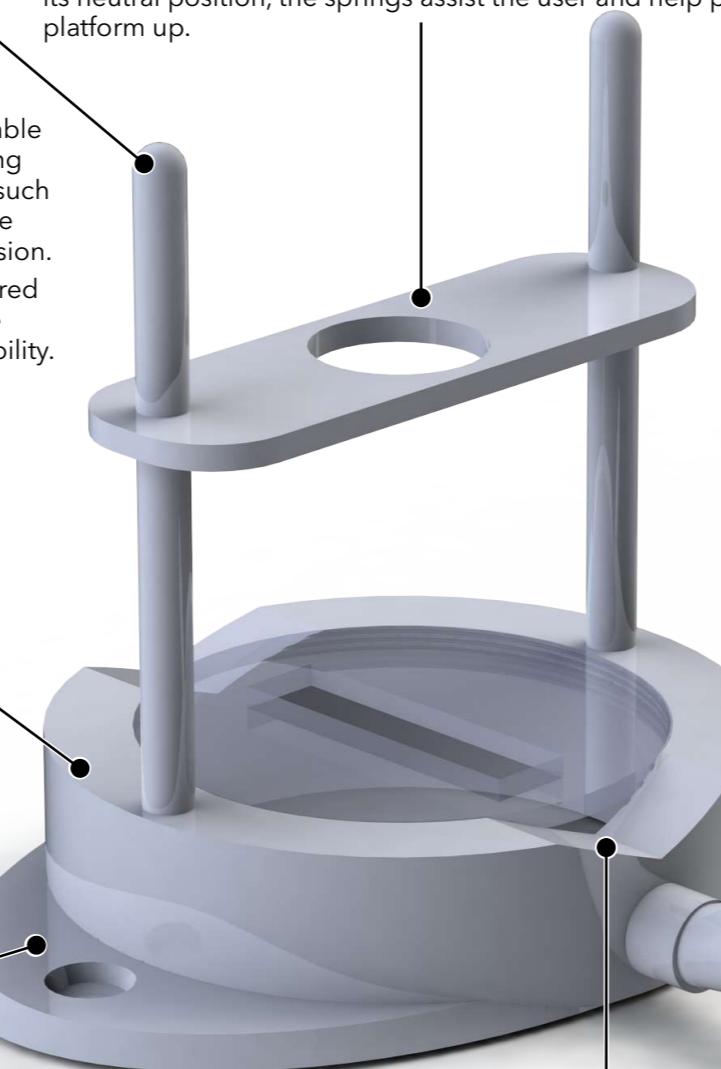
The chamfered edge makes this part more pleasing to press on to, if the user wishes to use this as a hand-rest, to keep the drilling apparatus secure.



Drill-Rest Platform

To enable the user to use a wide variety of drills with the product, this design features a platform with a sizeable hole in it. This enables the user to rest the majority of their drill-tool on it, with the drill-bit going through the hole so it is able to make contact with the surface to be drilled.

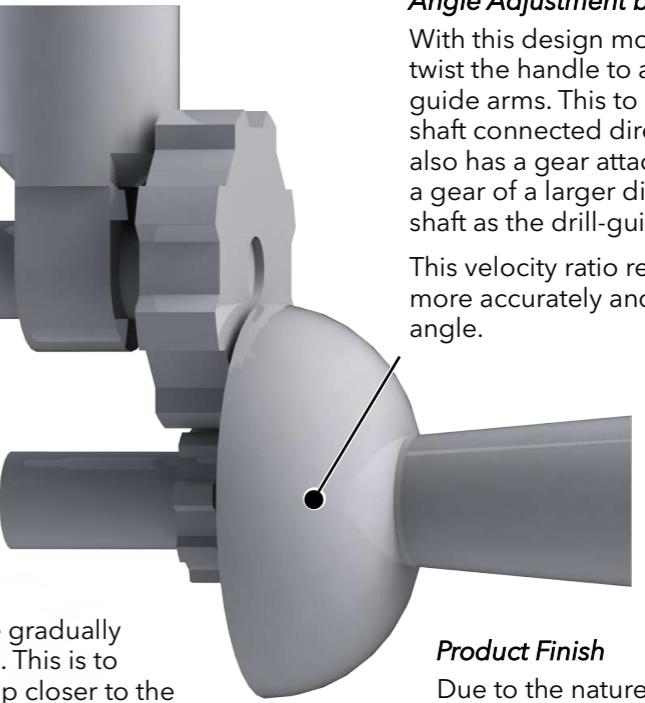
Two springs will support the platform so by default, the platform is raised and when the user uses the drill guide, the springs compress and the platform lowers. When the user wants to return the guide to its neutral position, the springs assist the user and help push the platform up.



Residue-Blocker

With this design, the residue-blocker is of a circular shape. In conjunction with the threaded shape as seen in the product's *main body*, this component is able to be attached and removed by the user screwing it in. This screw attachment method ensures that his part is held extremely secure in place.

Transparent acrylic will be the material of choice since it enables the user to view the progress of the surface they are drilling into.



Handle

The handle's shape gradually increases outwards. This is to guide the user's grip closer to the centre of the product, ensuring more stability to the apparatus.

Angle Adjustment by Handle

With this design modification, the user is able to twist the handle to adjust the angle of the drill-guide arms. This to be accomplished via use of a shaft connected directly onto the handle, which also has a gear attached to it. This is meshed with a gear of a larger diameter which is on the same shaft as the drill-guide arms.

This velocity ratio reduction enables the user to more accurately and precisely adjust their drilling angle.

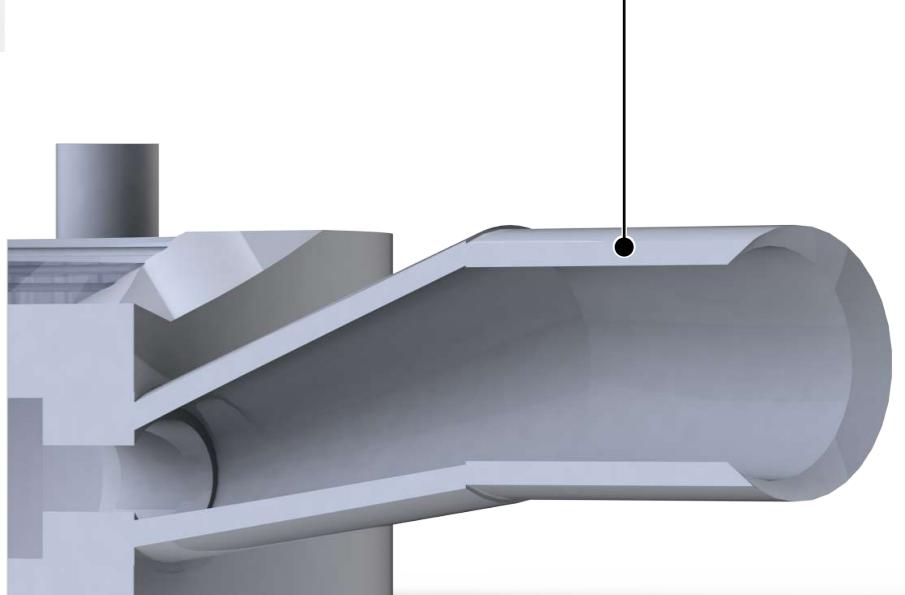
Product Finish

Due to the nature of this product (frequent exposure to rough dust, and power-drills), a matte finish would be highly suitable - this would more effectively hide wear and scratches as to opposed to a glossy finish.

Dust-Extractor Attachment (w/ cross-section view)

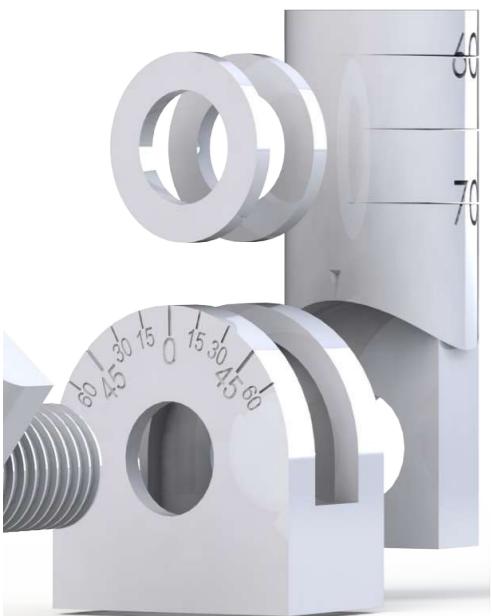
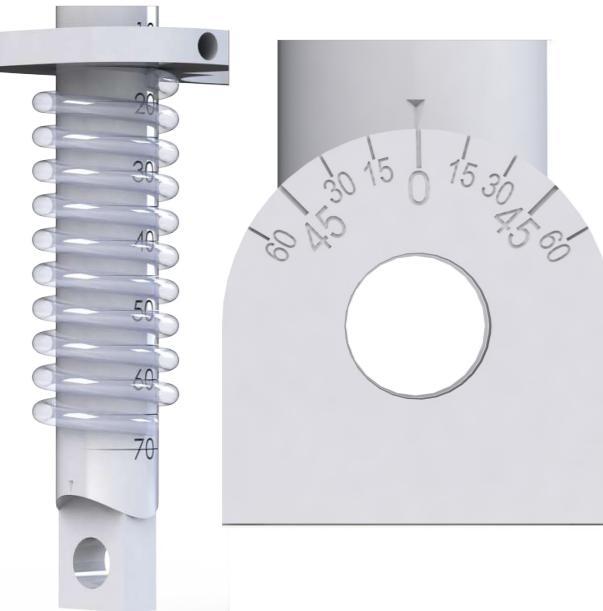
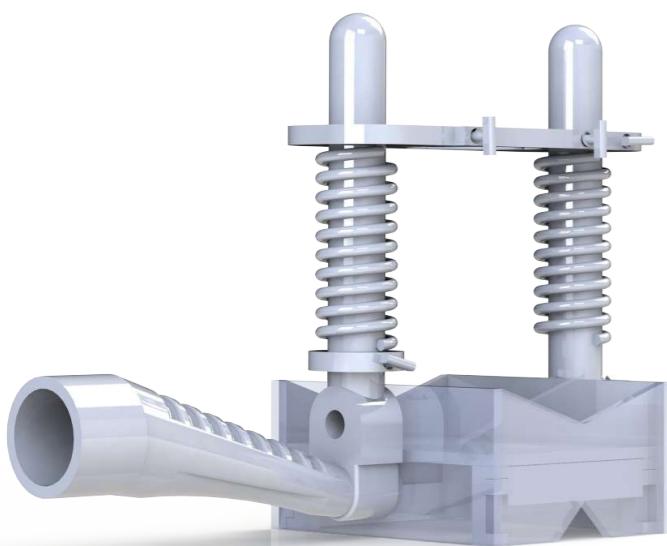
The shape of this component reduces the effort needed for the user to attach a vacuum cleaner hose to the product - the raised shape makes sure the attached hose does not make contact with the floor (keeping the drilling apparatus flat to maintain a sufficient vacuum seal). The entry hole for a vacuum hose is also chamfered (as seen in the cross-section view) to help the user align the hose with the long straight section of the attachment (the part which helps keep the attached hose securely in place).

This component of the product is also able to be detached from the main body of the product, this reduces the profile the product takes up in packaging.





Design Page 3



About this design

This final design iteration applies ideas from the previous ones, whilst still bringing new improvements to my design modification. Aspects carried includes; domed tops, support arm measurements and a residue blocker. Primarily, the new ideas that are introduced here would include the vacuum seals and handle/vacuum attachment.

Measurements

By also including distance measurements onto the support arms, this improves upon the original product. This allows the user to quickly adjust the bottom out & neutral drill holder positions. Angle measurements also included.

Manufacture: Laser-etched/3D printed

Clamp Hole

On the side opposite of the handle, the clamp hole attachment is present. This component is interchangeable with handle/vacuum one - improving user experience for left-handed users.

Manufacture: 3D printed

Angle Adjustment

To keep the drilling support arms fixed whilst the user is drilling, and to allow the user to change their drilling angle, this is the solution I will be using. The body of the arm holder, the rings along with the use of the adjusting screw, puts pressure onto the drill support arms, fixing it in place.

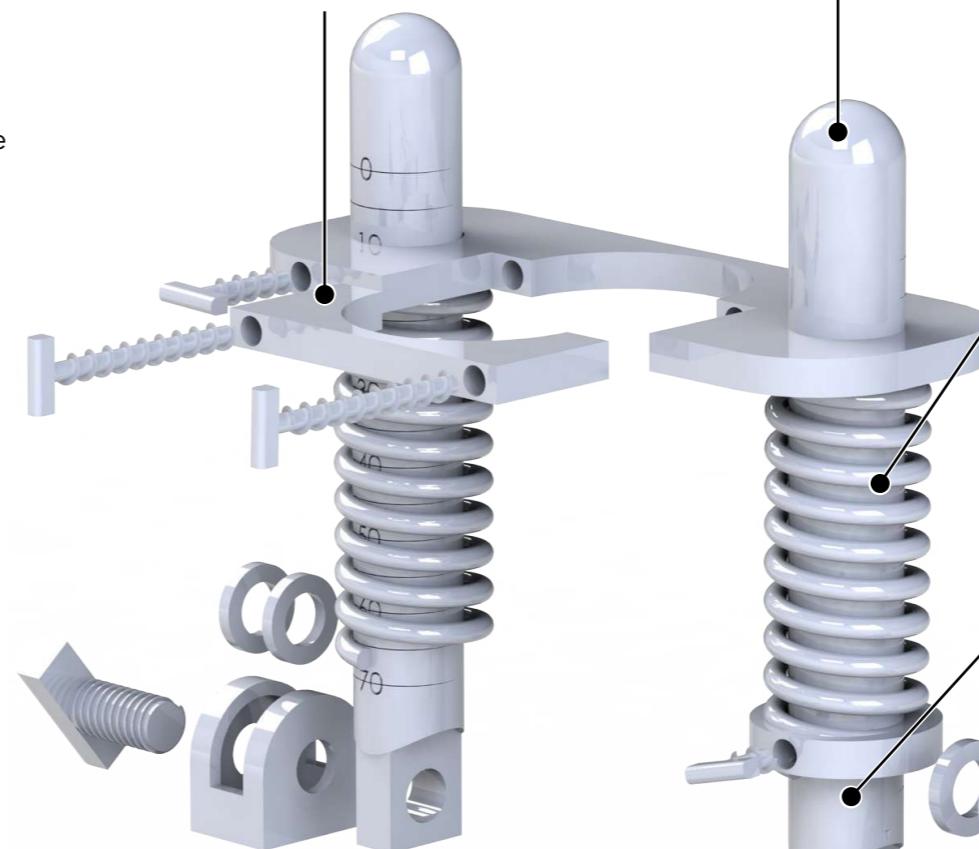
Manufacture: 3mm laser-cut/3D printed

Order: Ø 7.5mm screws

Holder Screw Adjustment

By use of screws and a detachable part, the user is able to secure power drills with various diameters.

Manufacture: 5mm laser-cut



Double V-Groove

This enables the user to drill small edged/tubular objects by resting them on the top groove, or large edged/tubular surfaces by resting the whole apparatus onto the surface, with the bottom groove positioned on the edge.

Manufacture: Laser-cut 3mm

Domed Tops

Helps align the drill holder onto its support arms.

Springs

Reduces effort for the user when they put drill holder back to its neutral position. Makes the product quicker and easier to use.

Order: 15mm internal diameter springs

Bottom out lock

This allows the user to set an easily repeatable, maximum drill depth - they move this part up/down then lock it in place and then this will stop the drill when the user bottom outs at this set distance.

Manufacture: Laser-cut 5mm

Residue Blocker

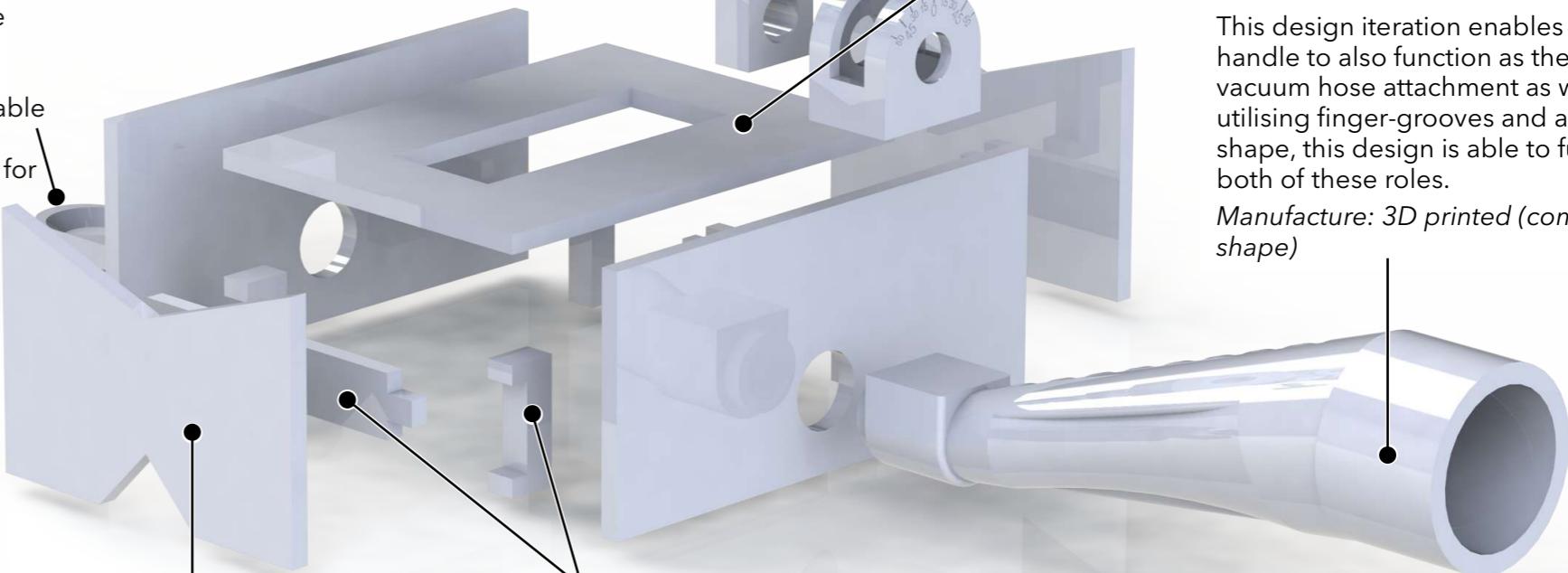
Made of transparent acrylic, this blocks the majority of the drilling residue, helps maintain adequate vacuum suction force, whilst still allowing the user to see their drilling target.

Manufacture: Laser-cut 3mm

Handle/Vacuum Attachment

This design iteration enables the handle to also function as the vacuum hose attachment as well. By utilising finger-grooves and a hollow shape, this design is able to fulfil both of these roles.

Manufacture: 3D printed (complex shape)



Vacuum Seals

These ensure the suction force of an attached vacuum is fully utilised. When the product is used on a flat surface, they are in their lowered position, when the product is used on a large edged surface, the edge of it pushes the seal up, allowing it to fit into the bottom groove.

Manufacture: Laser-cut 3/5mm



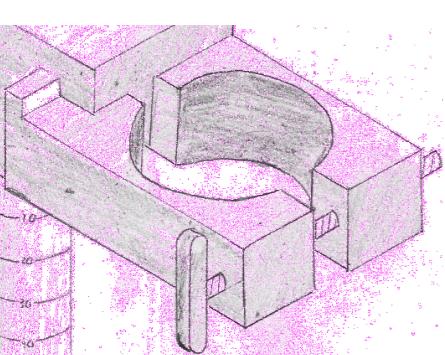
Design Feature Analysis



Design 1

The feature ideas I had for the first design do not all contribute to the user's experience, so most of them were disregarded moving forward. The *Ball and Socket* angle adjustment solution is a prime example as it does sound useful on paper, but would increase the difficulty of manufacture and using the product at normal drilling angles.

The *Drill Attaching* solution however is one idea I will continue with in the final iteration, as it proved to be affective at securing the user's drill.



Design Strength - Drill Attaching Solution

This method of securing the user's attached drill is the most suitable in my opinion. It allows them to adjust the arm diameter for larger power drills and the tightness with only a knob and without much thinking. This would be quite a secure and strong solution as well, as the *drill attaching arms* fit into a moving block for support and vertical mobility.

It would also be easy to manufacture, milled for prototyping (if I were to make it) or just injection moulded with acrylic granules if this were to make it into mass production.

Design Limitation - Ball and Socket

Supporting and adjusting the angle of the support arms with this method would have been a difficult idea to implement.

This ball and socket joint would need to be able to firmly support the guide arms, in addition to an attached drill. This would be difficult as the ball and socket would need to be able to be tightened with a lot of pressure and because of this, it would have to be fabricated from steel - much harder to work with than just acrylic.

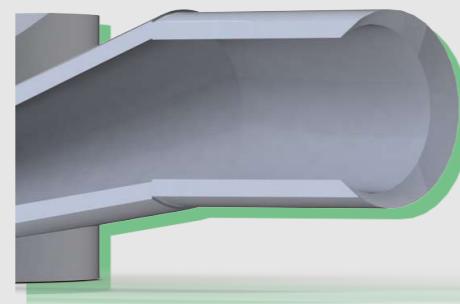
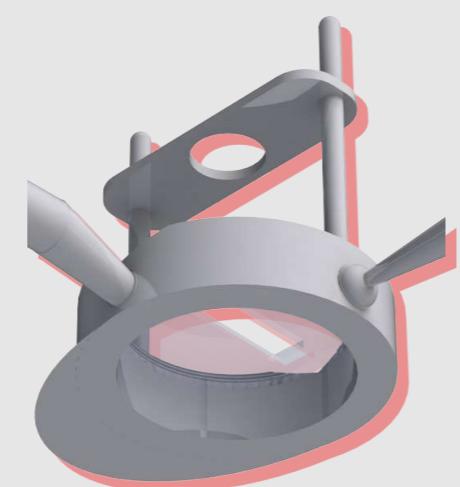
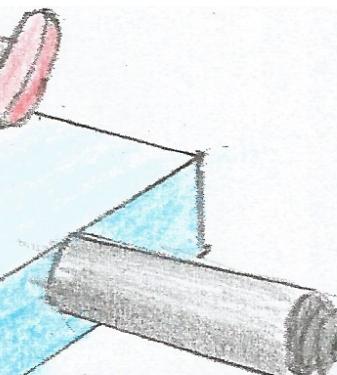
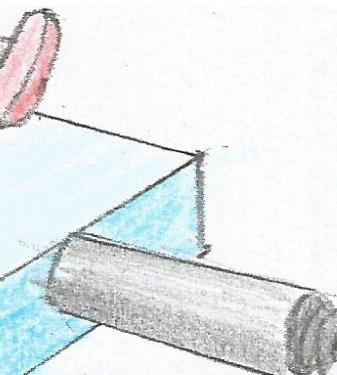
The one strength this solution has is that the support arm would be easily removable however, because of the firm support this ball and socket would need to be able to provide - it would be balance the design to fit both of these feature considerations.

Handle Design

The handle in *Design 1* was the weakest aspect of the design. One issue is that it is disproportionately small in comparison to a handle of an appropriate size - this means that it would not be ergonomic to hold onto in comparison to the handles/hand-rests of the other designs.

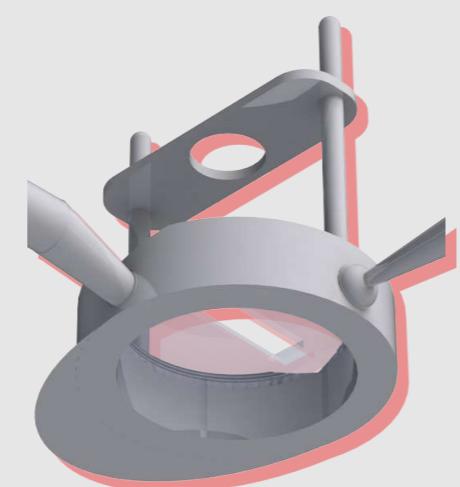
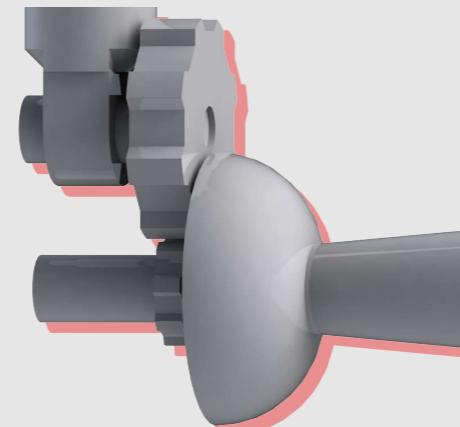
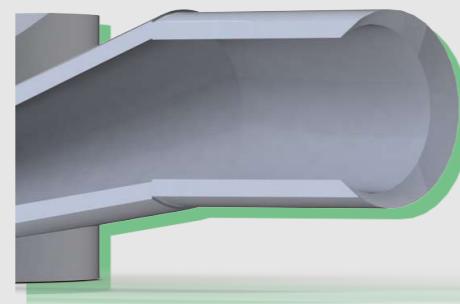
It is also not tapering upwards - this would mean that if the user is holding around the handle, their hand would likely make contact with the drilling surface - lifting the drilling apparatus. This would be unsafe and reduce the stability, and the effectiveness of the dust extraction as there would not be a air-seal.

Due to these important considerations, this handle design will not be used.



Design 2

This second design solution did contribute some ideas I will iterate on in the final design iteration (more specifically the *Vacuum Adapter* shape) however some ideas did negatively impact how the user would use the product. The *Support Arms* being adjustable by twisting the handle would be a useful design idea, however them being fixed is a regression in comparison to the original product, which had them removable. This would make the product much harder to store if I were to continue with this design limitation



Design Strength - Vacuum Adapter

One aspect that I find of use in this design is the general, and intricate shaping details of the vacuum-tube adapter.

The upwards shape ensures that attached tube does not make contact with the ground - keeping the product flat on the ground. This ensures the suction force of the vacuum cleaner is sufficiently utilised.

Additionally, the internal chamfering of the hole whereby a vacuum tube is inserted eases the effort needed to align the tube properly. This would improve the user's experience and ensure the vacuum tube is securely attached to the product.

Design Limitation - Angle Adjustment

I liked the concept of making the handle have a dual purpose - functioning as a handle and also letting the user adjust the drilling angle of the guide arms.

However, what this does is fix, and makes the support arms removable, which significantly increases the product's packaging/storage volume - this is in comparison to every other design whereby the support arms are removable - making this solution stand out as limitation to the product's user experience.

In addition, it takes up more space than the angle adjustment solution in *Design 3*, as two shafts - with gears - need to be put on top of each other, which increases the profile of this part.

Body Shape

The body shape of this particular design is limiting to the function of the product.

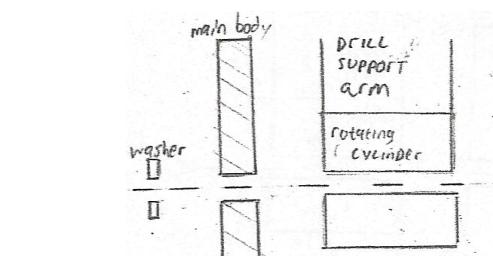
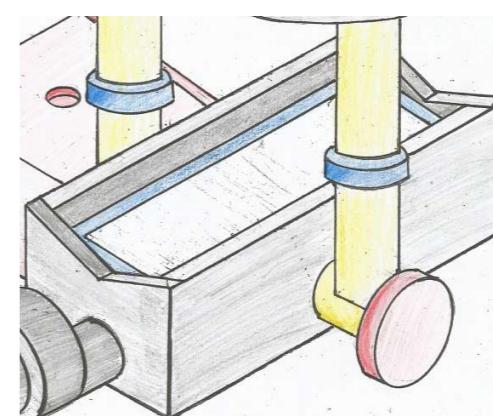
This would be due to the large size of it, which would make the product in particular harder to store on comparison to the other designs (further amplified by the fact the support arms cannot be removed due to the angle adjustment gears).

The thin body wall of the product also makes it difficult to fix, and secure the angle adjustment into place.

The one aspect I do like about this design is the hand-rest, however this further adds onto the bulk this design has and so makes it unsuitable to make.

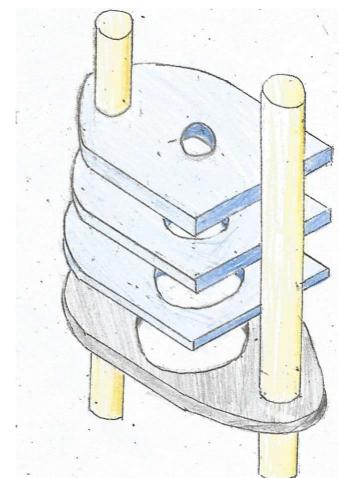
Design 3

Because of the design features that improve the ease of manufacturing and use of the product to the user - I will base the majority of the final design with aspects of this one. The *body*, and *angle adjustment* solutions do carry out their functions well ,whilst being simpler to fabricate in comparison to the other design solutions. The *Drill Holding Plates* however increase the amount of components the user is able to loose, and is functionally inferior to the drill holding solution that I drew in the first design.



Knob for Angle Adjustment

This screw-in solution to tightening the support arms, proved to be the most simple and practical approach. Here, the user is able to simply, and intuitively adjust the stiffness of the drill support arms (made even easier with an ergonomic knob) when they wish to change the angle they are going to be drilling at. It is also allows the support arms to be removable, the user just needs to fully untighten the knob and then the arms are able to be removed. This allows the profile in storage/packaging of the product to be reduced.



Design Limitation - Drill Holding Plates

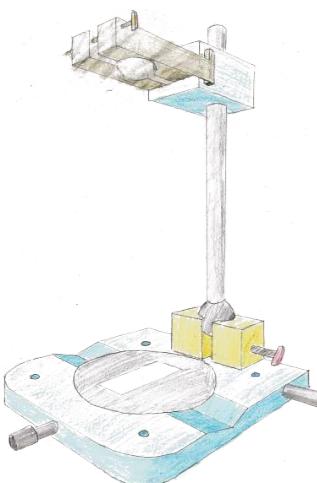
The idea of having multiple drill plates, interchangeable, as a means of letting the user use drills of varying diameters as its limitations.

A large issue is how this design would negatively impact the overall user experience - they would have to select a different drill support plate if they wish to use a different drill. This is inconvenient in comparison to just implying tightening a knob for a smaller diameter drill like as seen in the 2nd design solution.

It also does not have the granular aspect of a tightening knob solution - so here some functionality is lost in comparison to the drill securing solution in *Design 1*. This would make it so that the user would need to ensure that their drill, and included drill plates are able to be compatible with each other.



Evaluation of Designs



Design 1 - Compared to the Others

This design is unique in the aspect that it is the only one that allows the user to change the drilling angle not in just one axis, but around freely because of the ball joint. While this may be a useful idea, the fabrication challenges included make other angle adjustment methods far more suitable to pursue. The shape of the base is also different in comparison to the other designs - however I think it is too large to be suitable as a manufactured product.

As a first design draft, it did however still give me useful design ideas that I might use in the final design - such as the method of securing the attached drill. It also gave me the idea of using a transparent acrylic sheet as a means of blocking residue from escaping which I will use in the final design of my product modification.

12/20 - Function and Purpose

Due to the ball and socket of this design, the on paper function of the product is amplified as the user would be able to drill at any angle, however in reality this is too much freedom and would make the product harder to use. There are some features that do carry out their purposes appropriately, such as the v-groove shape, clamp holes and a well designed solution for securing a drill.

7/20 - Fabrication Ease

This design has some aspects that are easy to fabricate - the basic handle, the circular dust blocker, and the drill support part - but the main body would be hard to make. Due to its shape, manufacturing it in school would be difficult and in addition to this, ensuring that the ball and socket joint is secure and durable would be difficult

13/20 - Ergonomics & Aesthetics

The handle in this design drawing would not be ergonomic to use since if a user holds on to it, they are likely touching the drilling surface. The good ergonomic features however would be the coloured, and easily seen and twisted adjustment knobs that the user is able to use. Aesthetically, the design does look stand out because of its use of a primary colour scheme.

13/20 - Material & Design Choices

The main material of choice with this design was ABS plastic. This is a suitable material choice as it helps keep the weight of the product down, whilst still remaining sufficiently durable. It also would be material that would be easily machined and altered industrially. The design choice of having the dust cover being transparent (clear acrylic) is a positive one that I also implement in my further designs.

13/20 - Product Sustainability

This design iteration would have low sustainability, and ease of use due to the unusual choice of having a ball and socket as the mechanism to change the user's drilling angle. This would make the product harder to learn how to use, and use effectively in comparison to the other design solutions. The use of simple knobs to adjust the security of the drilling support, and securing the drill in place are simple and easy to use choices that positively affect the user's experience with the product.

Overall Score

Having a free moving guide/support arm for the drill holder would not be the most suitable design decision for this product. This is because there would not be a frequent use case for it and as a result, a more traditional one axis angle adjustment solution would be more suitable. The method of attaching the drill would however be suitable to be interacted upon and further modified for the final design iteration. It would work as a drill guide, but other design ideas have better functionality and feature-sets

58/100



13/20 - Function and Purpose

The functionality of this design version has been increased over the previous one - the scrapping of the ball and socket idea and the increased design detail on the vacuum adapter and handle, improve the overall functionality and use case of the product. The method of changing the drilling angle has been changed to a geared mechanism that can be hand twisted by the user - this would be a more functional feature to implement and use for the user.

9/20 - Fabrication Ease

The hollowed out tube shape of the product's body would be difficult to fabricate in school facilities, along with trying to fit several gears into the 10mm wall. The method of securing the drill in place is simplified in this design, so it is easier and quicker to manufacture.

14/20 - Ergonomics & Aesthetics

Even though the colour scheme for this product was undecided, having a grey/black colour palette may be one I might utilise in the final product due to it being safe choice (less chance of colours not looking well together). The use of a hand rest, and handle improve the ergonomics of the product, as the large, tapered shape of the handle, and large surface area of the hand rest, makes the product easier to hold onto.

12/20 - Material & Design Choices

The choice of acrylic plastic for the main construction of the product also helps keep its weight down whilst still having enough strength to ensure the product is able to be used for a long period of time. The design choice of having the hand rest/clamp hole being stuck onto the product body is a poor one as it increases the profile of the product permanently.

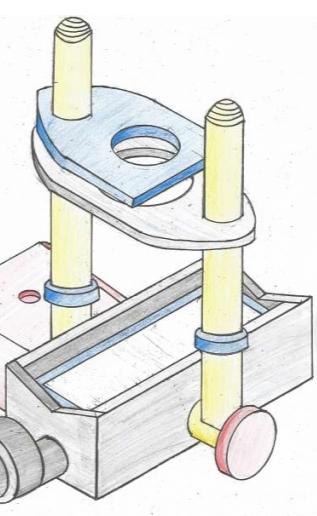
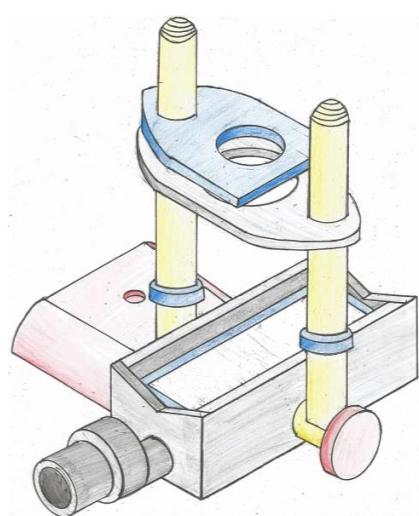
14/20 - Product Sustainability

Learning and using this design long term as a product would be easier and more sustainable due to the addition of the more ergonomically shaped handle, and fine control of the drilling angle by use of the same handle also turning gears to precisely change the drilling angle. Where this product falls down in product sustainability would be its footprint - not having the support arms removable due to said gear adjustment makes this design harder to store, and fix.

Overall Score

Although giving the handle another function is a great idea - in this case as a way of tightening the angle adjustment mechanism - it makes the product's profile much larger since the support arms are not removable making it not suitable for the final product design. I'll look further into the idea of giving the handle a second function - such as maybe integrating it into a more suitable part - such as the vacuum adapter. The body is too large and complicated to manufacture in comparison to Design 3

62/100



Design 3 - Compared to the Others

The rectangular shape of the base, compared to the circular ones of the other designs, reduces the overall footprint of the product. It still maintains a sufficient length to allow the use to drill at a steep angle - e.g. 45° or more. As a result of this, there is a high possibility I will go for this body shape for my final design.

The idea of using bristles as a residue blocker in this design would be more effective, however it does block the visibility of the drilling surface to the user, so I will just continue to use a transparent acrylic plate to block dust in my final design iteration - and plus, it would be much more easier to manufacture and implement.

15/20 - Function and Purpose

This design, in my opinion, fits the function of being a drill guide and residue extractor the most effectively. The v-groove shape embedded in the product's long rectangular body increase the length of tubular/edged items the user would want to drill into in comparison to the circular bodies of the other designs. The use of drill plates (to support drills of different diameters), while not being ideal, do carry the purpose of supporting drills effectively

15/20 - Fabrication Ease

This design solution is significantly easier to fabricate than the others. The simple rectangular body is able to be cut out on a laser cutter in multiple components. The support arms being tightened with a screw is able to be easier implemented and it would probably be the solution I will go with in the final design.

13/20 - Ergonomics & Aesthetics

Whilst the choice of bright colours make the product stand out, I think it should be toned down to a darker palette to be less distracting to the user's eye while in use. The very large hand rest however, is a great ergonomic choice, which improved the user experience. With this size, and the filleted edges, they are able to rest their whole hand onto it comfortably.

14/20 - Material & Design Choices

Acrylic is used for the same reasons as design 2, however in addition to this, durable nylon bristles are also featured in this design to help prevent residue from escaping the underside of the product. The hand rest of this product will be removable if the user wants to, and this reduces the footprint of the product when in storage.

15/20 - Product Sustainability

Out of all the design solutions, this is the most intuitive one. An adjustable knob, for the angle adjustment tightness is a simple concept that many people would expect and easily understand. The use of the hand rest, and drill support arms both being removable improve the design's portability, and ease of repair long term - making the product overall more sustainable to use for the user.

Overall Score

The functionality of this design's features - such as the rectangular body shape and the use of a knob for the drilling angle adjustment - makes these aspects of this design the most suitable to be integrated into the final one. One aspect that would not be suitable for the final design would be the use of Drill Holding Plates to hold the user's drill. However in comparison to the other designs and the Modification Specification - this design would be the most suitable for the product's overall function.

72/100



Manufacturing Plan



Manufacturing Plan

Main Body

1 - Initially the *main body* my project would be drawn in 3D with (*SolidWorks*) CAD. This step is essential as it allows me to easily visualise each drawn part in a 3D space, change drawing dimensions quickly, and send each drawing file over to a CAM machine for manufacturing.

2 - Next after every single component of my project is drawn in CAD, they would be put into a *validation assembly* to ensure that very part is able to fit together once manufactured. This is important for the *main body* as it features moving *residue seals* and a *residue blocker*.

3 - The parts that are to be laser cut are placed into a DXF drawing file for the laser cutting to read and process. The majority of the *main body* would be cut out in 3mm grey acrylic for quicker finishing and to reduce the weight of the product - 5mm will be used for the support components to ensure they have higher strength.

4 - After the components for the *main body* of the project were laser cut, they are to be sanded and polished. This needs to happen before the body is assembled since finishing after each part is bound together with *liquid solvent cement* would be more difficult. First, 240-grit sandpaper would be utilised to remove rough edges and marks left by the laser cutter, then 600-grit paper smoothens out the edges even further. For the final finish, a polisher machine is to be used - first the parts are to be coated with beeswax then a final polish applied for a shiny finish.

5 - Liquid solvent cement enables each separate component to be fixed permanently - however some parts do need to move freely such as the *residue blockers* so they are not glued in the assembly of the main product body.

Handle & Clamp Holder

1 - For the handle of the project to be made, it is essential that it is drawn in CAD - as it allows me to send it off to a 3D printer to be manufactured. This part would be challenging to draw as it both has to be ergonomic and functional (it also will also have to be able to attach to a vacuum cleaner for dust extraction). The clamp in comparison would be simple to draw in comparison due to its simple shape.

2 - In this stage these parts are to be placed into a validation assembly to ensure they all fit together. It would also give me an idea on how large the final assembly of the product would turn out to be.

3 - For the 3D printed handle, the SolidWorks drawing would need to be converted to a STL file. The material of choice is loaded into the 3D printer and then the printing process is able to start - due to the size of the handle, it would take several hours to print. The *clamp holder* component is laser cut in 5mm for higher strength.

4 - After those parts are machine made, they are then hand finished. The clamp holder would also uses the 240-grit, 600-grit, and finally polisher machine approach as the main product body.

5 - The handle would then be tested if it would be able to be interference fitted, and removed by the user - if this is not the case, further sanding of the component would be needed until the diameter of the fitting face is of a sufficient diameter.

Drill Support

1 - Like the other components, this is to be drawn in CAD so fitting validation and quick dimension changing is able to be carried out. Springs would also have to be drawn in case they are not able to be ordered.

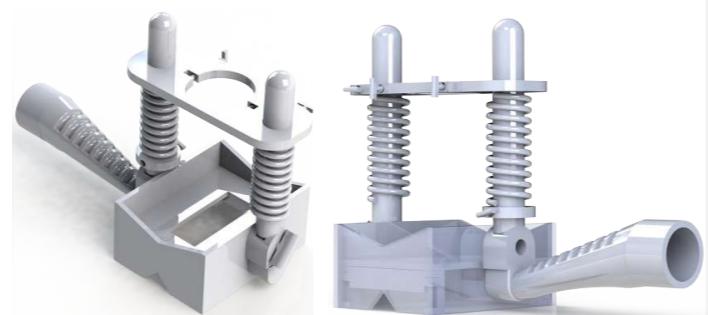
2 - The base of the drill support are to be laser cut in 5mm blue for extra strength over 3mm, and the tubular support arms cut with a saw. The part that connects the support arms to the base is 3D printed using a STL file due to its complex shape.

3 - Small informatics engraving would need to be carried out for the base of the product, and the support arms (this would give angle and drilling depth information to the user). These parts are to be engraved with the laser cutter, and gone over with tipex for increased

4 - The base of the drill support is then to be finished via sandpaper and the polisher machine as it would be difficult to carry this step out after this part is glued together. The inner face however, would be made rougher with abrasive paper to increase the force needed to change the drilling angle.

5 - The drill support component is then to be assembled. The base is glued together and then self tapping screws are to be used to create a tight screw thread - this would allow the user to adjust the tightness of the angle adjuster.

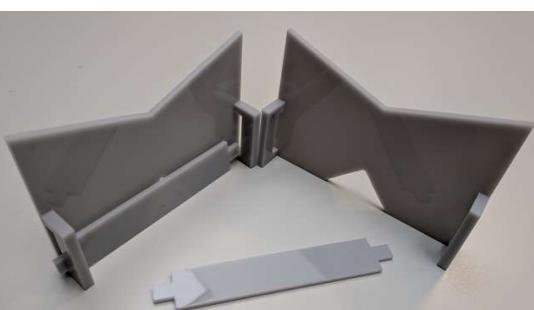
CAD Prototyping



Laser-Cutting & 3D Printing



Component Assembly



The image above showcases the component validation assembly. Each component is mated in the correct place to give me an idea on how the final product will look, and if the parts will fit together.

The handle had to be redimensioned after putting it in the assembly - as the original dimensions were too small. It was redrawn and reshaped afterwards to the correct dimensions.

The handle was the main component that I was 3D printing. The final time took 6 hours to print and then a further few hours were needed to remove the support material (as seen in white) which dissolved in a solution. The finished handle had all of the exact dimensions and features that the CAD drawing had.

After each component was sanded, polished and checked to see if they had the specified dimensions - they were glued together using *liquid solvent cement*.

This permanent gluing solution has high strength and ensures each part is well fixed into place.