Exemplar Candidate Work

GCSE D&T: Industrial Technology

OCR GCSE in D&T: Industrial Technology: J304 / J044

Unit A541: Introduction to designing and making

Portfolio 1: Theme – Machine Vice

Contents

Introduction

This exemplar material serves as a general guide. It provides the following benefits to a teacher:

- Gives teachers an appreciation of the variety of work that can be produced for this unit
- Shows how the mark scheme has been applied by a senior assessor
- Provides examples of both good and weak application of different parts of the mark scheme
- Provides real examples of work conducted under controlled assessment conditions.

It is important to make the point that the teacher support materials play a secondary role to the Specification itself. The Specification is the document on which assessment is based and specifies what content and skills need to be covered in delivering the course. At all times, therefore, this teacher support should be read in conjunction with the Specification. If clarification on a particular point is sought then that clarification should be found in the Specification itself.

Moderator's Commentary: Theme – Machine Vice

The portfolio exemplifies the work of a candidate working at a generally competent level in all sections of the project.

Creativity

The candidate has used analysis of a range of existing products to identify technical details relating to the product and to users' needs. A suitable context for a design modification has been identified and a simple design brief given.

Rather than limit research to similar products, the use of mechanisms in general has been considered as pert of the technical analysis.

The candidate has also demonstrated creativity in the designing and making elements of the project.

Mark: 8 (Max 10)

Designing

A detailed specification for a modified vice has been produced from the analysis of products and mechanisms carried out.

Design ideas are creative and original, presented using scanned drawings that are suitably annotated. These ideas have been evaluated with some reference to the design specification and also consideration of the practicalities of the modifications.

One design idea has been clearly chosen and developed, with CAD drawings being used to show details of the prototype parts, extending the range of communication techniques used by the candidate.

Simple models can also be used to good effect in this section when developing and communicating designs.

Mark: 12 (Max 14)

Making

A well presented plan has been produced given details of materials, tools and processes. Some consideration of safety and time is also shown.

The parts for the prototype have been made to a generally good standard using appropriate materials and employing a range of practical skills. The prototype is complete and fully functioning, as evidenced by digital photographs. Centre staff have assessed the candidate's ability to work safely and independently, and to solve technical problems as they arise.

The production diary is well presented and shows the individual parts as they are made. Photographic evidence of the candidate working on the project would be useful here and, if an electronic portfolio were to be produced, short video clips could be embedded within the text.

Mark: 16 + 4 + 3 = 23 (Max 28)

Critical Evaluation

It should be emphasized that it is the processes involved in the designing and making that are evaluated in this unit and NOT the finished prototype.

The candidate has justified the choice of communication techniques used in the designing element and has made relevant comments relating to the making of the prototype. Modifications to the making processes that would result in an improved prototype are suggested and justified.

Some specialist terms are used where appropriate and the candidate has demonstrated accurate use of spelling, punctuation and grammar. (QWC)

Mark: 7 (Max 8)

Total mark for portfolio: 50 (Max 60)

Marking criteria

Unit A541

Basic ability	Demonstrates ability	Works competently
Creativity • Make simple/limited links between principles of good design and technological knowledge, showing limited awareness of the user. • Identify one or two trends in existing solutions and use this understanding in a design context. **[0 - 3]**	**Creativity** • Identify associations linking principles of good design and technological knowledge, relating products to users' needs. • Demonstrate the significance of research that identifies trends in existing solutions; interpret and apply this understanding in a design context. **[4 - 7]**	**Creativity** • Identify complex associations linking principles of good design and technological knowledge, relating products to users' needs and wants. (AO1) • Demonstrate and understand the significance of trends in existing solutions; reinterpret and apply this understanding in imaginative ways. (AO1) **[8 - 10]**
Designing • Demonstrate a limited response to a brief and produce a simple specification for a prototype. • Produce one or two simple design ideas using a limited range of strategies. **[0 - 4]**	**Designing** • Demonstrate an appropriate response to a brief and produce a suitable specification for a prototype as a result of analysis. • Produce a range of creative ideas and communicate these by using appropriate strategies. **[5 - 10]**	**Designing** • Demonstrate an appropriate and considered response to a brief and produce a detailed specification for a prototype as a result of analysis. (AO2) • Produce creative and original ideas by generating, developing and communicating designs using appropriate strategies. (AO2) **[11 - 14]**

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Basic ability	Demonstrates ability	Works competently
Making	**Making**	**Making**
• Plan and organise activities: o Select and use appropriate materials o Select and use hand and machine tools as appropriate to realise the product. • Work safely to assemble, construct and finish materials and components as appropriate to generate a prototype. • Use workshop/design studio facilities as appropriate to realise the prototype. **[0 - 6]**	• Plan and organise activities: o Select and use appropriate materials o Select and use hand and machine tools as appropriate to realise the product. • Work effectively and safely to assemble, construct and finish materials and components as appropriate to achieve a good quality prototype. • Choose and use workshop/design studio facilities as appropriate to realise the prototype. **[7 - 13]**	• Plan and organise activities: o Select and use appropriate materials o Select and use hand and machine tools as appropriate to realise the product. (AO1/AO2) • Work skilfully and safely to assemble, construct and finish materials and components as appropriate to achieve a high quality prototype. (AO2) • Assess and apply knowledge of the workshop/design studio facilities as appropriate to realise the prototype. (AO1/AO2) **[14 - 20]**
• Demonstrate a simple understanding of how to solve technical problems as they arise. **[0 - 1]**	• Demonstrate a practical understanding and ability in solving some technical problems as they arise. **[2 - 3]**	• Demonstrate a practical and thorough understanding and ability in solving technical problems effectively and efficiently as they arise. (AO2) **[4]**
• Simply record the making of the prototype using notes and/or photographic evidence. **[0 - 1]**	• Record key stages involved in the making of the prototype; provide notes and photographic evidence. **[2 - 3]**	• Record key stages involved in the making of the prototype; provide comprehensive notes and photographic evidence. (AO2) **[4]**
Critical evaluation	**Critical evaluation**	**Critical evaluation**
• Give a limited evaluation of the modelling and prototyping process. • There will be little or no use of specialist terms. • Answers may be ambiguous or disorganised. • Errors of spelling, punctuation and grammar may be intrusive. **[0 - 2]**	• Give an evaluation of the making process. • Reflect on how to improve the modelling and prototyping process. • There will be some use of specialist terms, although these may not always be used appropriately. • The information will be presented for the most part in a structured format. • There may be occasional errors in spelling, punctuation and grammar. **[3 - 5]**	• Critically evaluate the processes involved in designing and making the prototype. (AO3) • Reflect and suggest modifications to improve the modelling and prototyping process. (AO3) • Specialist terms will be used appropriately and correctly. • The information will be presented in a structured format. • The candidate can demonstrate the accurate use of spelling, punctuation and grammar. **[6 - 8]**

Candidate’s work

Unit A541

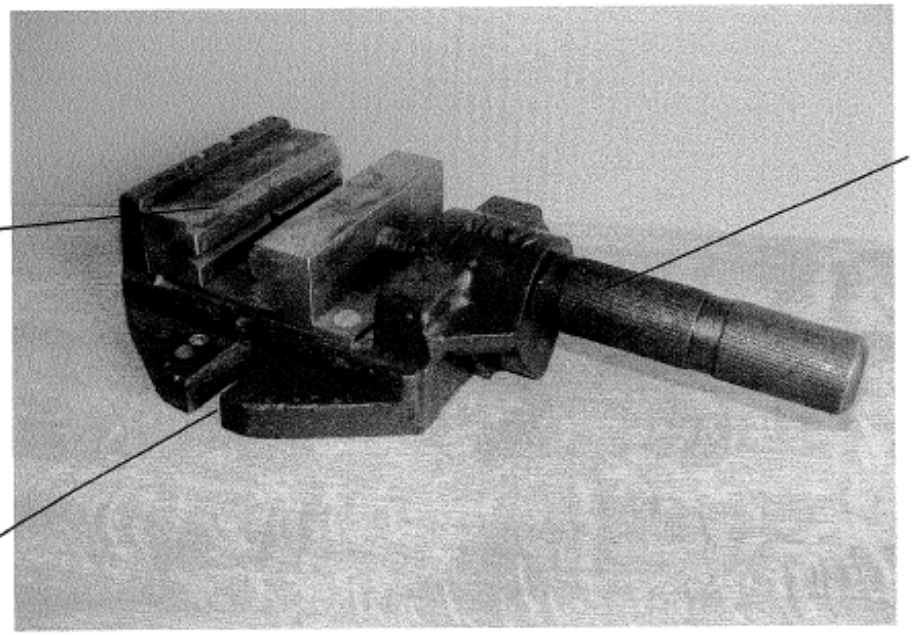
Introduction to designing and making

Project Theme: Machine Vice

General principles and user needs.

A machine vice is used to hold pieces of metal or plastic when drilling holes on a drilling machine. It would be very dangerous to hold something in your hand when using a drilling machine because it could spin round and cut you. To keep the user safe the machine vice has to be able to clamp the metal or plastic tightly so that it can't spin round on the drill.

Most small machine vices are tightened up using the handle that you hold the vice with. If you're drilling large holes it could be difficult to stop the vice turning, so the machine vices usually have slots or holes so that they can be clamped on the table of the machine.



Most machine vices have got a screw thread in the handle to tighten the vice with and if you have a lot of pieces to drill it can take a long time to keep tightening and loosening the vice. It would be useful to have some sort of quick-release mechanism to tighten and loosen the vice so that lots of pieces that are the same could be drilled more quickly.

Design Brief

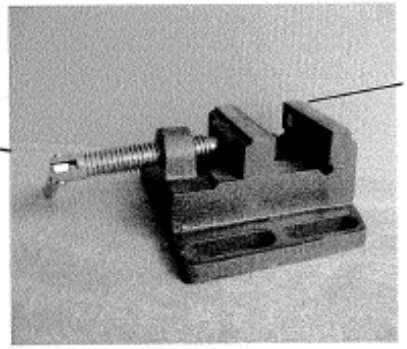
I am going to design a modification to a simple machine vice that will make it easier and quicker to tighten and loosen.

The new vice will have to be safe to use and hold the metal or plastic tightly to stop it from spinning round.

What I'm going to do:

- Look at some existing vices and clamps to see how they work.
- Analyse the existing products to see if there are any technical principles I could use in my design.
- Write a specification for my design.
- Sketch some design ideas that I might be able to develop into a final design.
- Choose one design idea to use for my prototype.
- Plan how I'm going to make my prototype.
- Make my prototype and record the main stages.
- Evaluate the designing and making processes and suggest possible improvements.

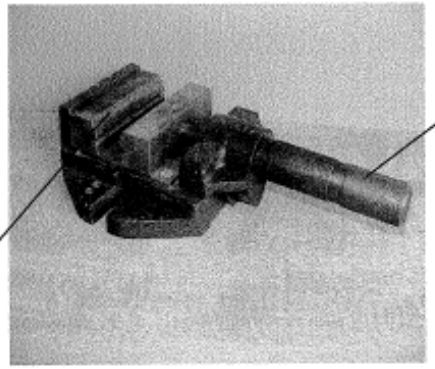
Existing products



Handle with tommy-bar (awkward to use)

Plain jaws without a step

This is a small machine vice that's quite cheap. The threaded handle moves the jaw and a small screw in the jaw stops it from coming out when it is loosened

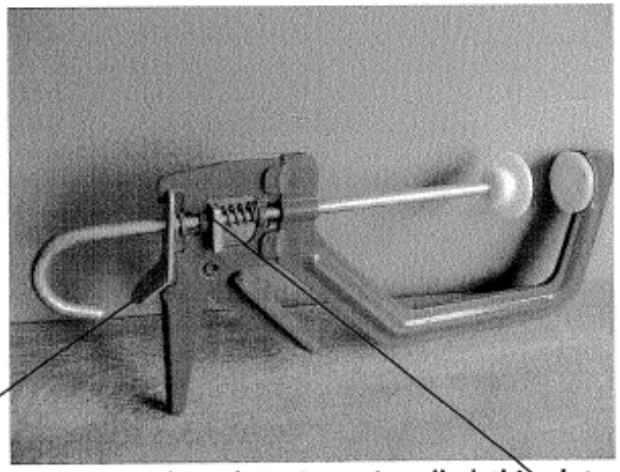


The steps on the jaws stop the drill pushing the work down

The handle is knurled to make it easier to grip and more comfortable.

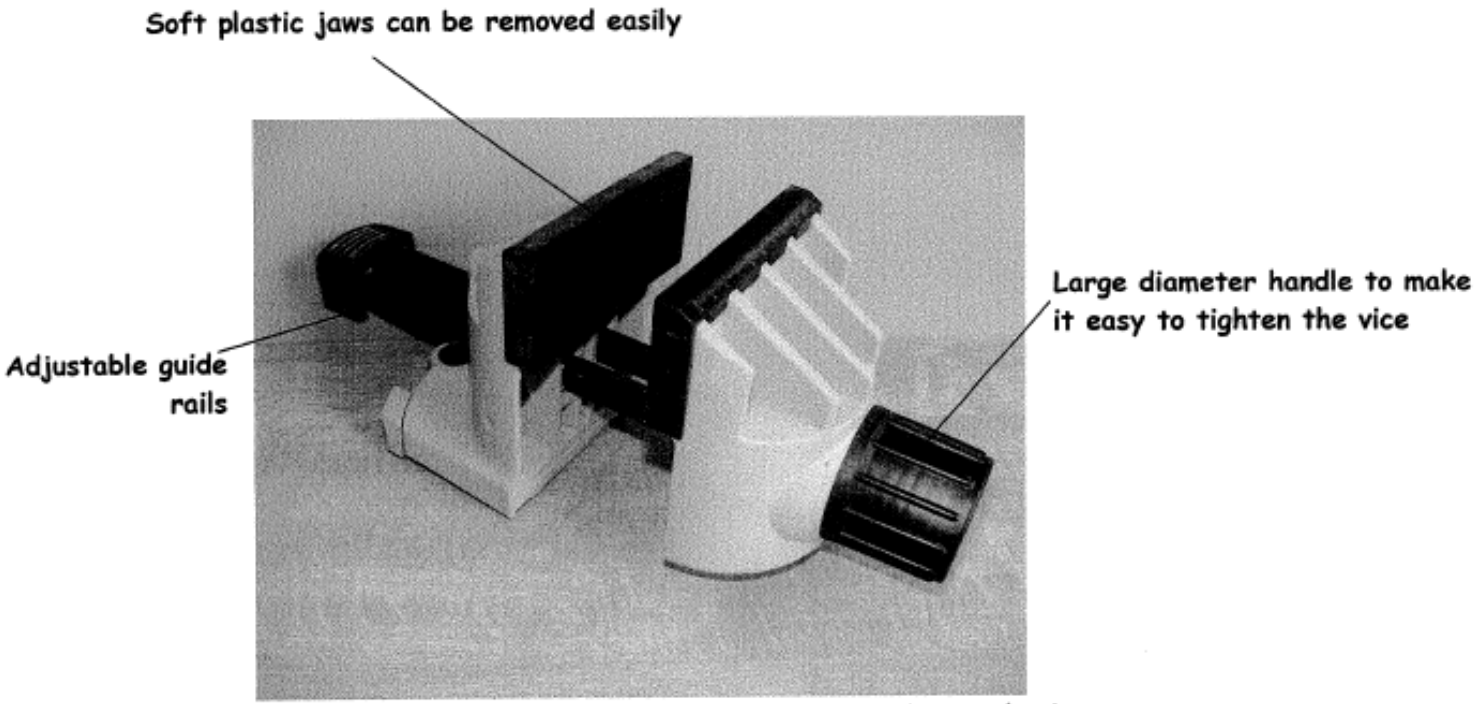
This is a much better quality vice as it's stronger and heavier. This means that the vice won't be turned by the spinning drill so easily.

This is a quick-release clamp that works on a simple lever and spring principle.



To loosen the clamp push this lever forward and pull the shaft back

When the trigger is pulled this plate grips the shaft and pushes it forward



This is really a bench vice but it has an interesting operating mechanism.

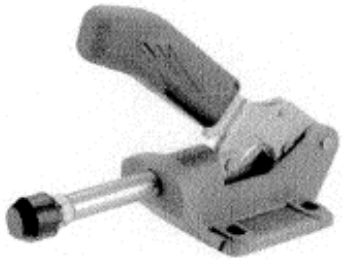
The adjustable guide rails can be moved backwards and forwards through the fixed jaw to get the jaws close together.

When the workpiece has been put in place, the large diameter handle is just used to tighten the jaws. Tightening the jaws pulls the guide rails down and locks them in place.
It only takes less than one full turn of the handle to tighten the vice.

As well as these existing products there are some basic mechanisms that are often used for clemping.

Mechanisms

Here are some examples of mechanisms that might be useful for my quick-release vice.

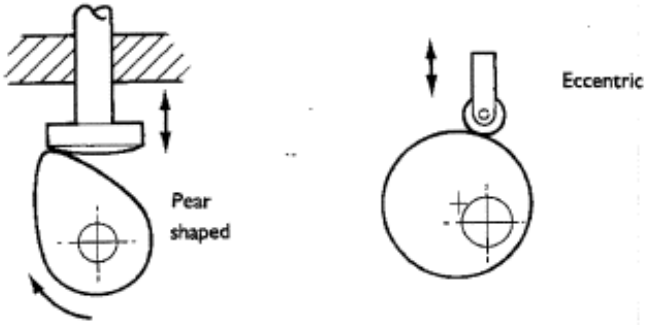


Levers are the simplest type of mechanism.

This is a clamping device called a **Toggle Clamp** that I found on the Internet.
It works with a series of levers to move the clamping plunger backwards and forwards. These are sometimes called **Over-Centre** clamps.

Cams are simple mechanisms used to change **rotary** motion into **linear or reciprocating** motion.

Pear shaped cams are used to move the **follower** up slowly but let it come back down more quickly. This sort of cam is used in car engines to open and close the valves in the engine.
Eccentric cams are very simple because they are just a circular disc with an off-centre hole.
This sort of cam would be easy to make and use for a clamp.



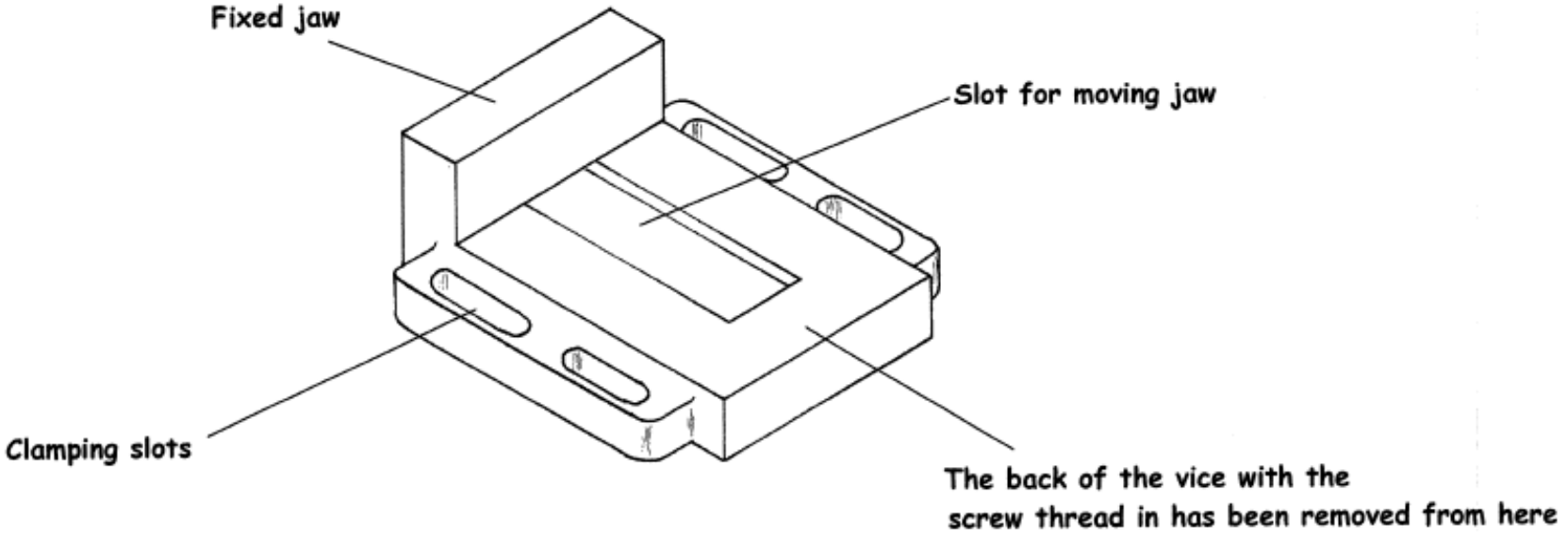
Specification

- The machine vice must be adjustable for different size pieces of metal or plastic.
- The vice must have some mechanism to make it quick and easy to tighten and loosen.
- The vice must be able to clamp the work tightly for drilling.
- The vice must be easy for a lower school pupil to use.
- The user should be able to hold the vice easily when drilling
- It must be possible to clamp the vice down if needed.
- There should not be any sharp edges on the vice.
- It should not be possible for pupils to get their fingers trapped in moving parts.
- The mechanism needs to be simple and strong so that it does not break easily.
- The prototype vice must be made from resistant materials and be able to be tested.

Design Ideas

I'm going to make my prototype vice by modifying a cheap small machine vice like the one I analysed in the existing products section. I shall use the base and fixed jaw from the original machine vice.

All my design ideas will be the modified moving jaw mechanisms needed to make the vice quick and easy to open and close.



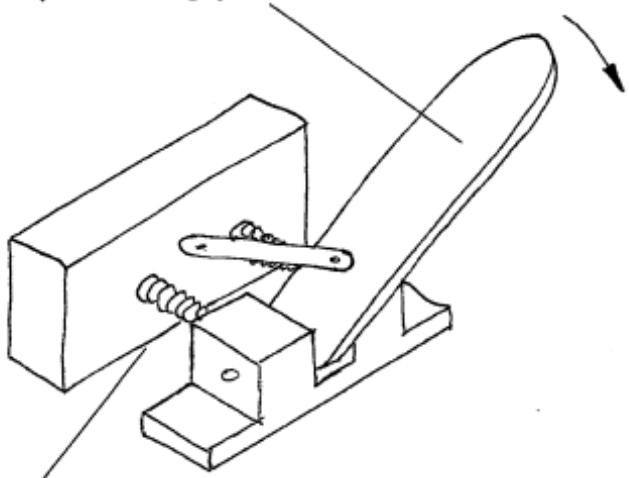
The base is made of cast iron because it is an awkward shape and because cast iron is heavy and slightly self-lubricating, so the moving parts can slide easily.

Design Ideas

Both of these ideas use levers to operate the mechanism.

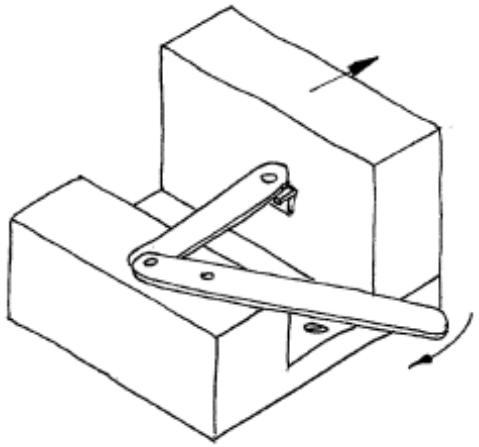
Idea 2

Handle to pull moving jaw back



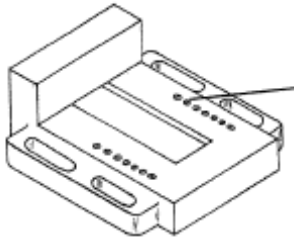
Springs to push moving jaw closed

Idea 1



Lever used to move jaw backwards and forwards

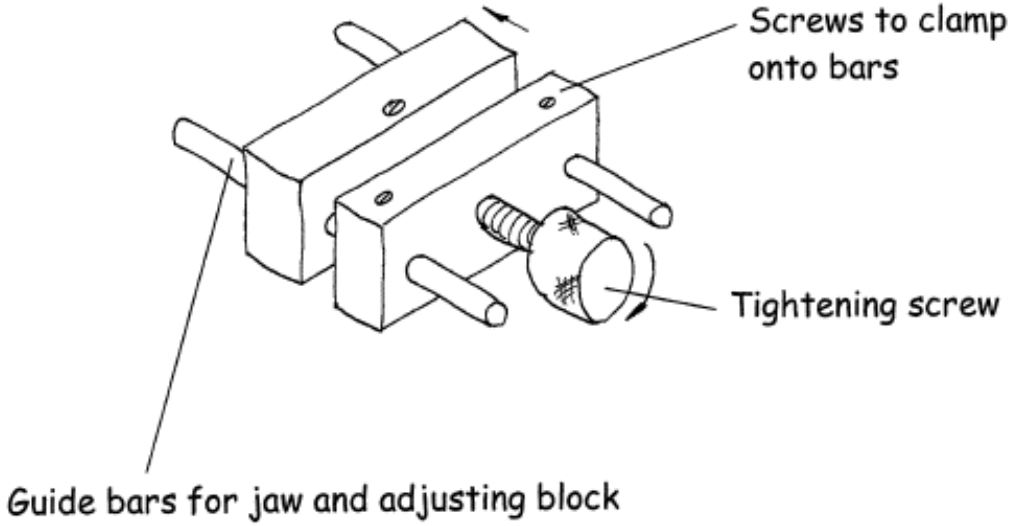
Modifications to base

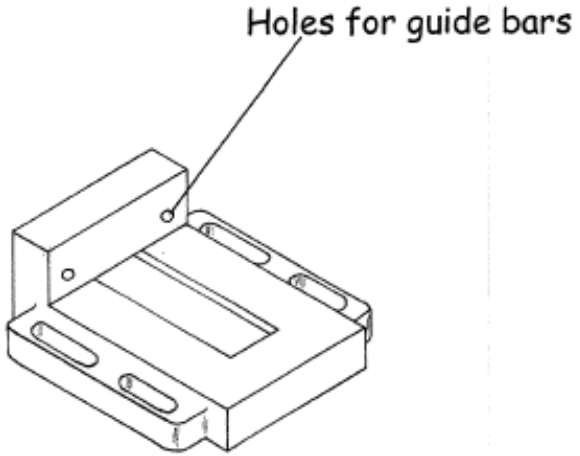


Tapped holes to fix block in place

Ideas 1 and 2 could be fixed to the base with bolts in the tapped holes

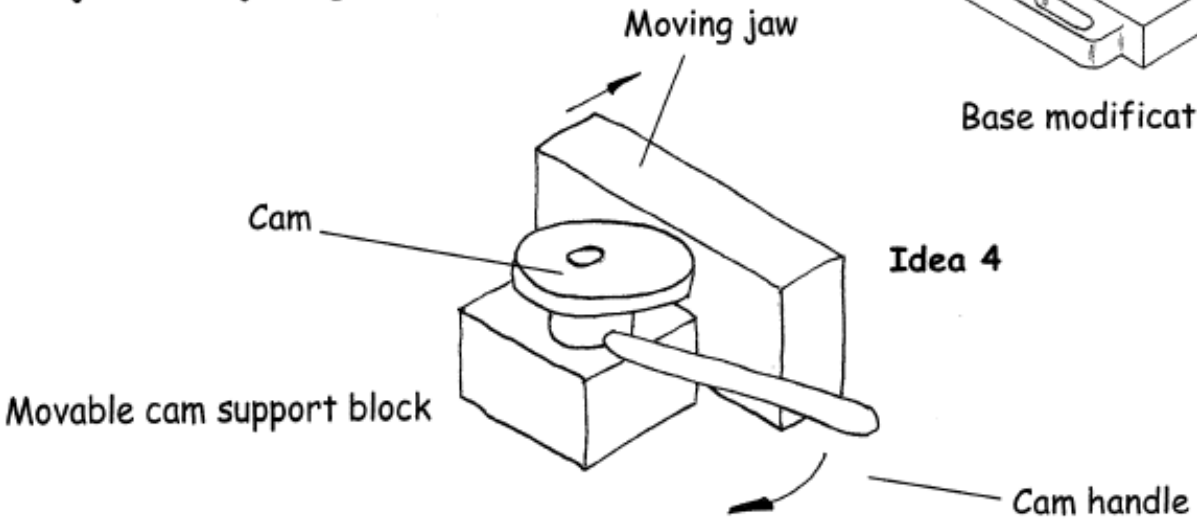
Idea 3





Base modification for Idea 3

Idea 4



Evaluation of design ideas

Design Idea 1 is quite simple but may not clamp the vice up tightly enough. It would also need a series of tapped holes putting in the base so that the clamping device can be moved along into different positions.

Design Idea 2 uses strong springs to hold the sliding jaw against the part being drilled and a lever to pull it back to take the work out of the vice. This could either be fitted onto the base the same way as Design 1, or it could be fitted with plates underneath the base, like the existing method of holding the sliding jaw in place. If the vice was used by lower school pupils, they probably would not be strong enough to pull the jaw back against the spring pressure.

Design Idea 3 is similar to the yellow plastic vice I looked at in my research. The jaw and adjusting block are slid along the guide bars until the jaw is almost in the right place. The adjusting block is then clamped onto the guide bars and the tightening screw is used to close up the jaw. I think this arrangement would work well, but the guide bars might get in the way of the pieces being drilled.

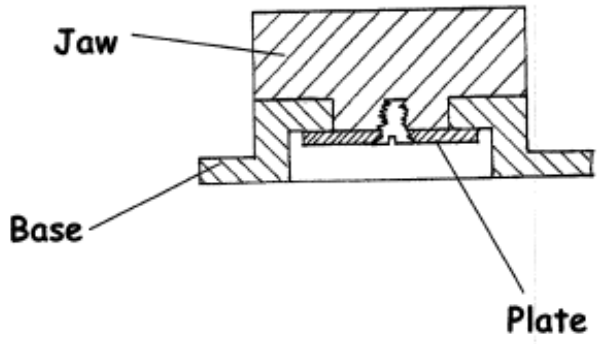
Design Idea 4 is quite simple and does not need as much modification to the vice base for it to be fitted. The moving jaw and the cam support block can be fitted to the base in the same way that the jaw was originally. All that will be needed then is a stop to prevent the cam support block moving back when the vice is tightened.

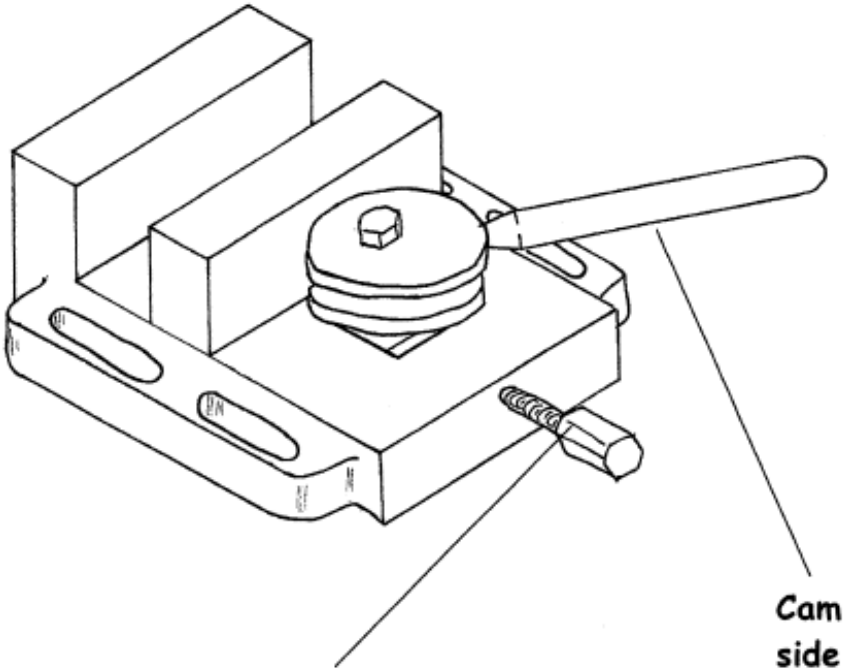
Out of the 4 ideas, I'm going to develop Idea 4 because it is simple and should work well. It would also be easy for lower school pupils to use and the cam handle could be made longer to give more leverage if needed. This fits the needs of the specification better than the other ideas as it is simple, safe and easy to use.

Development of chosen design.

I'm going to make the cam out of two 4mm thick Acrylic discs glued onto an M6 nut. Using two discs will give a more even pressure on the jaw.

How the jaw and cam support block are held in the base

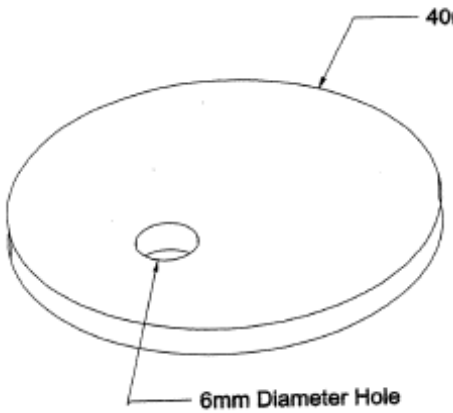




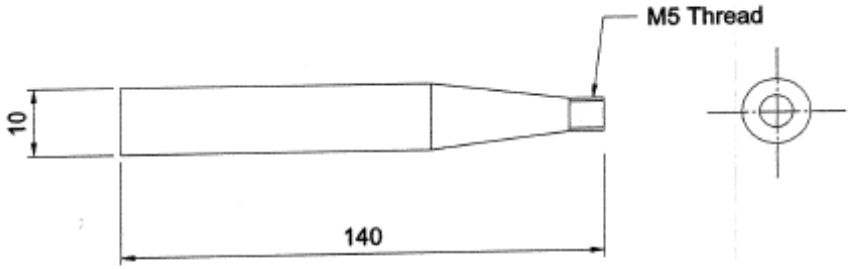
Cam handle screwed into side of M6 nut

Adjustable stop to prevent cam support block moving back when the vice is tightened

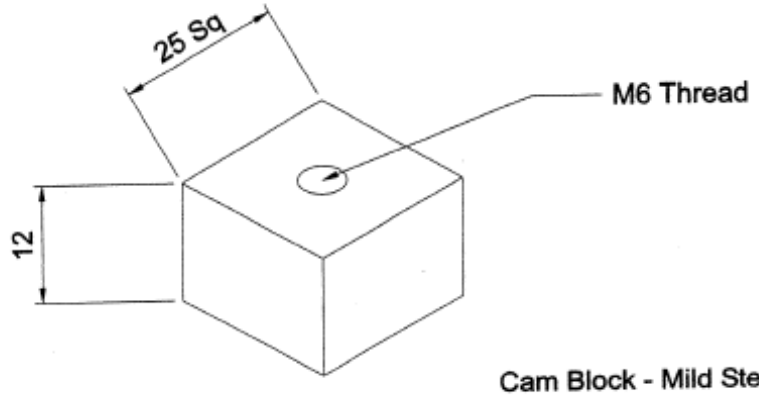
CAD drawings of prototype parts



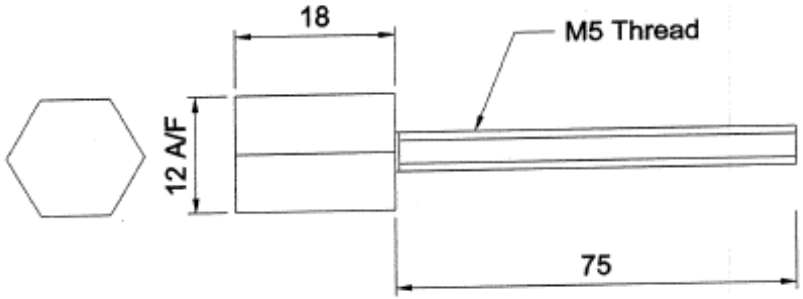
Cam - 2off
4mm thick Acrylic



Cam Handle - Aluminium Alloy



Cam Block - Mild Steel



Adjusting screw - Head - brass
Thread - M5 studding

Assembling the parts

First an M5 hole is drilled and tapped in one side of the M6 nut.

The cam handle is screwed into the M5 hole in the nut.

The two cams are then glued onto each face of the nut with epoxy-resin adhesive, using an M6 nut and bolt to keep them in line while the adhesive sets.

A plate is cut from 4mm acrylic sheet to hold the cam support block into the base.

The cam support block is fitted into the base, then an M6 bolt is used to fix the cam assembly onto the block. The bolt is cut to exactly the right length so that it can be tightened without stopping the cam from moving.

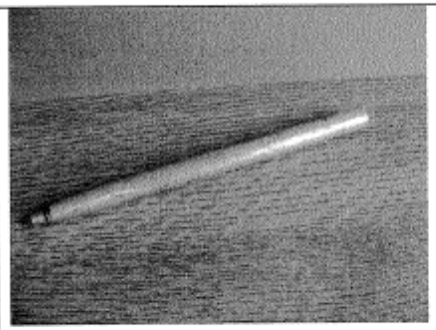
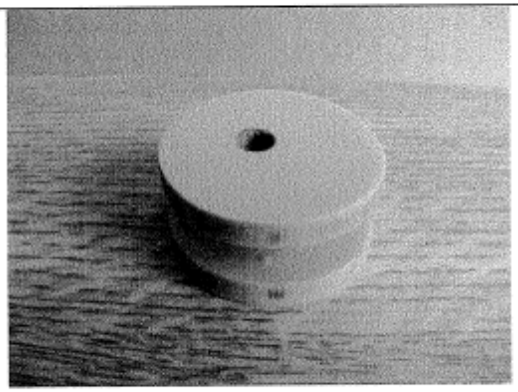
The adjustable stop is screwed into an M5 hole drilled and tapped in the back of the base.

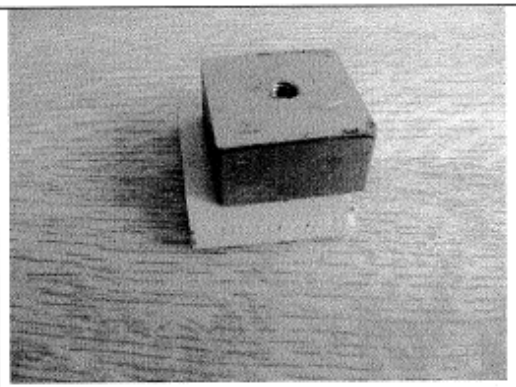
Planning

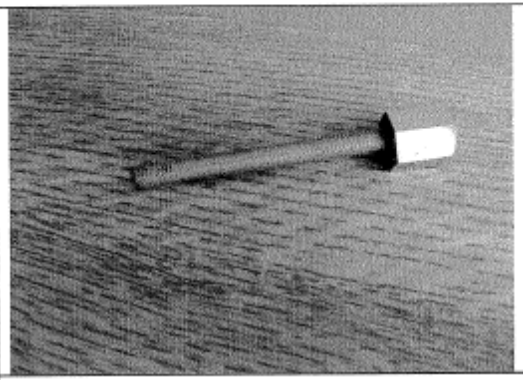
Part	Material	Tools & Equipment	Process	Safety	Time
Base	Cast Iron (casting)	Rule; Scriber; Centre punch; Drilling machine; M5 tap and tap holder	Mark out position of hole for adjustable stop screw. Set up base on drilling machine and drill 4.2 mm Clamp in vice and tap M5 using taper tap first and then plug tap as hole is deep.	Goggles needed as cast iron dust is very fine.	1 Hour
Cam	4mm Acrylic; M6 nut	Dividers; Coping saw; sanding disc; Drilling machine; M6 Tap and tap wrench	Mark out circular cams with dividers. Drill offset hole in both cams together Cut out cams with coping saw and finish on sanding machine. Mark and centre punch for hole in one side of M6 nut. Drill 4.2mm and tap with M5 taper tap	Goggles and apron for drilling. Dust extraction and goggles on sanding machine	2 hours
Sliding Block	25 square mild steel; 4mm Acrylic	Rule; try square; scriber; centre punch; Hacksaw; Drilling machine; M6 tap.	Mark and cut to length 25mm square mild steel File ends flat and square Find centre of end face and centre punch Drill 5mm and tap with M6 taper and plug taps (deep hole) Cut 4mm acrylic plate to size with coping saw Drill 6mm diameter hole and countersink it for screw.	Goggles and apron for drilling.	1 Hour and 30 mins
Cam Handle	Ø10 Aluminium alloy	Hacksaw; Centre lathe; M6 die and holder	Cut off length of 10mm diameter aluminium alloy rod. Turn down end to 5mm diameter for thread. Taper turn to join thread size to handle size	Guards, Goggles and Apron when using lathe.	1 hour

			Start off thread in lathe with M5 die. Finish off thread with handle held in vice		
Adjusting Screw	M5 Studding; Hexagon brass	Hacksaw; Drilling machine; M5 tap	Cut off length of 12mm hexagonal brass File ends flat and square Find centre on one end of brass and centre punch for drilling Set vertical in machine vice and drill 4.2mm Hold brass in bench vice and tap with M5 taper and plug taps. Cut off length of M5 studding Remove sharp edges from end of thread and screw into brass	Goggles and apron for drilling.	1 Hour
Assembly		Screwdrivers ; spanner	Fit cam support block to base with acrylic plate Fit cam handle into M5 hole on the cam assembly Fit cam and handle assembly to cam support block using M6 bolt cut to correct length Fit adjustable stop screw into M5 hole at back of base		20 mins

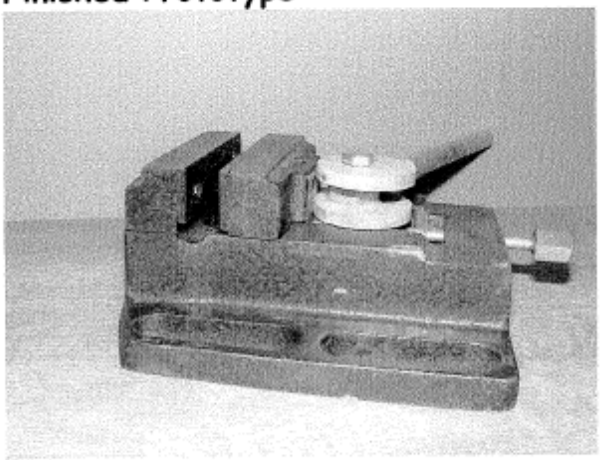
Production Diary

Work done	Photo of part	Time Taken	Notes
Make cam handle out of 10mm aluminium alloy bar on the lathe. Cut an M5 thread on the end of the handle.		1 hour 30 mins	I started the thread off with the handle still in the lathe to make sure it went on straight. I then put it in a vice to finish cutting the thread, with some soft jaws on the vice to stop it damaging the soft aluminium alloy
Mark out and cut two cams from 4mm acrylic sheet. Drill and tap M5 hole in side of nut Glue cams onto the nut		1 hour 45 mins 30 mins	When the cams were glued in place I used an M6 bolt to hold them in position while the glue set. This had to be left for a few hours to harden properly. When the glue had hardened I lightly sanded the cams on the sanding machine to make sure they were the same shape as each other.

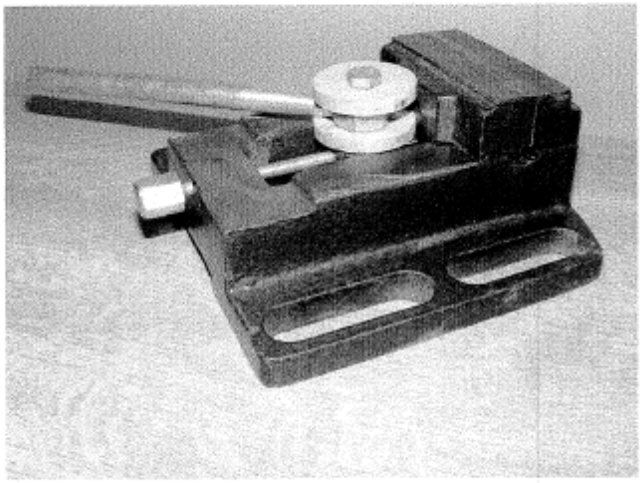
Assemble handle into cams		15mins	
Drill and tap an M5 hole in the back of the base for the adjustable stop.		2 hours	This took a long time because the base had to be clamped onto an angle plate to keep it vertical while it was drilled. I had to set it up one lesson and drill it the next.
Cut off a piece of 25mm square mild steel for the cam support block. Drill and tap an M6 hole in the middle of the block		1 hour and 15 mins	I did this by hacksawing and filing. It was difficult to get the top and bottom of the block flat and square.
Cut a piece of 4mm thick acrylic for the cam support block plate. Drill a 6mm hole in the plate and countersink it for a screw		30 mins	

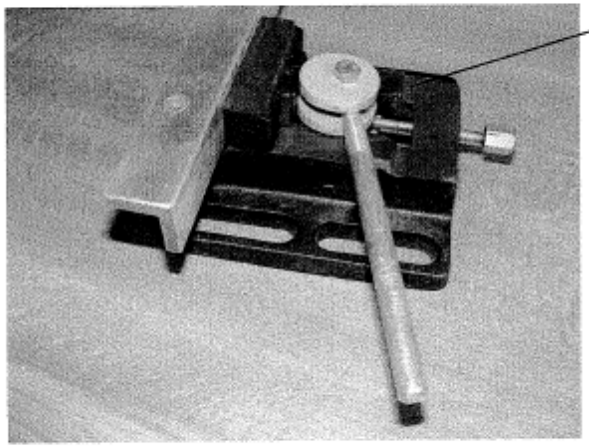
Make the adjustable stop to fit in the back of the base.		1 hour and 15 mins	Instead of making this out of a solid bar, I made the head from hexagonal brass and threaded some M5 studding into it. I used some Loctite on the thread so that it would not come loose again.
Assemble all the parts together onto the base. Test the vice on different sizes of metal and plastic		30 mins	Assembling the parts was quite fiddly and took longer than I expected.

Finished Prototype



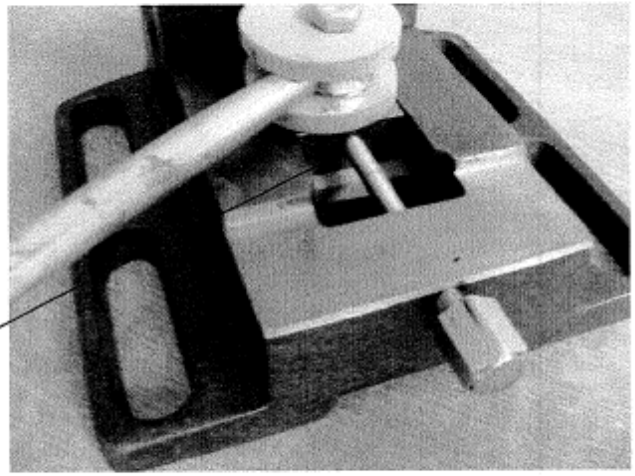
Two views of the finished prototype





The prototype vice in use

How the adjustable stop works



Evaluation

The research I did on existing products and mechanisms helped a lot with the designing of the prototype vice. I was able to get some ideas about how the vice could be made to work and how it might be put together.

Because the vice is quite an awkward shape it was quicker to draw my ideas on the drawing board and then scan them in. As I was using the modified standard vice base to build the prototype onto, I just sketched the mechanism parts of my design ideas. It would have taken much longer to produce the drawings using ProDesktop or Techsoft 2D, so I just used the CAD to do the detail drawings of the parts I needed to make for the prototype.

When I came to make the prototype all the parts were made using normal workshop tools and equipment but some improvements could have been made.
The cam support block was made by cutting a piece of 25mm square mild steel with a hacksaw and then filing it to finished size. This would have been far easier and more accurate if I had been able to finish it to size on the lathe because then the ends would have been square to the sides. It would also have been possible to get a more accurate size for the thickness of the block and then it would run more smoothly in the base.
When I made the adjustable stop screw I cut the head from a piece of 12mm hexagon brass and drilled and tapped an M5 hole in the end of it. I did this by marking out the centre for the hole and drilling it in a vice on the bench drilling machine. It would have been much better if I had done this on the lathe because the hole finished up being off centre. Although it didn't make any difference to how the prototype worked, it didn't look very good.

The materials I used for the prototype parts were good for the purpose and perhaps only the material for the cams would need to be changed if making a fully functioning quality product. What was good about the acrylic for the cams is that they did not slip against the back of the jaw when the vice was tested.