

Design & Manufacturing of Components of Modified Bench Vise on Rapid Prototype Machine

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ABSTRACT

Prototyping or model making is one of the important steps to finalize a product design. Traditional Rapid Prototyping (RP) is commonly referred to as layered manufacturing or solid free form fabrication. It is used for the physical modelling of a new product design directly from computer aided design (CAD) data without the use of any special tooling or significant process engineering. This rapid procedure reduces the lead time required to produce a prototype of a product by eliminating much or all of the process engineering time and tooling requirements. It helps in conceptualization of a design. Designing a rigid, flexible, cost effective and highly durable vise is need of today's era. Safety should also be taken into consideration while designing the vise. This paper is related to designing and manufacturing of modified bench vise components on rapid prototype machining process. We have designed the conventional and modified bench vise in Pro-E CAD software and manufactured it on Dimension 1200es RPT machine.

Keywords: Rapid Prototyping, Rapid Tooling, Rapid Manufacturing, Bench Vise, Value Addition

1. INTRODUCTION

Vise is a mechanical *screw* apparatus used for holding or clamping a work piece to allow work to be performed on it with tools such as saws, planes, mills, drills, screwdrivers sandpaper, etc. Vises usually have one fixed jaw and another, parallel jaw which is moved towards or away from the fixed jaw by the screw. Vises are used as holding devise on machines like lathes, milling machine, drilling machine etc. and also by tool makers for holding jobs. Design wise three types of vises are very common in use namely plain vise, swivel vise and tool maker's vise which is commonly known as bench vise. Vise is usually refers to a bench vise with flat, parallel jaws, attached to a workbench. There are two main types: a woodworking vise and engineer's vise. The woodworker's bench vise main characteristic is its integration into the bench. An engineer's bench vise is usually clamped or bolted onto the top of the bench. The handle is usually adjustable so that it can be tightened in small places.

There are four main types of bench vises these are machinist vise, mechanics vise, post vise and woodworkers vise. The machinist's vise is considered as "cream of the crop". They are stoutly made and are finely machined. The jaws should match up perfectly, and they will be made of very high grade (60,000psi or greater) cast iron. The mechanic's vises are made of lower grade iron. They usually have an integrated anvil area. The post vise is a blacksmith's tool, these vises are made of forged wrought iron, not cast iron, allowing them to have ductility. The woodworker's vise is an under-mount vise, usually with a retractable dog for clamping work upon the workbench.

There are two main types of jaws used on vises: hard and soft. Hard jaws are available with either a coarse gripping surface or are ground flat and smooth to increase accuracy. The latter relies on pressure for gripping, instead of a rough surface. An unskilled operator has the tendency to over tighten jaws, leading to part deformation and error in the finished workpiece. Soft jaws are usually made from a soft metal (usually aluminum), plastic, or wood. They are used to either hold delicate workpieces. These specifically cut jaws are often used in place of fixtures and most commonly used in gang operations. They are also used for rapid change-over type set-ups since they can be easily engraved with the part number, the job number, or other information relevant to the job being run. Soft jaws are considered a consumable item, because they are discarded or recycled after multiple uses.

2. Rapid Prototyping

Prototyping or model making is one of the important steps to finalize a product design. It helps in conceptualization of a design. Before the start of full production a prototype is usually fabricated and tested. Manual prototyping by a skilled craftsman has been an age old practice for many centuries. Second phase of prototyping started around mid-1970s, when a soft prototype modelled by 3D curves and surfaces could be stressed in virtual environment, simulated and tested with exact material and other properties. Third and the latest trend of prototyping, i.e., Rapid Prototyping (RP)

by layer-by-layer material deposition, started during early 1980s with the enormous growth in Computer Aided Design and Manufacturing (CAD/CAM) technologies when almost unambiguous solid models with knitted information of edges and surfaces could define a product and also manufacture it by CNC machining.

Rapid Prototyping (RP) is capable of producing prototypes of almost any geometrical complexity in relatively short time using the additive manufacturing approach. RP is a technology for quickly fabricating physical models, functional prototypes and small batches of parts directly from computer aided design (CAD) data. RT (Rapid tooling) generally concerns the production of moulds and tooling inserts using RP. Figure 1.2 various applications and processes of rapid prototyping.

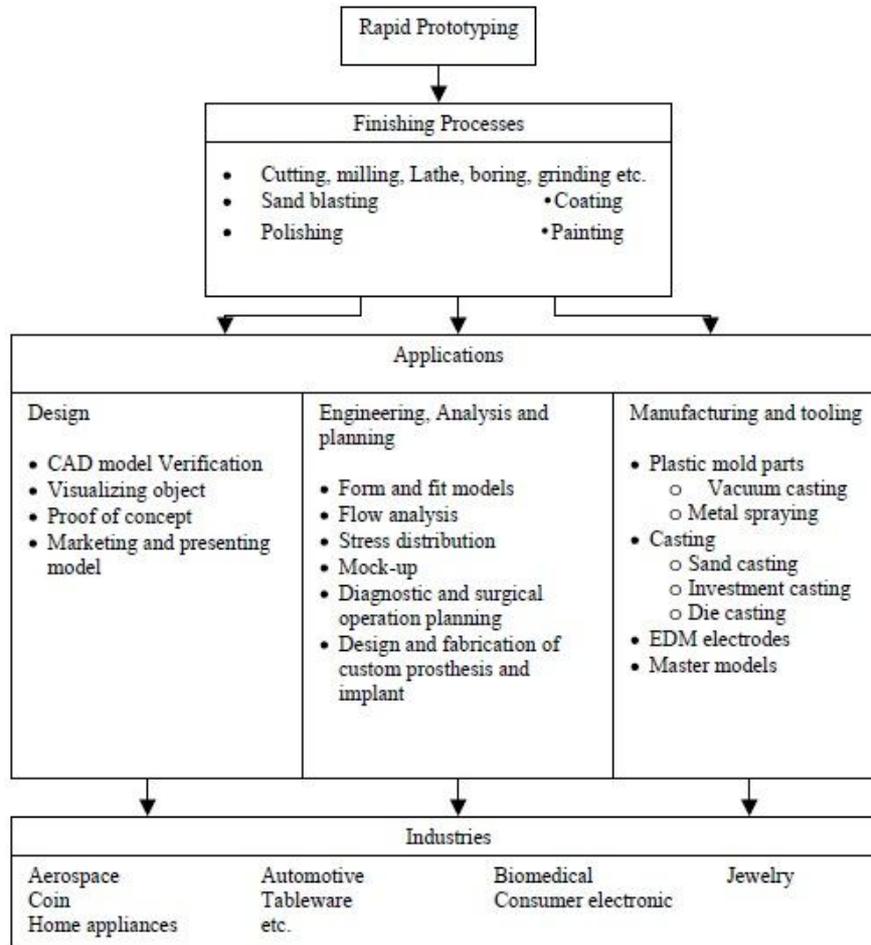


Fig. 1.2 Applications of rapid prototyping

The rapid prototyping (RP) process is being used widely with great potential for rapid manufacturing of functional parts. The RP process involves translation of the CAD file to STL (standard triangular language) format followed by slicing of the model into multiple horizontal layers, each of which is reproduced physically in making the prototype. The thickness of the resulting slices has a profound effect on the surface finish and builds time of the prototype. Three objects were modelled and STL files were generated. One STL file for each object was sliced using different slice thicknesses, and the build times were obtained. Screenshots were used to show the slicing effect on layering error and surface finish and to demonstrate the means to a more efficient STL file. Rapid prototyping is an innovating manufacturing technology with inherent capability to transform CAD models directly into physical parts, thereby positively influencing product development effort on time, cost and quality fronts.

2.1 Fused Deposition Modeling Technology

Fused deposition modeling (FDM) is gaining distinct advantage in manufacturing industries because of its ability to manufacture parts with complex shapes without any tooling requirement and human interface. Method of Rapid Prototyping (RP) is most commonly used for rapid production of new part intended for presentation purposes. Manufactured models can also be used for different tests and analyses, for example for testing of fluids flow, aerodynamic tests, confirmation of results of FEM and DEM analyses. Another application area is covered with verification of assembling procedures and checking on their kinematical and dynamical properties. Typical examples are successfully created proto types or reconstructions of bones, joints. Created prototypes dramatically increase level of possible engineering interaction, as real 3D objects are easier to explain and understand as presented 2D ideas of models. For testing purposes the models can be printed in scale what can lead to lower requirements for testing forces,

loads, etc. RP technology also shortens times for classical prototyping in sense of creating-testing-redesigning-rebuilding and repeatedly.

For better orientation of user in process of setting of suitable parameters during the preparation of printing there was algorithm elaborated which accumulates all factors and steps that lead to selection of most suitable variant. All the attempts were realized as a part of preparation stage for printing on RP machine that utilize FDM technology to build the prototype. This technology, developed by Stratasys, uses the software program to orient the model and generate building slices. Printer dispenses with basic building material and support material which is used if necessary for creation of holes, cavities, drafts, etc. Each material has its own nozzle. Creation of particular prototype layers with use FDM method is shown in following figure 1.3.

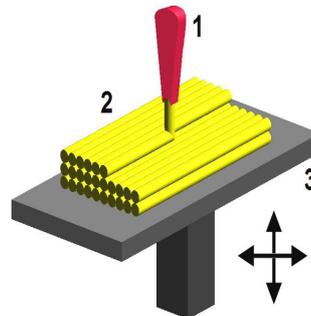


Fig. 1.3 Schematic model of FDM (1-nozzle, 2-building material, 3-movable table) (11)

2.2 Types of RP Systems

Prototyping is an important stage in any product development process and the prototype can be defined as “an approximation of a product (or system) or its components in some form for a definite purpose in its implementation”

There are three main Rapid Prototyping systems, depending on initial the form of materials involved:

- Liquid-based RP systems – The initial form of material is in liquid state and, by a curing process, the liquid is converted into solid state; the system includes: 3D Systems’ Stereolithography (SLA), Light Sculpting, Rapid Freeze and Two Laser Beams
- Solid-based RP systems – The initial form of material is in solid state, except for powders (wire, roll, laminates, pellets); this system includes: Stratasys ‘Fused Deposition Modeling (FDM), 3D Systems, Multi-Jet Modeling System(MJM) and Pares lamination Technology (PLT)
- Powder-based RP systems – The initial form of material is powder; the system includes: 3D Systems, Selective Laser Sintering (SLA), Precision Optical Manufacturing’s Direct Metal Deposition (DMD) and Z Corporation’s Three Dimensional Printing (3DP).

2.3 Basic Principle of Rapid Prototyping Processes

RP process belong to the generative (or additive) production processes unlike subtractive or forming processes such as lathing, milling, grinding or coining etc. in which form is shaped by material removal or plastic deformation. In all commercial RP processes, the part is fabricated by deposition of layers contoured in a (x-y) plane two dimensionally. The third dimension (z) results from single layers being stacked up on top of each other, but not as a continuous z-coordinate. Therefore, the prototypes are very exact on the x-y plane but have stair-stepping effect in z-direction. If model is deposited with very fine layers, i.e., smaller z-stepping, model looks like original. RP can be classified into two fundamental process steps namely generation of mathematical layer information an generation of physical layer model. Typical process chain of various RP systems is shown in figure 2.1.

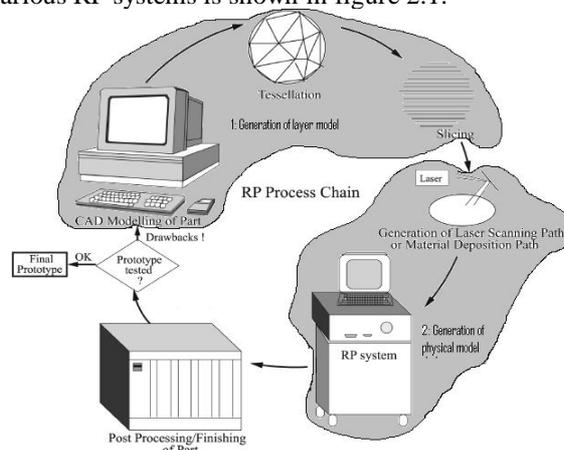


Fig. 2.1 RP process chain showing fundamental process steps

It can be seen from figure 2.1 that process starts with 3D modelling of the product and then STL file is exported by tessellating the geometric 3D model. In tessellation various surfaces of a CAD model are piecewise approximated by a series of triangles and co-ordinate of vertices of triangles and their surface normals are listed. The number and size of triangles are decided by facet deviation or chordal error. These STL files are checked for defects like flip triangles, missing facets, overlapping facets, dangling edges or faces etc. and are repaired if found faulty. Defect free STL files are used as an input to various slicing softwares. At this stage choice of part deposition orientation is the most important factor as part building time, surface quality, amount of support structures, cost etc. are influenced. Once part deposition orientation is decided and slice thickness is selected, tessellated model is sliced and the generated data in standard data formats like SLC (stereolithography contour) or CLI (common layer interface) is stored. This information is used to move to step 2, i.e., generation of physical model.

The software that operates RP systems generates laser-scanning paths (in processes like Stereolithography, Selective Laser Sintering etc.) or material deposition paths (in processes like Fused Deposition Modelling). This step is different for different processes and depends on the basic deposition principle used in RP machine. Information computed here is used to deposit the part layer-by-layer on RP system platform. The generalized data flow in RP is given in figure 2.2. The final step in the process chain is the post-processing task. At this stage, generally some manual operations are necessary therefore skilled operator is required. In cleaning, excess elements adhered with the part are removed. Sometimes the surface of the model is finished by sanding, polishing or painting for better surface finish or aesthetic appearance. Prototype is then tested or verified and suggested engineering changes are once again incorporated during the solid modelling stage.

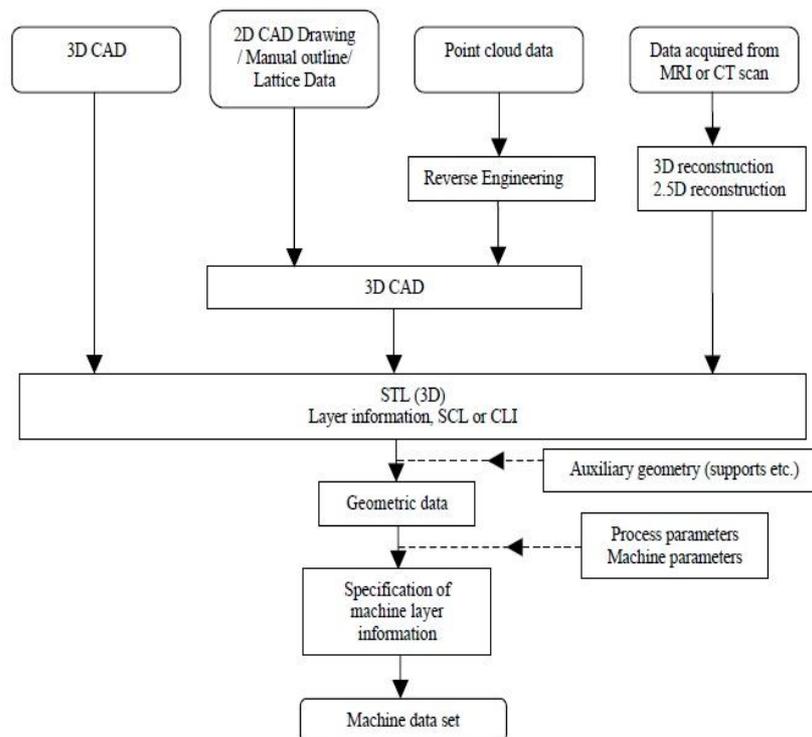


Fig. 2.2 Generalized illustration of data flow in RP

3. Case Study

The Manufacturing industry is operating on tighter margins and ever increasing competition. With more competition and ever changing consumer demands, small scale industries are frequently realizing the necessity to reengineer their facility to satisfy the needs of many product groups and styles.

In the Mechanical Engineering field bench vise plays a vital role during manufacturing of various components. Therefore we have selected the bench vise for the case study. In market different types of bench vises are available to meet the industry demand but till the existing bench vise can be modified in different types to complete the operations safely, efficiently and to increase the productivity of manufacturing industry. We have manufactured the proposed modified bench vice by using Rapid Prototyping process.

3.1 Objectives

Every organization attempts to reduce the costs through number of ways. Effective control of costs is one of the important functions of management. Rapid prototyping technique is aimed to finalize a product design. It helps in

conceptualization of a design. Before the start of full production a prototype is usually fabricated and tested. It helps to improve effectiveness of work, design, method of manufacture of the product eliminating unnecessary costs without adversely affecting quality, safety and other customer features.

It also involves a systematic consideration of alternative methods of accomplishing required functions and alternative materials, processes. Rapid prototyping technique is used to increase the effectiveness of the final product before manufacturing. Therefore Rapid prototyping is used for cost reduction and design modification of bench vise.

Rapid prototyping manufacturing technology has a capability to transform CAD models directly into physical parts, thereby positively influencing product development effort on time, cost and quality. Vises are used as holding device on machines like lathes, milling machine, drilling machine etc. and also by tool makers for holding jobs i. e. vise is used on large scale for different applications. So it is necessary to design a rigid, flexible, cost effective and highly durable vise. Safety should also be taken into consideration while designing the vise. Present work is to design a bench vise with modifications in conventional vise. Consequently the main objective of this work is to make modifications in present vise and manufacture its prototype on RPT machine.

The main objectives of this project are:

1. Study of Rapid Prototyping and bench Vise.
2. Designing a conventional bench vise using Pro-E.
3. Design modification by value addition in the bench vise.
4. One side locking arrangement (C Clamp with one screw) for bench vise to make it portable& fix bench vice on different tables at any location.
5. Providing surface plate with right angle plate on stationary jaw for measurement of right angles between two surfaces of job.
6. Manufacturing a prototype of modified bench vise on RPT machine.
7. Making bench vise more cost effective and reliable.

4. Design Process

Design process can be achieved by relying on new design methods and with the help of computer programs like CATIA. The advantage of using these options when designing these product variants is the speed of manufacturing and time to market and the result is reduction of cost production. The overall process of design, from beginning to end, is defined in following figure. The process begins with identification of need and then making the decision. After much iteration, the process ends with the presentation of the project which fulfils the request.

4.1 Design of Bench Vise

Following details and exploded view of Bench vise is designed in Creo parametric (Pro-E) designing software. Designing (drafting and 3D orientation) of each separate part is also added in following sections.

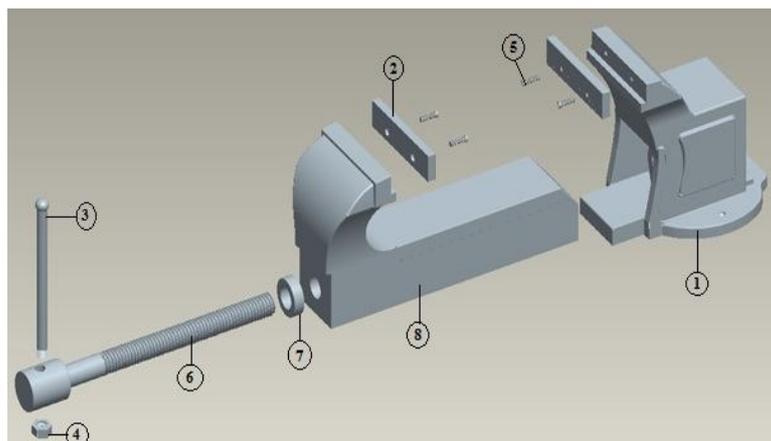


Fig. 4.5 Different components of bench vise shown in exploded view

Exploded view of assembled bench vise is shown in figure 4.5.

Table no.4.1 Bill of materials of conventional bench vise

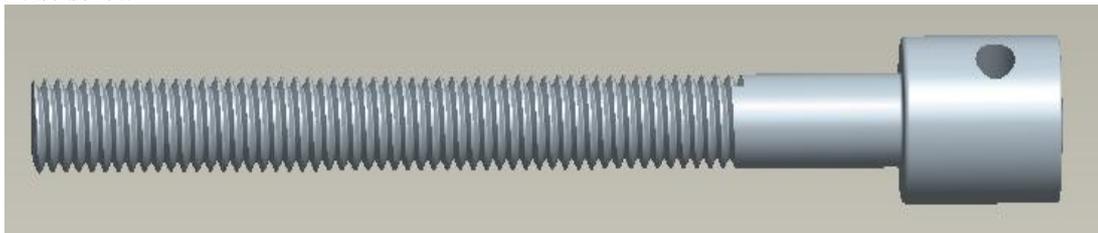
Sr. No.	Part name	Quantity	Material
1	Fixed jaw	1	C. I.
2	Jaw plate	2	SAE 3140
3	Handle rod	1	C R S
4	Handle nut	1	SAE 1020
5	Flat tapping screw	4	MILD STEEL
6	Vise screw	1	SAE 3140

7	Collar	1	SAE1020
8	Sliding jaw	1	C. I.

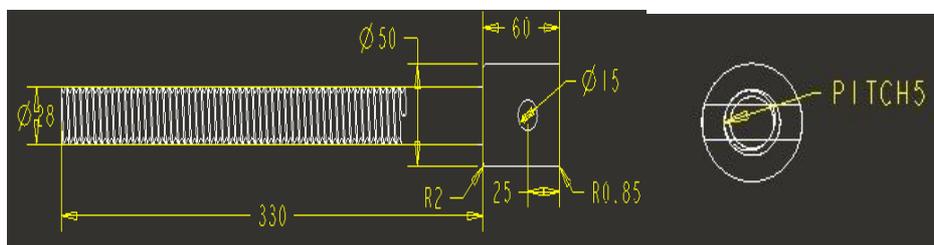
Design of each part of bench vise

Pro-E is parametric integrated 3D CAD/CAM/CAE solution created by Parametric Technology Corporation (PTC). It provides solid modelling, assembly modelling and drafting, finite element analysis, direct and parametric modelling. It is more user friendly than any other CAD software for solid modelling. Hence we decided to carry out the designing of our bench vise in Pro-E CAD software. While designing there are various processes which described below every part design figure.

Design of vise screw



3D orientation of vise screw

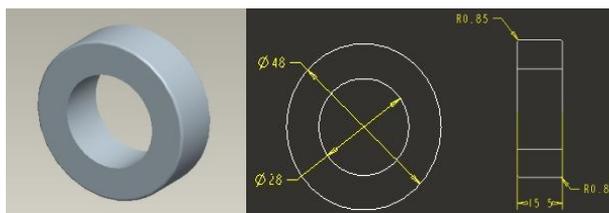


Front and L.H. S. view of vise screw (Scale 1.67:4.00)

The function of vise screw of bench vise is to give the movement for movable jaw in to and fro direction. This is used for tightening the work piece in fixed and movable jaws. It is manufactured by usng material of SAE 3140.

Design of collar

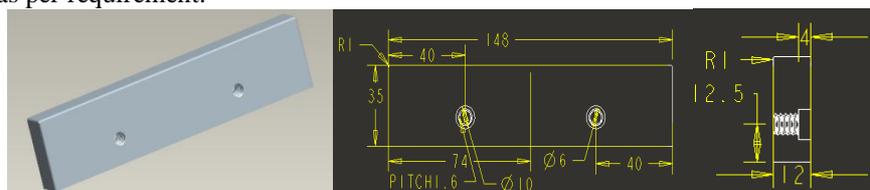
Collar is circular ring that goes round a vise screw to make it stronger, especially where screw head and movable jaw are to be joined for movement purpose of the movable jaw. It located between screw head and base of movable jaw. It also gives the strong support to the screw head at the time of tightening the work piece between the jaws. Generally it is made of SAE 1020 material.



3D orientation, front& L.H.S. view of Collar (Scale 1.0:1.5)

Design of jaw plate

Jaw plate is simple metallic strip made from SAE 3140 material. It is fixed on the both movable and fixed jaw. Its function is to grip the work piece firmly when different operations are to be performed on the work piece. For effective grip, diamond knurling is provided on gripping surface. Depending upon the material of work-piece, different jaw plates can be used as per requirement.

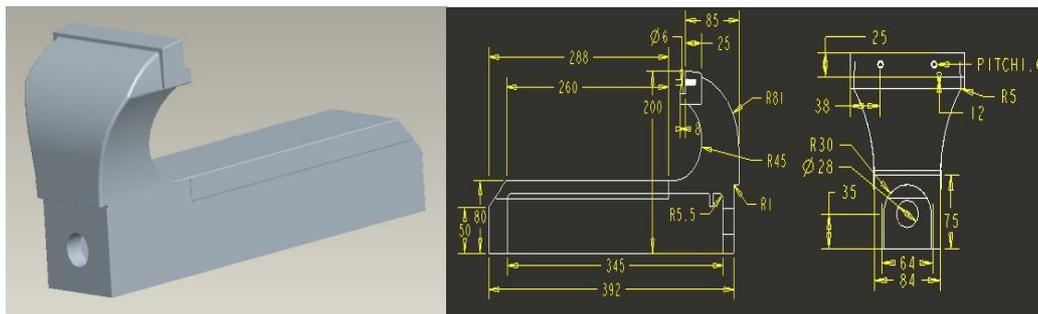


Front & L.H.S.W. of Jaw plate (Scale 0.500:1.000)

Design of sliding jaw

Sliding jaw is also called as movable jaw which is used to hold the work-piece between movable and fixed jaw. Depending upon the size of work-piece, the sliding jaw can be operated in to and fro direction to hold the work-piece.

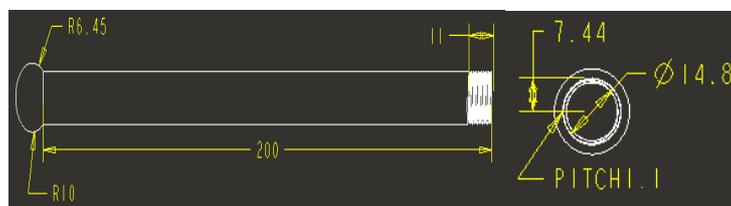
Generally it is made from cast iron (CI). It is a rigid part of bench vise to remain stable when the operations are carried out.



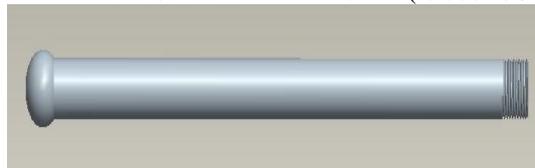
Front and left hand side view of sliding jaw (Scale 0.143:0.300)

Design of vise handle

The function of vise handle is to give the rotating motion to vise screw when tightening and loosening of work-piece between two jaws are required. It is inserted in the hole provided on vise screw. On one side of vise handle threaded portion is provided and other side is ball headed. It is made from CRS material.



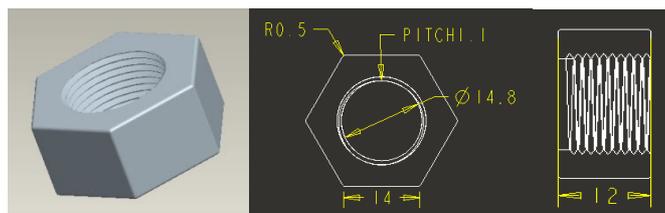
Front and L. H. S. view of handleScale (0.333: 0.900)



3D orientation of vise handle

Design of handle nut

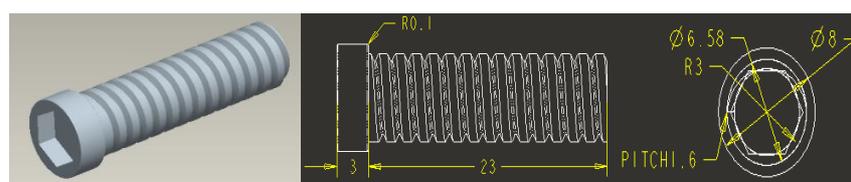
This nut is fixed on vise handle. Its function is to restrict the vice handle from falling down from the vise screw. It is made from the material MS.



3D orientation, front and L. H. S. view of handle nut (Scale 1.00:1.60)

Design of flat tapping screw

The tapping screw is used to fix the jaw plate on the face of the both jaws i.e. sliding and fixed jaw which is used to hold the work-piece. It is tightened with the help of Allan key. Generally two tapping screws are required for each jaw and are manufactured in MS.



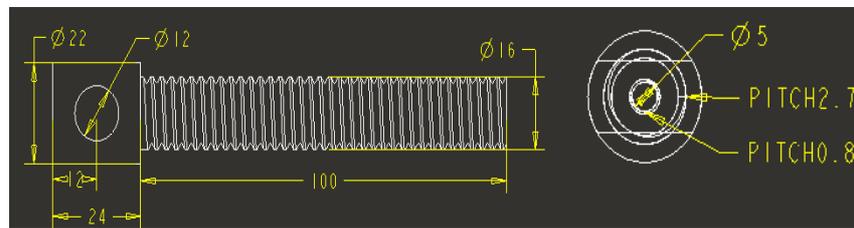
Front and L. H. S. view of tapping screw (scale 1.000:3.000)

Design of fixed jaw of bench vise

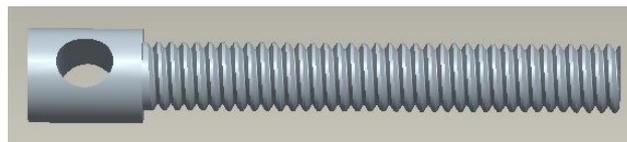
The fixed jaw is the main part the bench vise which supports the whole assembly of bench vise. The fixed jaw is rigidly fixed on work bench with the help of nut and bolt arrangement on both sides. Its function is to guide the movable jaw and vise screw which are operated in to and fro direction. Fixed jaw is manufactured form cast iron (CI) metal. The

Design of clamping screw

Clamping screw is design fit into the c-clamp and at the top of the clamping screw circular disc is provided to fit the bench between circular disc and base of fixed jaw. The designing dimensions of the clamping screw are given in following figure.



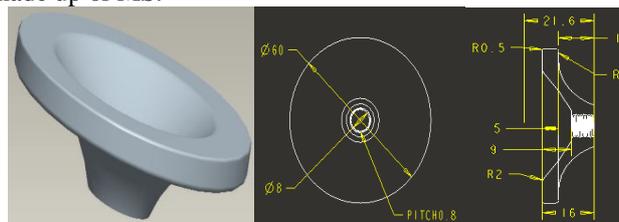
Front and L. H. S. view of clamping screw (Scale 0.500:1.000)



3D orientation of clamping screw

Design of circular disc

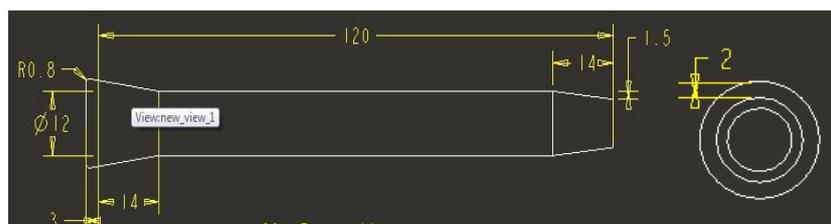
This circular disc is mounted on clamping screw to hold the bench wise. The upper face of the disc should provide good resistant to bench to hold it properly against bench. Inner threads are provided at lower portion of circular disc to attach circular disc. Circular disc is made up of MS.



3D orientation, Front and L. H. S. view of circular disc used in c-clamp (Scale 1.0:1.2)

Design of handle for c-clamp

This handle is used for rotating clamping screw. The hole is provided at the top of the handle to accommodate handle. This handle is rotated by applying torque to fit the bench vise to the bench.



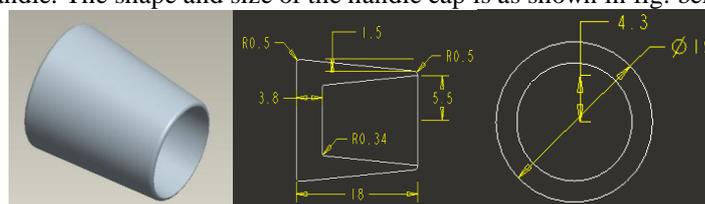
Front and L. H. S. view of handle used for c-clamp(Scale 0.500:1.500)



3D orientation of handle used in c-clamp

Design of handle cap

To lock the handle from one side this handle cap is provided. This handle serves as a locking system and made up of same material as that of handle. The shape and size of the handle cap is as shown in fig. below.



3D orientation, Front and L. H. S. view of handle cap (Scale 2.00:3.00)

Actual pictures after modifications in CAD software

The main components of modified bench vise are fixed jaw, movable jaw, lead screw with handle, c-clamp, clamping handle, nut and bolt.

The fixed jaw is fixed to the c-clamp with base with the help of nut and bolt. A lead screw is fit between movable jaw and fixed jaw to control the movement of movable jaw. The whole assembly is then fitted to bench with help of c-clamp as shown in fig. The work piece is held between movable jaw and fixed jaw with the help of lead screw.

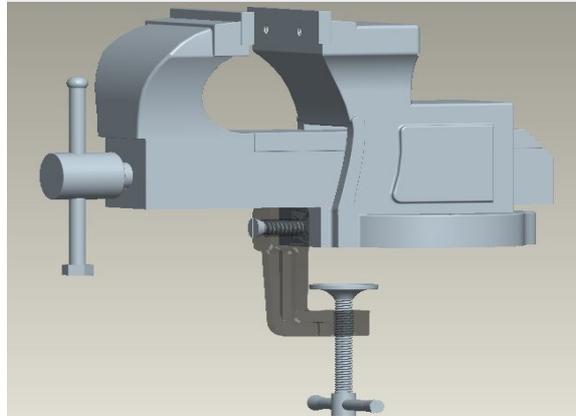


Fig. 4.7 Highlighted C-clamp is fixed to bench vise with one screw

5. Rapid Prototyping of Bench Vise

Dimension 1200es printers are designed with ultimate simplicity in mind. The systems enable you to build parts quickly, even if you have never used a 3D printer before. The systems model with ABS *plus* plastic, so modeled parts are strong and durable. ABS *plus* so ensures that you will be able to drill, tap, sand, and paint your creations. With the speed and convenience of Soluble Support Technology, completed parts are quickly available for review and test.

Dimension 1200es printers are an innovative combination of proprietary hardware, software, and material technology. Dimension 1200es printers build models, including internal features, from CAD STL files. Three dimensional parts are built by extruding a bead of ABS plastic through a computer-controlled extrusion head, producing high quality parts that are ready to use immediately after completion. With two layer resolution settings, you can choose to build a part quickly for design verification, or we can choose a finer setting for higher quality surface detail. The Dimension 1200es systems consist of two primary components-the Dimension 1200es 3Dprinter and Catalyst EX. Catalyst EX is the preprocessing software that runs on a Windows XP Pro, Windows Vista or Windows 7 platform. The build envelope measures 254 x 254 x 305 mm (10 x 10 x 12 in). Each material cartridge contains 922 cc (56.3 cu. in.) of usable material (10).

Table. 5.1 Manufacturing details of various parts of bench vise

Name of Parts	Model Material (in3)	Support Material (in3)	Estimated Time (Hrs)	Weight (gm)
Movable Jaw	3.62	2.05	5.36	57.3
Fixed Jaw	3.26	1.59	6.02	83.3
Vise screw with handle	0.52	0.46	1.32	8.2
C-clamp fixing screw	0.07	0.04	0.14	1.6
C-clamp	0.48	0.15	0.40	4.4
Collar	0.04	0.01	0.04	1.9
Screw	0.02	0.01	0.06	1.6
Assembly 1	7.52	4.16	12.94	150.3
Assembly 2	8.05	4.32	13.38	153.5
Assembly 3	7.48	4.13	12.78	149.1

Assembly 1: Assembly of conventional bench vise

Assembly 2: Assembly of modified bench vise with C-clamp having one screw

Assembly 3: Assembly of movable jaw and modified fixed jaw

5.2 Manufacturing of modified Bench vise on RPT

For better visualization we used Catalyst Ex software which gives model material, support material, model cartridge and support cartridge in cubic inch. Also it gives estimated time for manufacturing of part.

1. Fixed jaw

Inserting STL file - orientating as per requirement (minimum support material should be used) - packing it for final printing (locating its position on base clamp) – checking availability of enough material for manufacturing a packed part and printing finally on rapid prototype machine

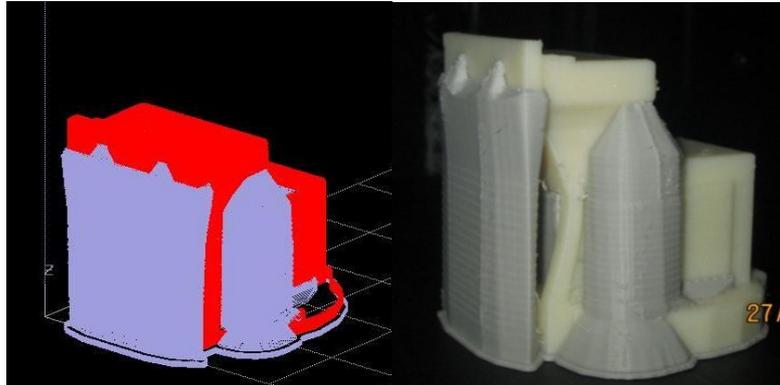


Fig.5.3 Visualization of fixed jaw in catalyst software and its final manufacturing

2. Movable Jaw

Movable jaw of bench vise manufactured on RPT machine, by converting its CAD model into STL format.



Fig.5.4 Movable jaw manufactured on RPT machine

3. Lead Screw with handle

For better visualization we used Catalyst Ex software which gives model material, support material, model cartridge and support cartridge in cubic inch. Also it gives estimated time for manufacturing of part.

By using Catalyst Ex software we get following data for Vise Screw with vise handle



Fig.5.5 Preview and final manufactured view of lead screw

4. C-clamp

Assembly of C-clamp and fixing screw manufactured on RPT machine which is further assembled to modified fixed jaw.

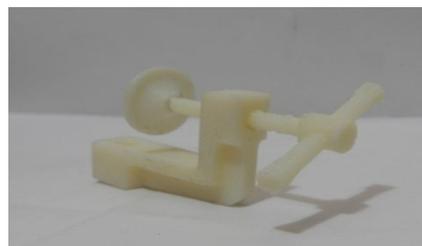


Fig.5.6 C-clamp with base plate and without base plate

Assembly of modified Bench vise Manufactured by RPT



Fig.5.7 Assembly of movable jaw and modified fixed jaw

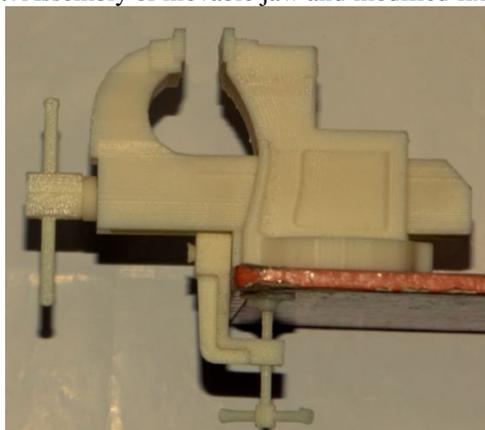


Fig.5.8 Assembly of modified bench vise with C-clamp & C-clamp having base plate

Table no.5.2 Comparison between Existing and Modified Bench Vise

Sr. No.	Part Name	Existing Bench Vise	Modified Bench Vise
01	Fixed Jaw	Traditional Fixed Jaw used for clamping the work-piece firmly while performing the operation.	Fixed jaw takes the shape of surface plate. This will help to insure that either two faces are in 90° or not. Also it saves time while measuring this angle between two faces of work-piece.
02	C-Clamp	C-clamp is not provided in traditional bench vise.	C-clamp is attached below the base of traditional fixed jaw and then we can move & fix the bench vise on any table as per the requirement.
03	C-Clamp With Base Plate	C-clamp with Base plate is not provided in traditional bench vise.	C-clamp with base plate performs the same function as mentioned above but with this bench vise can be clamped rigidly to the table at any place as per requirements.

5.2 Results of Prototyping

- A **visualized specification in the form of an interactive prototype** of future applications is obtained, enabling easier communication between the designer and the manufacturer.
- It will help ensure **more specific feedback from the manufacturer** in the early stages of the project.
- **The accuracy of every detail** of the design/functionalities/product/services can be checked before programming starts.
- The speed of incorporating the changes to the prototype is more, **the entire process of creating the application can be speeded and the number of requests for changes** in advanced stages of development can be reduced.
- It will help ensure **better defined application requirements** and validate their implementation in the prototype.
- A better idea of the estimated cost of application development can be obtained.
- In prototype, a visual representation of the final application is gained **and enables better demonstration of the feasibility of our idea** to other people (investors, colleagues, and superiors).

5.3 Future Scope

RP pattern can be used in sand casting when pattern making is troublesome meaning that the design of the pattern is complicated which is not possible to make in wooden or metallic forms. They can be successfully used in mass production after making a metallic master pattern usually made of aluminum or by spraying layers of metal over the pattern

Future modification in the bench vise

1. Job recovery mechanism for catching work-piece to avoid accidents
2. Fixing different types of job holders for different materials and different types of shape and size
3. Providing Quick return mechanism for fixed jaw.
4. Providing guide ways in table for movement of vise in longitudinal direction (to and fro direction).

6. Conclusions

Design process is achieved by relying on new design methods and with the help of computer software's like CATIA, UG, Solid works and Pro-E. The need of modifications in actual design is to reduce overall cost of the product, increase the products life, minimizing material waste etc. These are achieved in the modifications of bench vise. In the next phase of the project all designed parts has to be converted into STL format. Using conventional methods, such as casting, forging, machining etc. engineers are limited in the ability to design bench vise by the drastic length of time required to prototype an idea.

Modified traditional fixed jaw to the shape of surface plate which helps to insure that either two faces of work-piece are in 90^0 or not. When it is necessary to measure the 90^0 angle between any two faces repetitively then this modification saves the time.

Most of the traditional bench vises are attached or clamped to a bench permanently with the help of two or three bolts. In modified design C-clamp is designed which can be attached below the base of traditional fixed jaw. Whenever we need to change the location of bench vise then first attach the C-clamp to vise and fix it on any side of the bench to perform the operations continently.

C-clamp with base plate is designed which is attached below the base of traditional fixed jaw. The base plate provides the extra strength for clamping the vise to the wooden table. This modified bench vise can be used at any place where required as it is flexible to fix on any table. The rapid prototyping technique is affordable methods for fast product development. The engineering practice uses a lot of computational methods to achieve the design which will fulfill all demands. Anyway, no numerical method is 100% accurate, and it is necessary to manufacture the physical model and to be tested before the product is manufactured in large series.

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