



DESIGN OF A MULTI PURPOSE FIXTURE FOR 4-AXIS CNC MACHINE

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Abstract

Many of the parts require sophisticated fixture in order to be machined. A variety of CNC machine brands all of which have differently designed tables. They needed a way of sharing the clamping systems with all of the machines. After reviewing the fixtures and machines, we designed, and tested a clamping system which would eliminate the need for different fixtures for each machine. This means that each time an operation is complete the part, with its current fixture, must be taken out of the CNC machine and re-fixture for the next operation. Information on the CNC machines will be gathered and the similarities and differences of the tables and fixtures will be analyzed. Based on this data a new process and design will be created. Finally, we will look at the effectiveness of the proposed designs and improvements to verify that it will improve the manufacturing process.

In the present design BFW BMV40 CNC machine take in to consideration for developing new fixture design. As a designer the drive table specifications are considered as per the machine developer and rest of the part is considered as per the customer requirement of individual parts.

Different stages of rotor blades take in to consideration to prepare a multiple usage fixture for all clamping requirements.

Key word: fixtures, 4-axis rotary CNC machines, clamping, time monitoring design optimization.

CHAPTER-1

INTRODUCTION

1.1 Introduction to fixtures

1.1.1 Definition of Fixture and Jig

Fixtures, being used in machine shop, are strong and rigid mechanical devices which enable easy, quick and consistently accurate locating, supporting and clamping, blanks against cutting tool(s) and result faster and accurate machining with consistent quality, functional ability and interchangeability.

Jig is a fixture with an additional feature of tool guidance.

1.1.2 Purpose of Using Fixtures and Jigs

The fixture is a special tool for holding a work piece in proper position during manufacturing operation. For supporting and clamping the work piece, device is provided. Frequent checking, positioning, individual marking and non-uniform quality in manufacturing process is eliminated by fixture. This increase productivity and reduce operation time.

Fixture is widely used in the Industry practical production because of feature and advantages.

To locate and immobilize work pieces for machining, inspection, assembly and other operations fixtures are used. A fixture consists of a set of locators and clamps. Locators are used to determine the position and orientation of a , whereas clamps exert clamping forces so that the work piece is pressed firmly against locators. Clamping has to be appropriately planned at the stage of machining fixture design. The design of a fixture is a highly complex and intuitive process, which require knowledge. Fixture design plays an important role at the setup planning phase. Proper fixture design is crucial for developing product quality in different terms of accuracy, surface finish and precision of the machined parts In existing design the fixture set up is done manually, so the aim of this project is to replace with hydraulic fixture to save time for loading and unloading of component. Hydraulic fixture provides the manufacturer for flexibility in holding forces and to optimize design for machine operation as well as process function ability.

1.2 Problem statement for present project:

To initiate the fixture-design process, clearly state the problem to be solved or needs to be met. State these requirements as broadly as possible, but specifically enough to define the scope of the design project. The designer should ask some basic questions: Is the new tooling required for first-time production or to improve existing production.

This phase of the fixture-design process requires the most creativity. A typical work piece can be located and clamped several different ways. The natural tendency is to think of one solution, then develop and refine it while

blocking out other, perhaps better solutions. A designer should brainstorm for several good tooling alternatives, not just choose one path right away. During this phase, the designer's goal should be adding options, not discarding them. In the interest of economy, alternative designs should be developed only far enough to make sure they are feasible and to do a cost estimate. The designer usually starts with at least three options: permanent, modular, and general-purpose work holding. Each of these options has many clamping and locating options of its own. The more standard locating and clamping devices that a designer is familiar with, the more creative he can be. Areas for locating a part include flat exterior surfaces (machined and un machined), cylindrical and curved exterior surfaces. The exact procedure used to construct the preliminary design sketches is not as important as the items sketched. Generally, the preliminary sketch should start should start with the part to be fixture. The required locating and supporting elements, including a base, should be the next items added. Then sketch the clamping devices. Finally, add the machine tool and cutting tools. Sketching these items together helps identify any problem areas in the design of the complete fixture.

1.3 Introduction to Implement the Design:

The final phase of the fixture-design process consists of turning the chosen design approach into reality. Final details are decided, final drawings are made, and the tooling is built and tested. The following guidelines should be considered during the final-design process to make the fixture less costly while improving its efficiency. These rules are a mix of practical considerations, sound design practices, and common sense.

1.3.1. Important considerations while designing fixtures:

Designing of jigs and fixtures depends upon so many factors. These factors are analyzed to get design inputs for jigs and fixtures. The list of such factors is mentioned below:

- a. Study of work piece and finished component size and geometry.
- b. Type and capacity of the machine, its extent of automation.
- c. Provision of locating devices in the machine.
- d. Available clamping arrangements in the machine.
- e. Available indexing devices, their accuracy.
- f. Evaluation of variability in the performance results of the machine.
- g. Rigidity and of the machine tool under consideration.
- h. Study of ejecting devices, safety devices, etc.
- i. Required level of the accuracy in the work and quality to be produced.

Introduction to 4-axis Milling

Adding a 4th axis rotary table to a milling machine in any sort of work setting provides several advantages to machine work. Having another axis to work with gives milling machine users more precision and accuracy, without having to change positions of the part being machined. Also, an additional axis would prove to make any milling machine more diverse in the work it is capable of doing; lathe machines introduce the aspect of a rotating part, so a rotary table would add the same benefits provided. A 4th axis rotary table, in general, can provide more precision and ease to a complex design,

reducing time and costs for the production of a certain piece.

The Importance of a 4th Axis Rotary Table

Just like with the other three axes of motion, the 4th axis can be adjusted for specific amounts of distances to accurately tell what position you are at in relation to the dimensions of the piece. Furthermore, the scales used to measure its motion can save time and resources by reducing the amount of mistakes that could result in major delays, such as re-working the piece from the beginning. Since users will easily be able to calculate and set the positions needed for the work done, machining multiple pieces is simpler to accomplish.

Objectives:

- (1) CNC with 4-axis attachments.
- (2) Clamping system for Fourth axis Rotary.
- (3) Fourth axis with flat bed clamping fixing system.
- (4) Fourth axis with chuck clamping system.
- (5) Special purpose fixture for different applications.
- (6) Study of market requirements for the present application.
- (7) Comparative study on both clamping system with motion analysis.

2. Literature survey

2.1 Design of machining fixture by C.Madhavi¹, B.Ramu², K. Srinivasulu stated that

Fixture Design consists of High product rate, low manufacturing operation cost. The fixture should be designed in such-a-way that part/product change overtime is very less. The report consists of study of input data from customers like Part drawing and Assembly drawing. The fixture design begins with part modeling, Machining and Analysis of various parts in the fixture assembly using AutoCAD and Solid works, for a analysis COSMOS Software package is used. The actual design begins with study details of project proposal summary from customer.

The main purpose of fixture is to locate the work quickly and accurately, support it properly and hold it securely, thereby ensuring the all parts produced in same fixture will come within specified limits. Another important aspect in designing the fixture is to reduce non production time i.e. setup time. Operator conformability has prime consideration in fixture design. In this fixture design ergonomic aspects have studied carefully reducing operator fatigue to minimum. Rigid clamping and proper loading sequence has achieved the total assembly accuracy within prescribed limit. The self alignment of components has achieved by designed loading sequence.

2.2 A Review on Design of Fixtures by Shailesh S.Pachbhai¹, Laukik P.Raut²
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The efficiency and reliability of the fixture design has enhanced by the system and the result of the fixture design has made more reasonable. To reduce cycle time required for loading and unloading of part, this approach is useful. If modern CAE, CAD are used in designing the systems then significant improvement can be assured. To fulfill the multifunctional and high performance fix turning requirements optimum design approach can be used to provide comprehensive analyses and determine an overall optimal design. Fixture layout and dynamic clamping forces optimization method based on optimal fixture layout could minimize the deformation and uniform the deformation most effectively. The proposed fixture will fulfilled researcher production target and enhanced the efficiency, Hydraulic fixture reduces operation time and increases productivity, high quality of operation, reduce accidents.

3.1 DESIGN CONSIDERATIONS

Specifications for present project:

- (1) The indexing chuck to chuck distance =450mm
- (2) Bed length in CNC VMC bmv45 =600 -850mm
- (3) Indexing chuck Diameter (ID - 150mm)
- (4) In case of flat Fixture the Side plates dimensions =80x80
- (5) No of Tap holes 16 no's of M12 Tap –on both plates
- (6) These side plates size is less than the job so that it can clamp rigidly.
- (7) side plates Thickness = 30mm
- (8) Overall chuck dia in O.D=350mm.

Supported wall thickness-12mm,
bottom wall thickness-10mm,

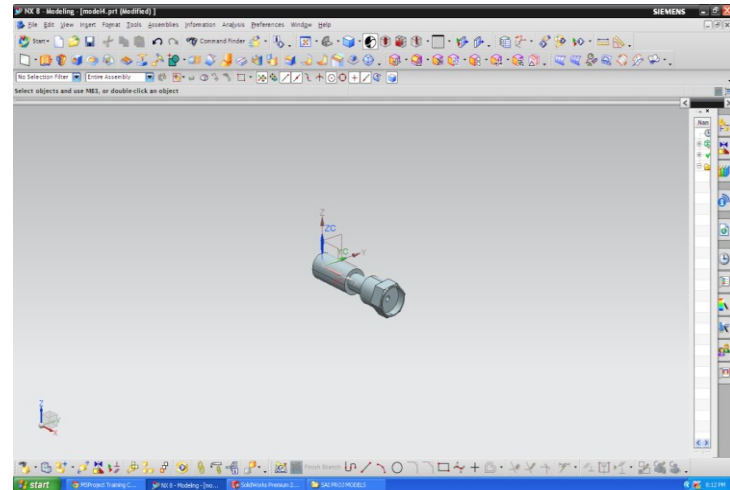
INTRODUCTION TO UNI- GRAPHICS:

Unigraphics software is one of the world's most advanced and tightly integrated CAD/CAM/CAE software package developed by Siemens PLM Software, offers several pre-packaged Mach Series solutions for NC machining. Available in a range of capability levels, these solutions accelerate programming and improve productivity for a variety of typical manufacturing challenges, from basic machining to complex, multiple-axis and multi-function machining, as well as mould and die manufacturing it also merges solid and surface modelling techniques into one powerful tool set. The packages include complete capabilities for geometry import, CAD modeling and drafting, full associatively to part designs, NC tool path creation, verification and post processing, along with productivity tools that streamline the overall machining process.

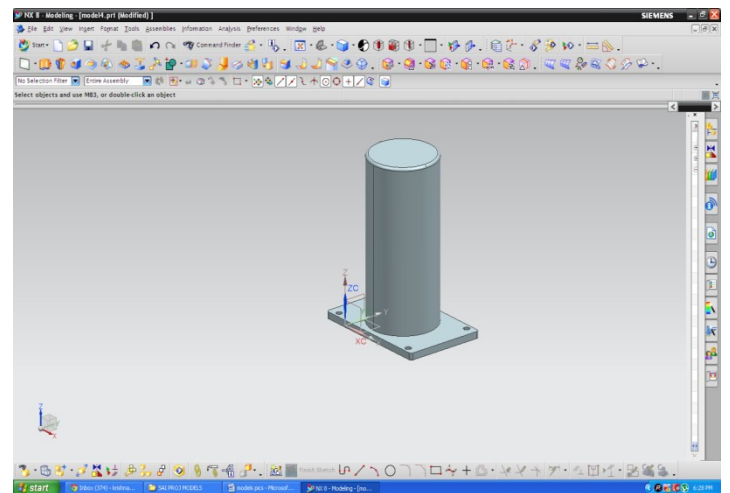
2D drawing in sketcher

3D development by extruding

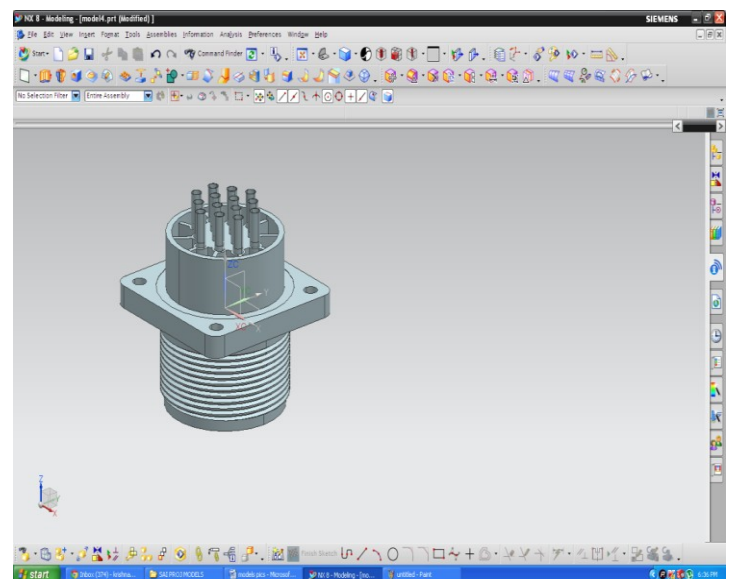
1st side attachments



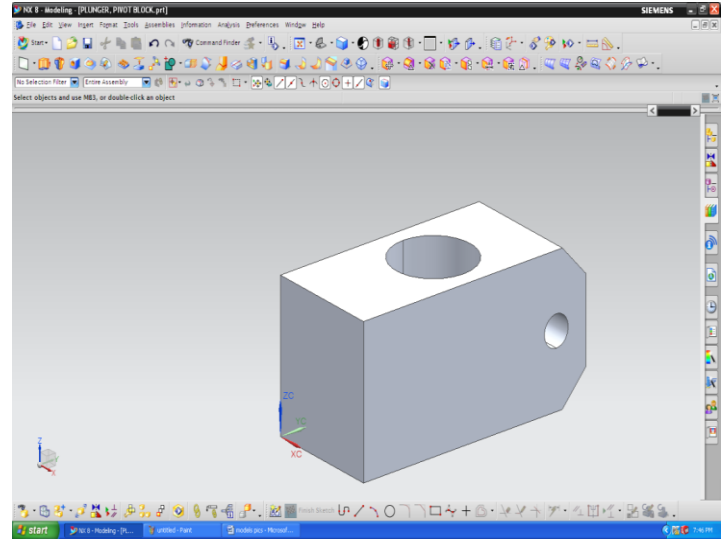
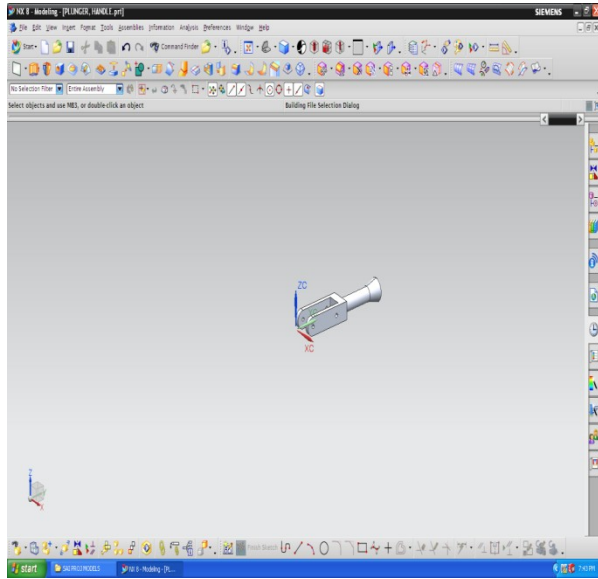
Connected shaft



Pin housing

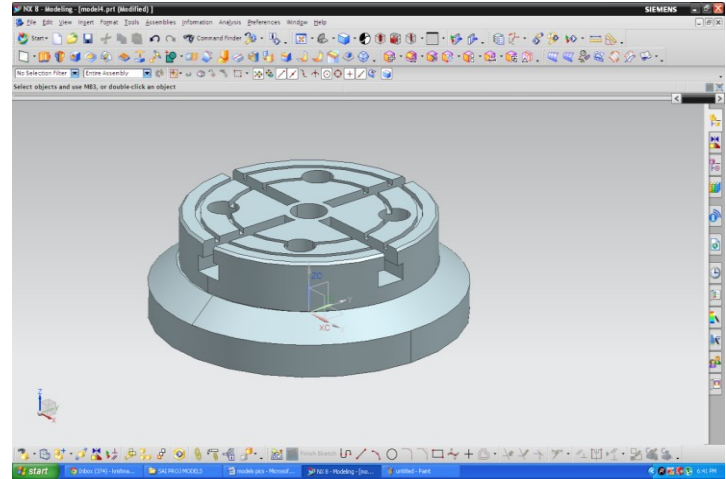
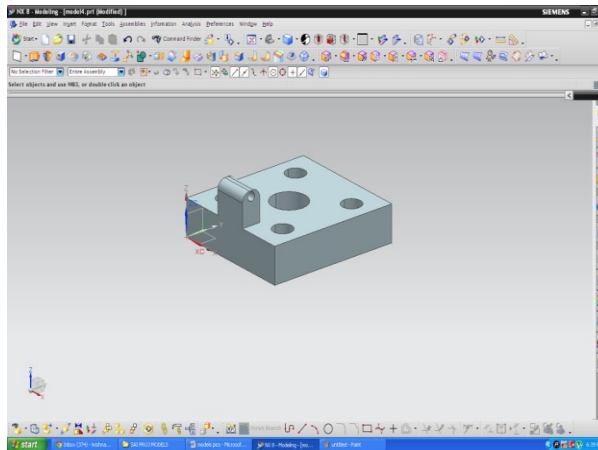


Connector



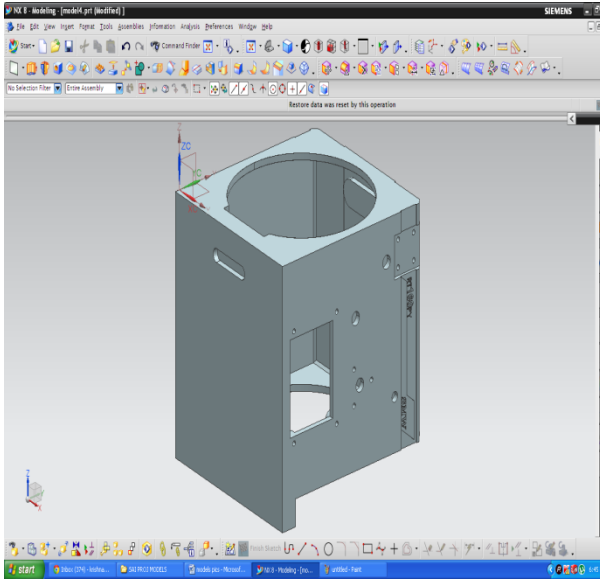
Jaw

Index lever

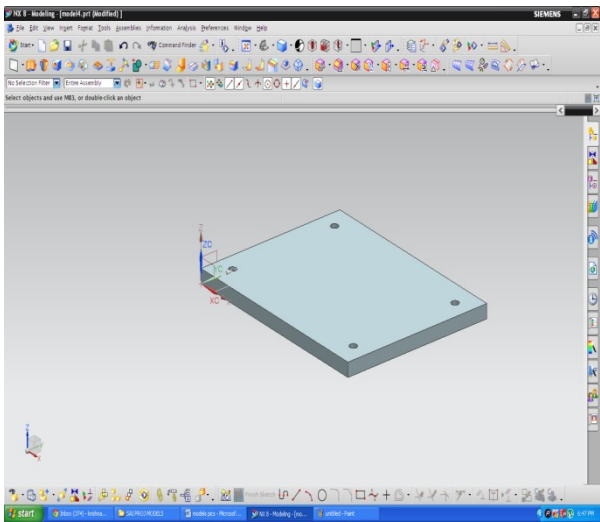


Chuck

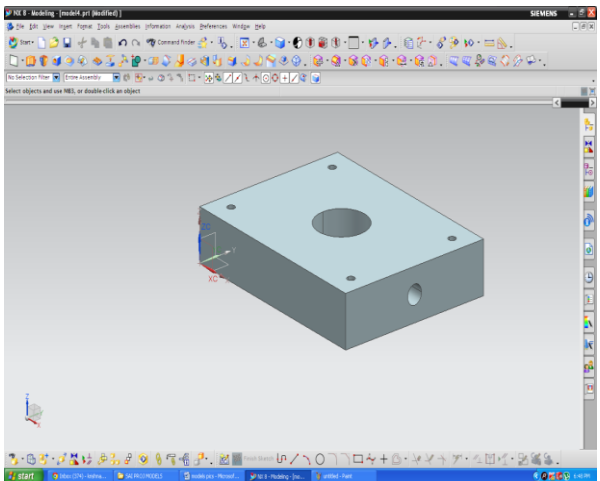
Base supporter



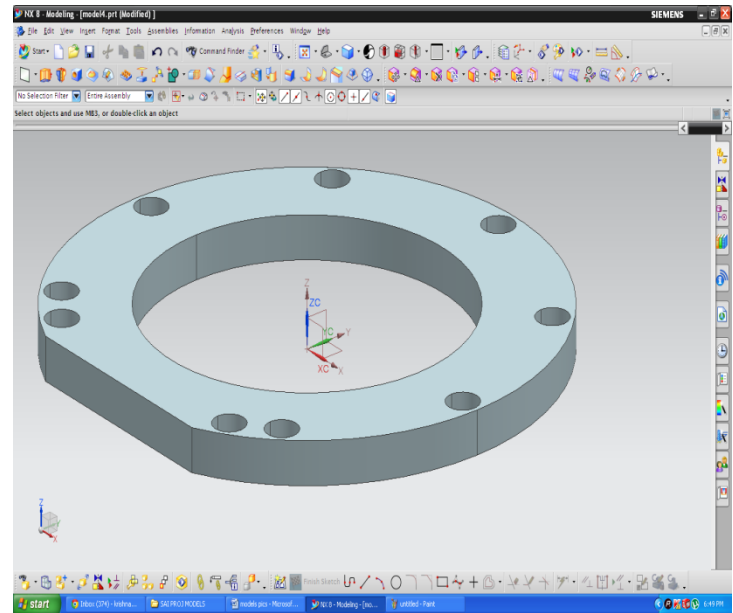
Housing



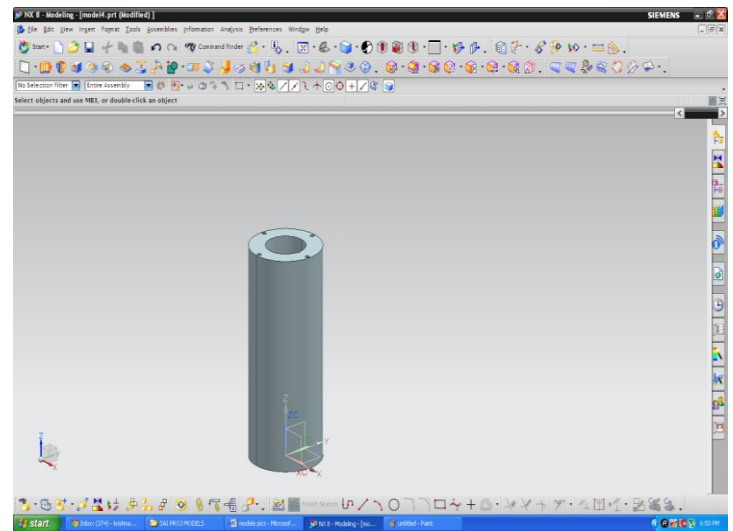
Support plate



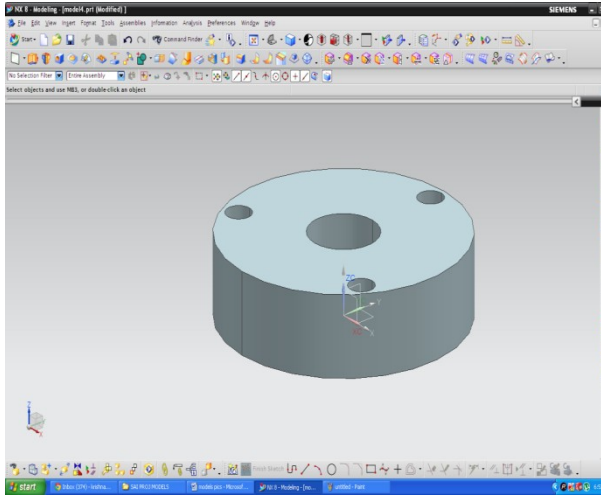
Base support plate



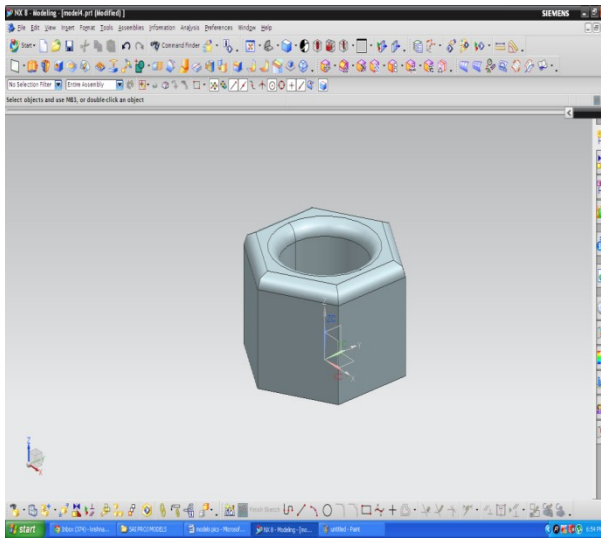
Chuck support ring



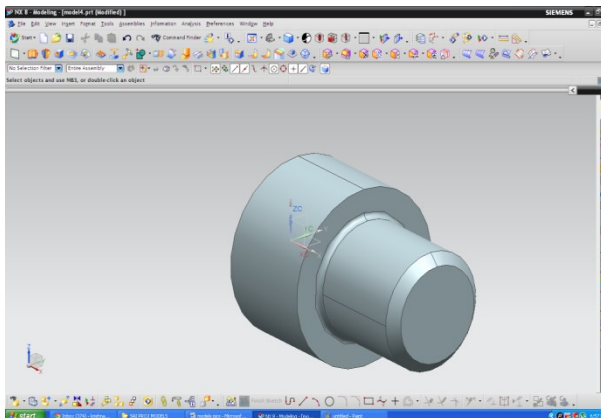
Shaft pin



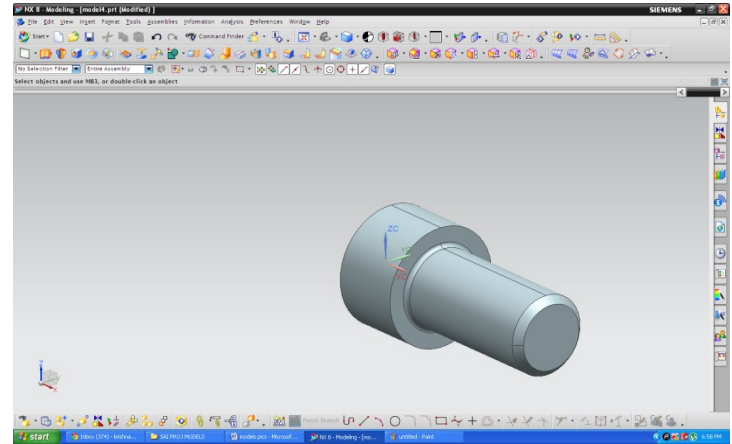
Indexing support plate



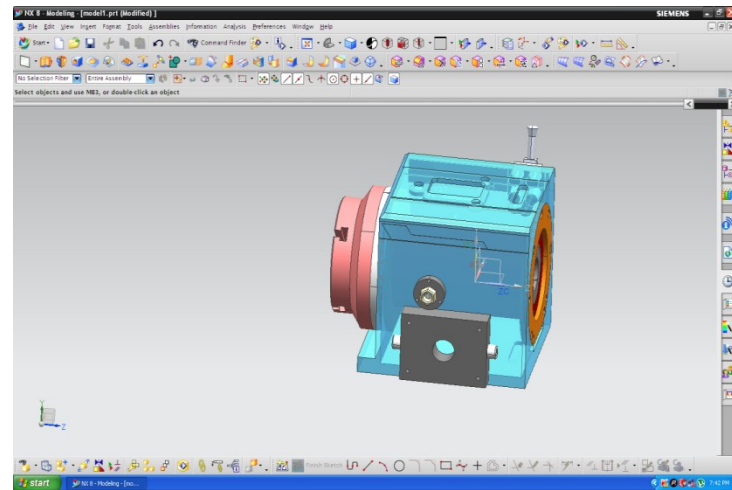
Nut



Back support pin

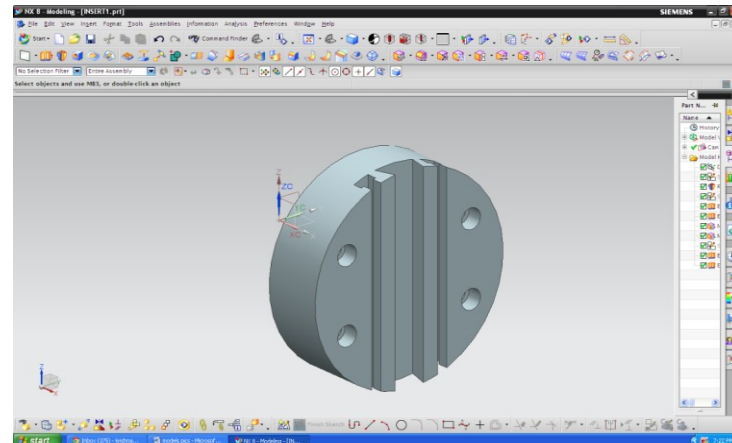


chuck Support pin

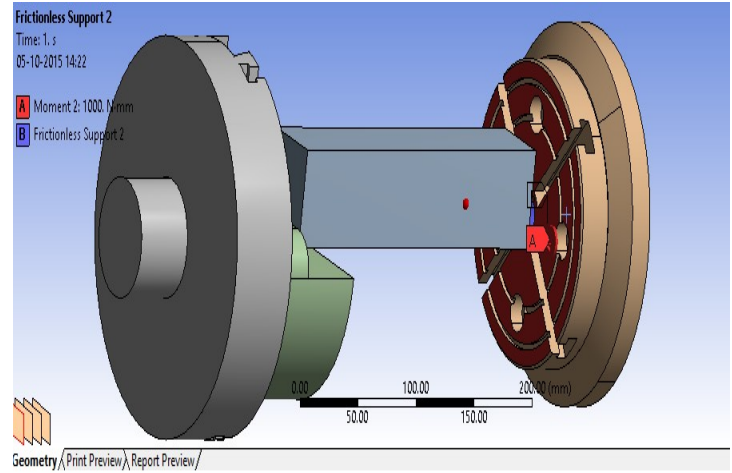
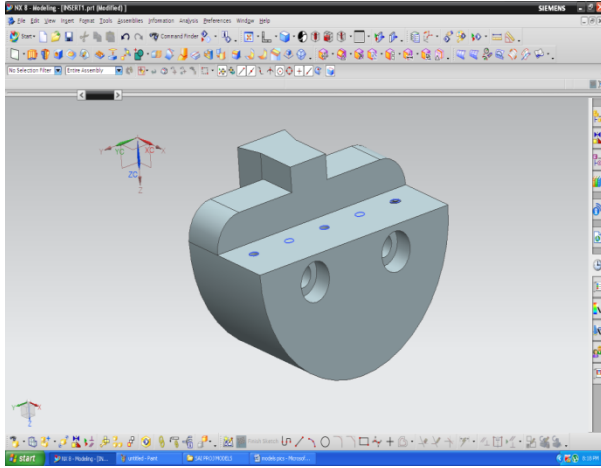


assembly of motor side drive steady rest

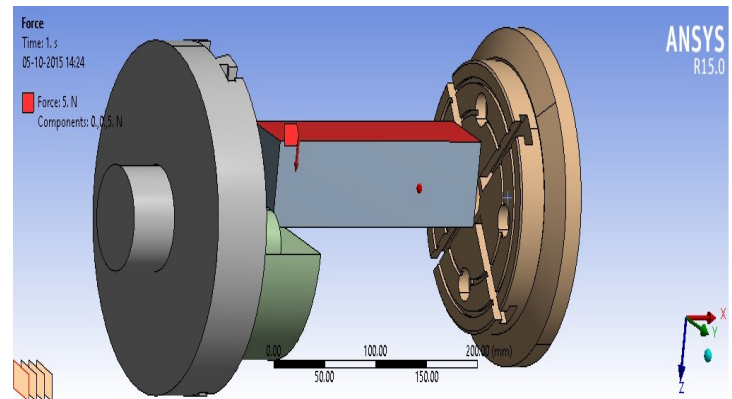
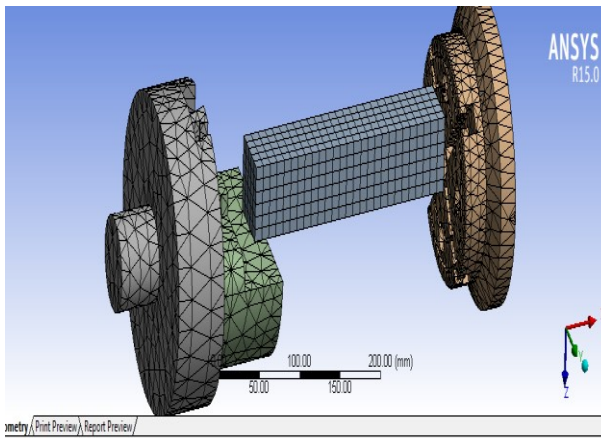
2nd side attachment



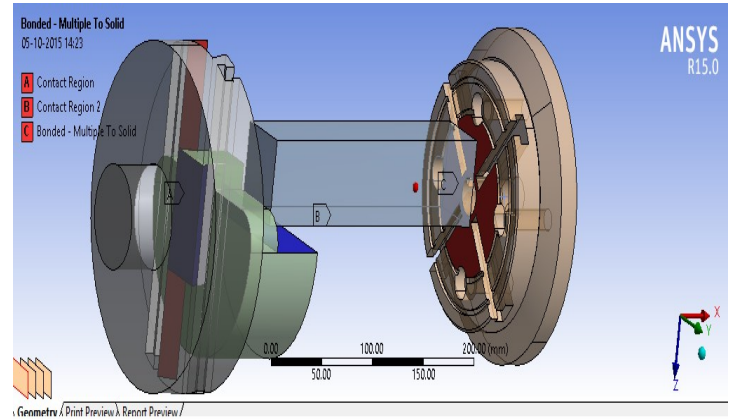
fixture plate on second side for vertical motion attachment

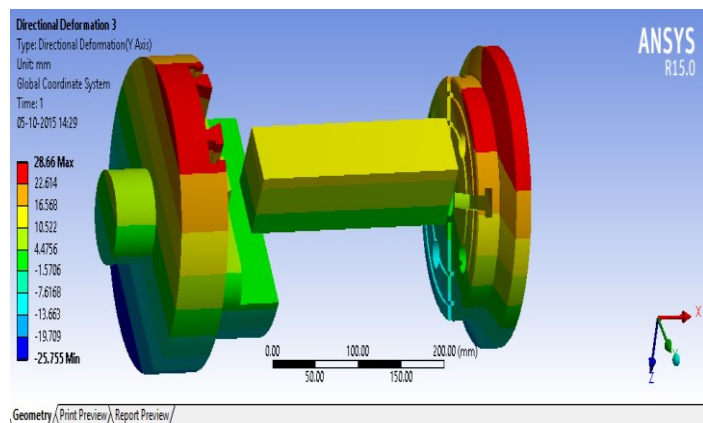
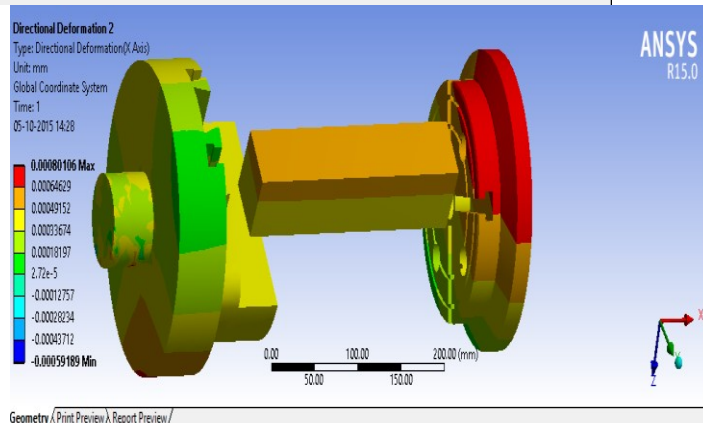
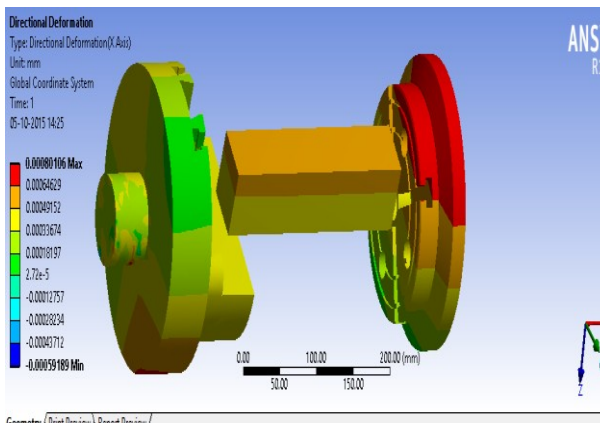
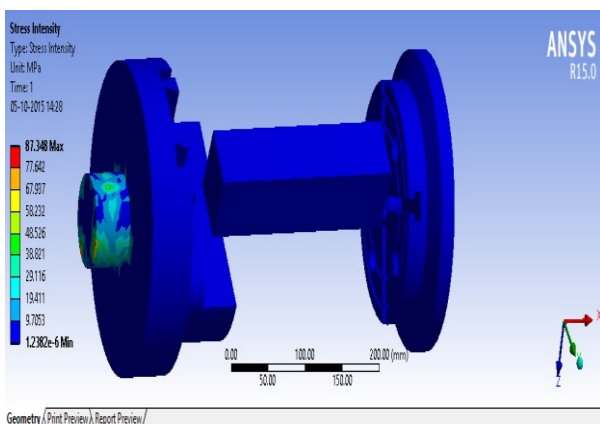
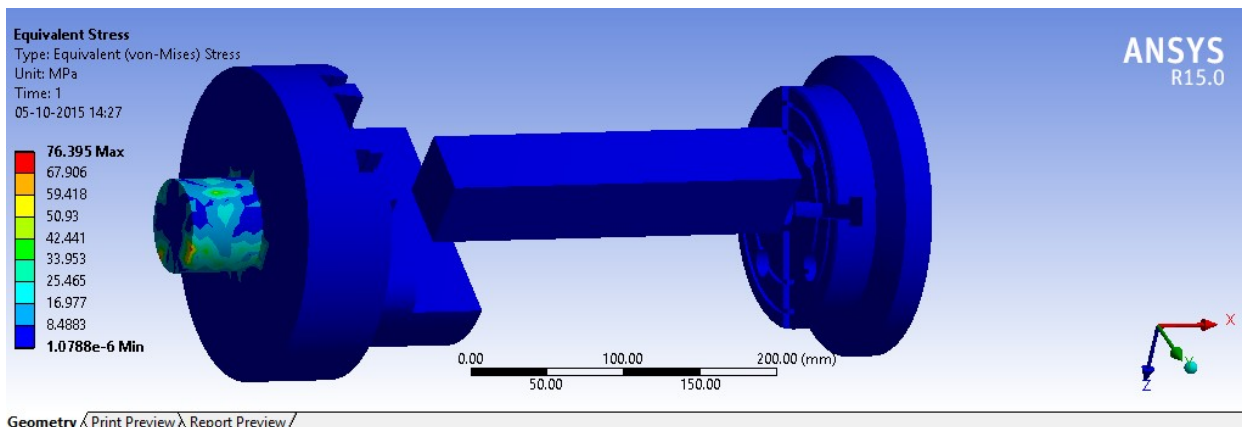


MESHING OF PRESENT PROJECT



Results & Discussions





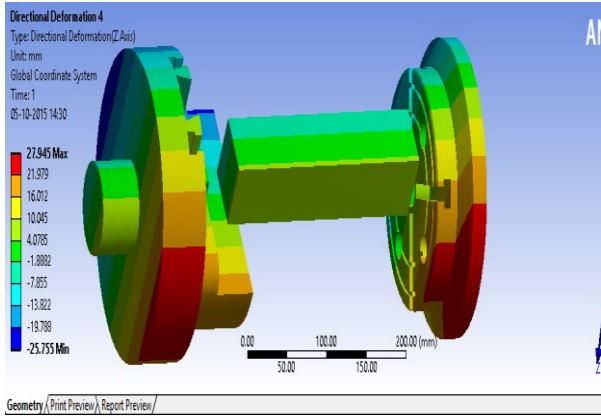


FIGURE 1
Model (A4) > Static Structural (A5) > Moment

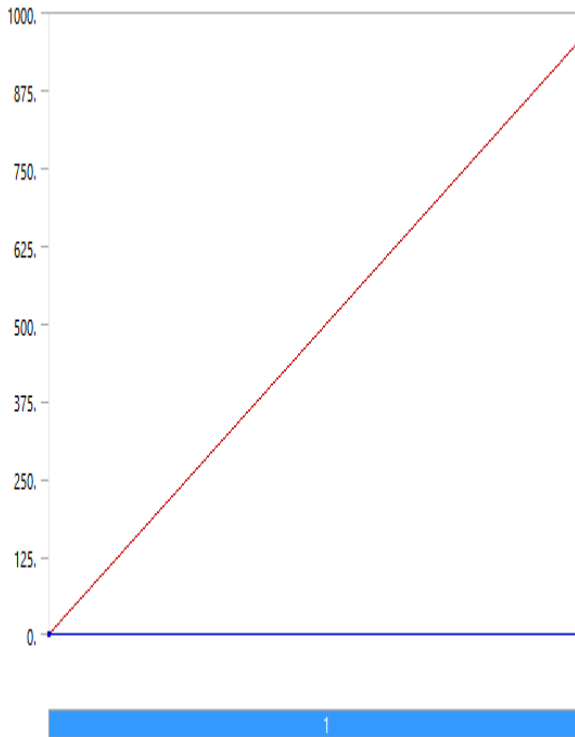
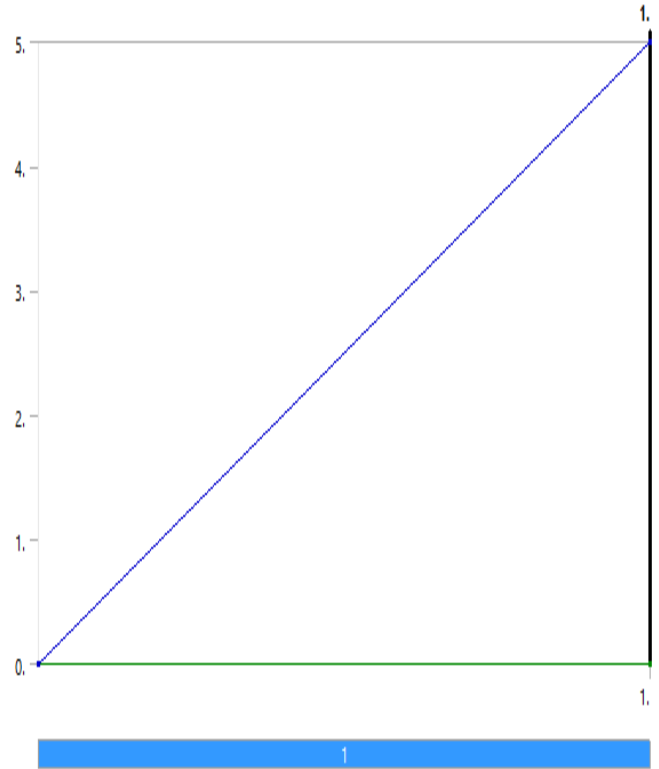


FIGURE 2
Model (A4) > Static Structural (A5) > Force

FIGURE 3
Model (A4) > Static Structural (A5) > Moment 2

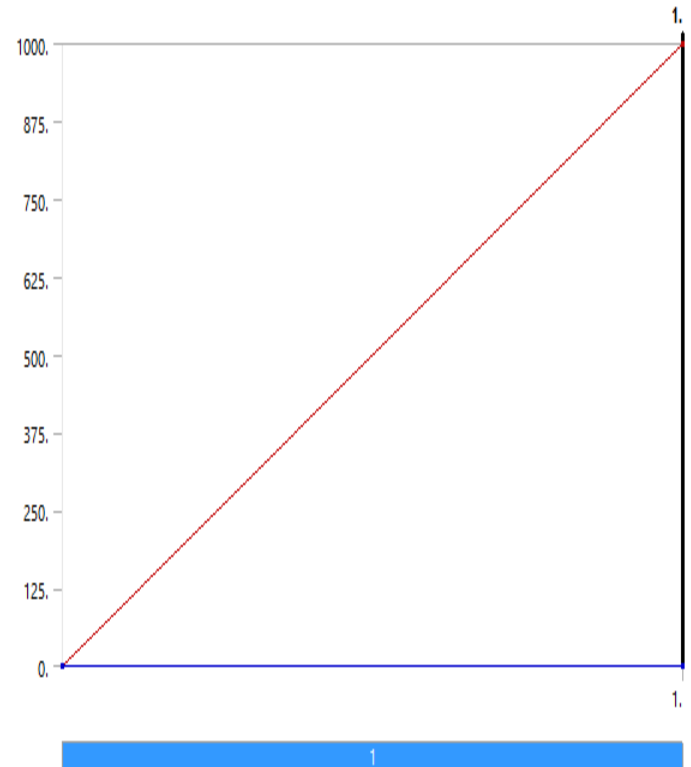


FIGURE 4



CONCLUSIONS

From the study of simulations on fixture there is not so much deflection occurring on the fixture when compared to single stated inserted fixture. The multipurpose use of the present fixture not showing any rotational deflection but with load and forces taken into account it shows a slight deflection comparably negligible as considered for practical approach. This project shows an edge of multipurpose job work can be done without changing number of inserts for each job.

Limitations & Future scope

1. Theoretical simulations only observed in the present project with material and work piece and loads are taken from practical values of work place.
2. Rotational forces can be studied by applying practical rpm of components can be studied.
3. Practical study may given a direct solution to the extension of this work.
4. Limitation of present study can be extended to a materialized practical work and comparison in industry.