Design Of Fixture To Optimise Process Plan Of Aerospace Component

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Abstract- *A missile is a self-propelled guided destructive weapon system. Missiles have four system components: targeting and guidance, flight system, engine, and warhead. These weapons come in various types adapted for different applications: surface-to-surface, air-to-surface (ballistic, cruise, anti-ship, anti-tank), surface-to-air (anti-aircraft and anti-ballistic), air-to-air, and anti-satellite missiles. And missile shield protects the missile by acting as a shield for the entire body. The detailed study of missile shield design and process planning is to be done. The missile shield is aerospace component it requires accurate machining and high finishing, and it is typical to manufacture in 3-axis machines, and it is highly impossible using 3-jaw chuck or machine vice for holding missile shield rigidly. To manufacture missile shield as per requirement with accurate dimension it demands a fixture to design considering the part holding points. It requires a designed fixture and clamping to hold the part rigidly. If the part is fixed rigidly easily, we can obtain smooth surfaces on the part. The main concept of this project is to optimize process plan and creating a 3D model using Unigraphics software. Generating NC program of missile shield using NX-CAM software which is exclusively CAM software used to generate a part program by feeding the geometry of the component and defining the proper tool path and thus transferring the generated part program to the required CNC machine with the help of DNC lines. As per the suitable requirements, the operator executes the program. The project deals with optimizing process plan by specifying appropriate tools, developing tools design if demanded.*

I. INTRODUCTION

1. MISSILE SHIELD

A missile is a self-propelled guided weapon system. Missiles have four system components: targeting and guidance, engine, flight system, and warhead. Missiles come in types adapted for different purposes: air-to-surface and surface-to-surface (anti-tank, ballistic, anti-ship, cruise), surface-to-air (anti-ballistic and anti-aircraft), anti-satellite missiles and air-to-air. The entire body of the missile is covered and protected by missile shields. The missile shield is aerospace component it requires accurate machining and high finishing, and it is typical to manufacture in 3-axis machines, and it is highly impossible using 3-jaw chuck or machine vice for holding missile shield rigidly. To manufacture missile shield as per requirement with accurate dimension it demands a fixture to design considering the part holding points. It requires a designed fixture and clamping to hold the part rigidly. If the part is fixed rigidly easily, we can obtain smooth surfaces on the part.

DESIGNING FIXTURE FOR MISSILE SHIELD

Fixtures precisely locate and secure a part during machining operations such that the part can be manufactured to design specifications. The optimization of the design costs is associated with fixturing design; various computer-aided fixture design methods have been introduced through the past years to assist the fixture designer. Automated fixture design systems development is processed by using the fixture layout design. The task of fixture layout design is to layout a set of locating & clamping points on work-piece surfaces such that the work-piece is accurately located & completely restrained during manufacturing operations. Fixtures accurately locate and secure a part during machining operations such that the part can be manufactured to design specifications. To optimize the design costs related with fixturing design, various computer-aided fixture design (CAFD) methods have been developed through the years to assist the fixture designer.

FIXTURE DESIGN CONCEPTS: (MANAGING DEGREE OF FREEDOM)

3:2:1 à(3 At least 3-Point to define a plane) (2 At least 2-Points to define location) (1 At least 1-point for clamping)Fixture layout design has received considerable attention in the recent years. However, little attention has focused on the optimization of manufacturing fixture layout under dynamic conditions of the work-piece.

2. COMPUTER-AIDED DESIGN (CAD)

Computer-aided design (CAD), also known as computer-aided design and drafting (CADD), is the use of computer systems to assist in the creation, modification, analysis, or optimization of the design. Computer-aided drafting describes the sequence of creating a technical drawing with the use of computer software. CAD software is mainly used to increase the productivity of the designer, improve communications through documentation, improve the quality of design, and the database is created for manufacturing. CAD output is often in the form of electronic files for print or machining operations. CAD software uses either vector based graphics to depict the objects of traditional drafting, or may also produce raster graphics showing the overall appearance of designed objects.

COMPUTER-AIDED MANUFACTURING (CAM)

Computer-aided manufacturing is the use of computer software to control machine tools and related machinery in the manufacturing of work-pieces. This is not the only definition for CAM, but it is the most common; CAM may also refer to the use of a computer to assist in all operations of a manufacturing plant including planning, management, transportation, storage. Its primary purpose to create a faster production process and components and to tool with more precise dimensions and material consistency, which in some cases, uses only the required amount of raw material (thus minimizing waste), while simultaneously reducing energy consumption. CAM is a subsequent computer-aided process after computer-aided design (CAD) and sometimes computer-aided engineering (CAE), as the model generated in CAD and verified in CAE can be input into CAM software, which then controls the machine tool. Integration of CAD with other components of CAD/CAE/CAM Product lifecycle management (PLM) environment requires an effective CAD data exchange. Usually, it had been necessary to force the CAD operator to export the data in one of the common data formats, such as IGES or STL, that are supported by a wide variety of software. The output from the CAM software is the simple text file of G-code, sometimes many thousands of commands long, that is then transferred to a machine tool using a direct numerical control (DNC) program.

3. NUMERICAL CONTROL (NC)

Numerical control refers to the automation of machine tools that are operated by abstractly programmed commands encoded on a storage medium, as opposed to controlled manually via hand wheels or levers, or mechanically automated via cams alone. The first NC machines are built-in the 1940s and 1950s, based on existing tools that are modified with motors that moved the controls to follow points fed into the system on punched tape. These early servo mechanisms were rapidly augmented with analogue and digital computers, creating the modern computer numerical control (CNC) machine tools that have revolutionized the machining processes.

4. COMPUTER NUMERICAL CONTROL

Computer Numerical Control (CNC) is one in which the functions and motions of a machine tool are controlled using a prepared program which contains coded alphanumeric data. CNC controls the movements of the tool or the input parameters such as feed, depth of cut, speed, and work-piece the functions such as turning the spindle on/off, turning coolant on/off.

5. UNIGRAPHICS INTRODUCTION

NX software is most advanced and tightly integrated CAD/CAM/CAE product NX is a premier 3D computer-aided design suite. It enables you to model solid components and assemblies, to perform engineering analyses such as stress analysis and mechanism simulation, to create tool paths for computer-based manufacturing processes and to perform numerous other engineering design activities in a single software environment. Software suites like NX are referred to as PLM.

II. LITERATURE SURVEY ON FIXTURES

Pollack, 1976 [1] A Fixture is a work-piece locating and holding device used for machine tools, inspection, welding and assembly; it does not control the position of the tool or instrument which is being used.

- Elements of the Jig or Fixture should be present which Support the work and elements called locators, which Position the work
- Once located and positioned, the work is clamped so that it will not move off the locators or supports.

Burley and Corbett, 1998 [2] A Jig is defined as a manufacturing aid that either holds a part or is itself located on the part and is fitted with devices to guide a cutting tool ensuring the correct location of the machining path relative to the part

- A Fixture is a manufacturing aid for holding and locating parts during machining or assembly operations, which do not provide definitive guidance for the cutting tools
- Tooling is used as the generic name for jigs and fixtures and also the tools set from the master gauges for calibrating jigs and fixtures
- Hence, Jig less Assembly is assembly without the use of jigs; it requires that parts are manufactured to sufficient

accuracy to ensure correct assembly; it is not necessarily fixtureless [or tool less] assembly.

J. C. Trappey and C. R. Liu 1990 [3] Fixture design can be classified as a part of process planning. The wise task description of process planning specifically states that "'fixture design for each work-piece set-up" is an integrated planning task. However, the automation of fixture design has been over looked in research into automated process planning.

1. Fixture configuration - determining the types of fixture elements required, and selecting locating points on the selected elements according to the specified process information.
2. Fixture assembly - constructing and assembling modular fixture components. According to the work piece set-up, the orientation of each component on the base plate is determined. Consequently, the assembly sequence of the fixture components is planned for automatic assembly by a robot hand.
3. Fixture verification - proving the validity of the fixture configuration with consideration of some operating factors, such as the cutting directions, the acting forces and the machining sequence.

III. 3D MODELING MISSILE SHIELD

1. Missile shield 2D Drawing

A 2D drawing is used to design a 3D model for our component using Unigraphics NX 7.5 CAD software. Below shows the 2D drawings of the missile shield with all the required dimensions representations the suits the best for manufacturing the component without any errors.

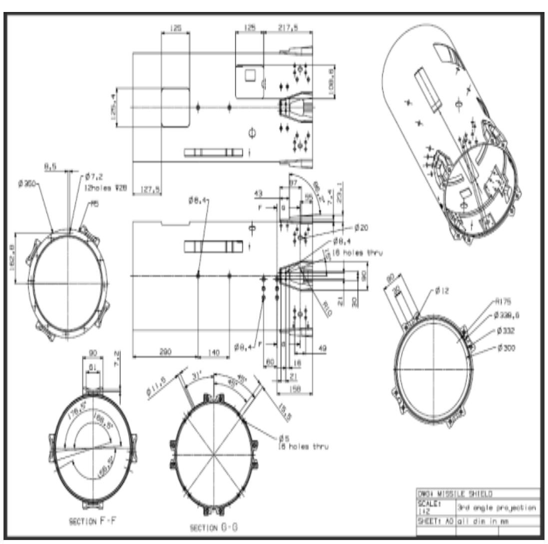


Figure 1. missile shield 2D drawing

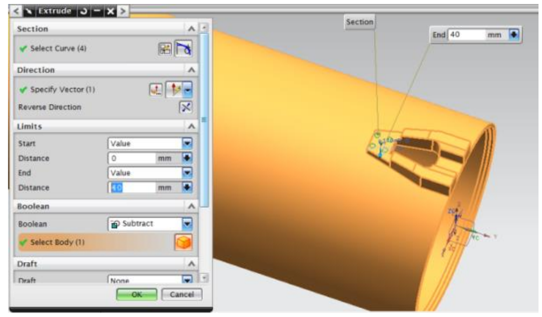


Figure 2.

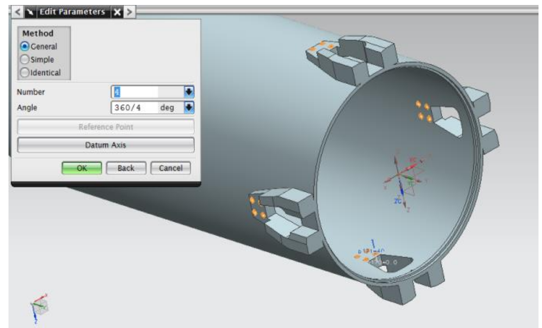
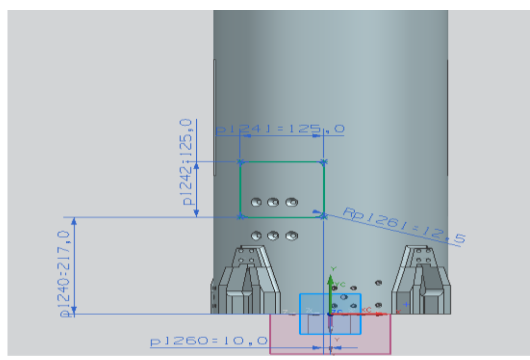


Figure 3. circular array of slots around shield

Below image shows sketch and extrude



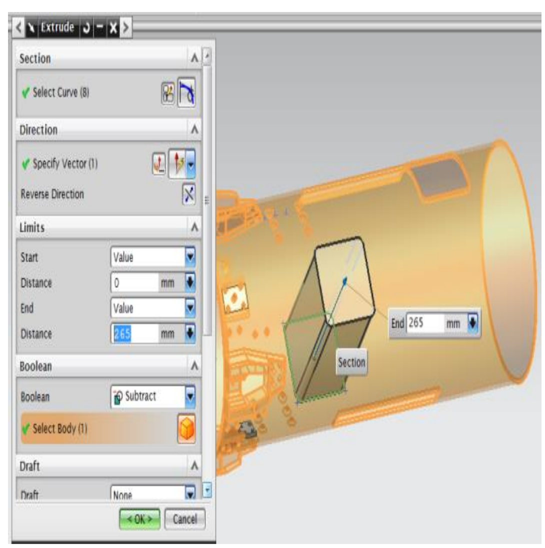


Figure 4.

Below image shows 3D models of missile shield

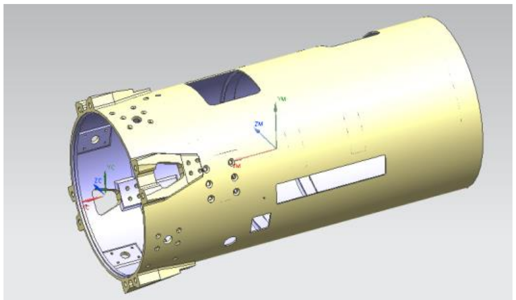


Figure 5.

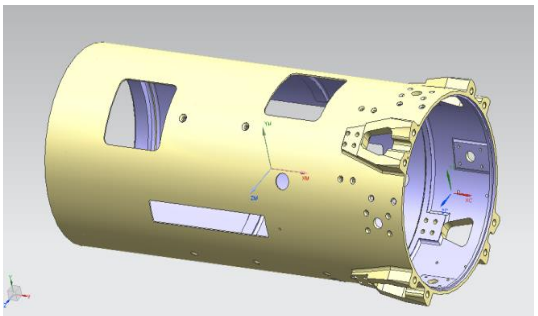


Figure 6. models of missile shield

IV. COMPUTER AIDED MANUFACTURING

Methodology used in manufacturing of missile shield is as mentioned below

- Identifying suitable machine.
- Selecting suitable tools for manufacturing the thinly walled component.
- Designing fixture/mandrel to support missile shield component for external operations.
- Listing down the Sequence of operations performed on missile shield component.
- Generating tool path at specified cutting speed.
- Generating NC program using the NX-CAM software.

1) IDENTIFY SUITABLE MACHINE TYPES OF CNC MACHINE USED IN THIS PROJECT

MORI SEIKI 4-AXIS CNC turning machine is used for machining missile shield. DMG MORI SEIKI offers the industry's best line-up of high-performance lathes with better precision and rigidity, greater multi-axis compatibility and smaller footprints. High rigidity with Integrated Turning Spindle. The spindle is directly coupled to the motor. Rigid Turret with BIM (Built-In Motor) Technology. Directly coupled Integrated driven tools. In a patent technology. Y-axis machining, Up to 100mm (+/-50). 4-axes simultaneous machining, C-axis with 360 deg and Y-axis, Machine accuracies, Positional Accuracy +/-0.005mm, Repeatability +/-0.003mm. In 4-axis turning machine, Axis represents as work-piece rotation and spindle movement in x, y, z directions.

2. GENERATING TOOL PATH ON MISSILE SHIELD

The series of movements made by the tip of a cutting tool. X and Z codes indicate the tool path in a part program. The path through the space that the tip of a cutting tool follows on its way producing the desired geometry of the work-piece. Below image shows Raw material and part of missile shield

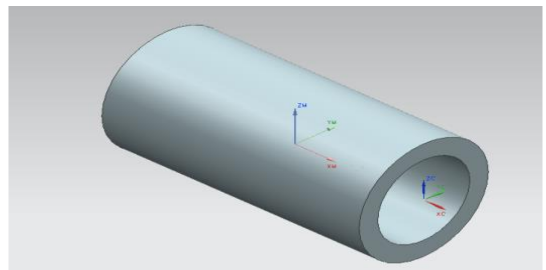


Figure 7.

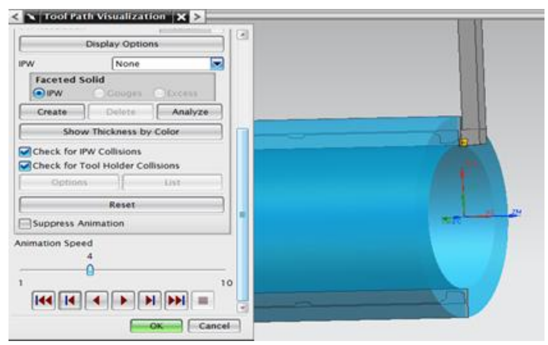


Figure 8.

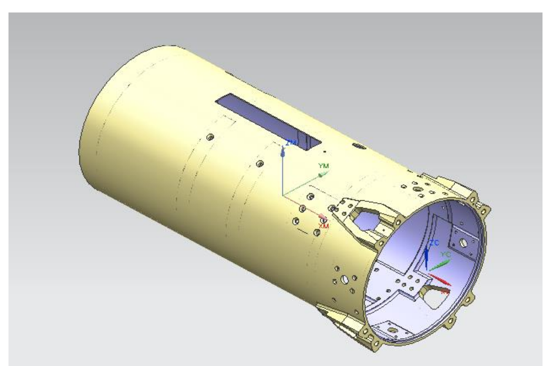


Figure 9. Raw material and part of missile shield

Set_up_1 tool path generation

Set_up_2

Below image shows Raw material for setup_2 turning

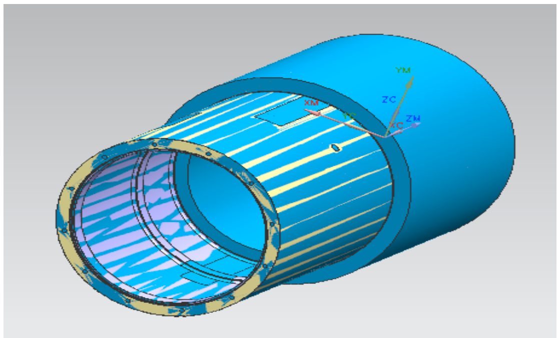


Figure 10.

In setup_2 raw material will be the semi-finished part which means the part left after setup_1 operations.

Milling operations

Below image shows Raw material for milling

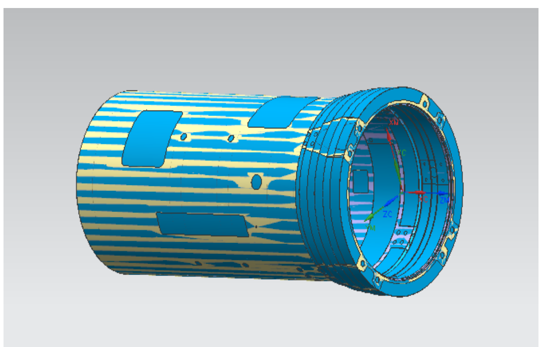


Figure 11.

Raw material for milling
Below image shows planar mill operations

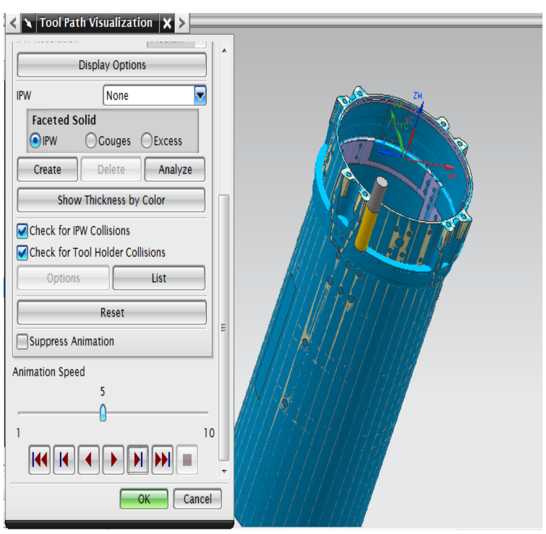


Figure 12.

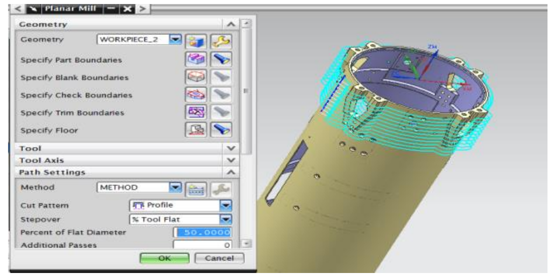


Figure 13.

Planar mill operations

Below image shows planar mill operations

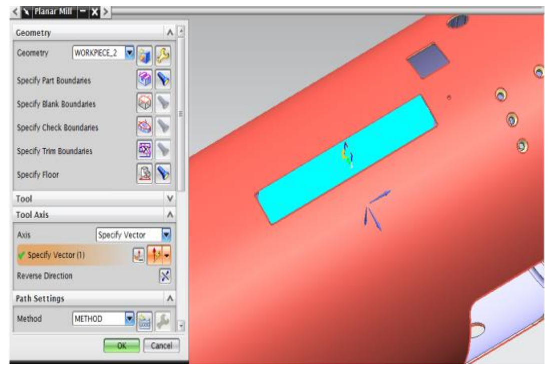


Figure 14.

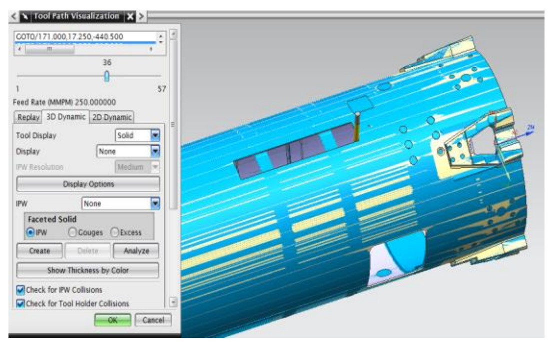


Figure 15. planar mill operations

Below image shows drilling operations

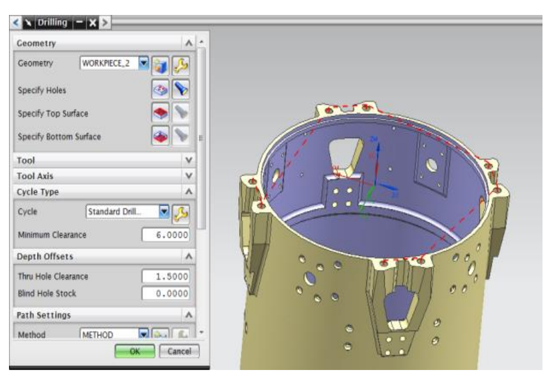


Figure 16.

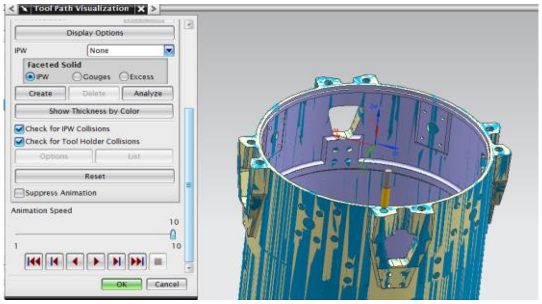


Figure 17. Drilling operations

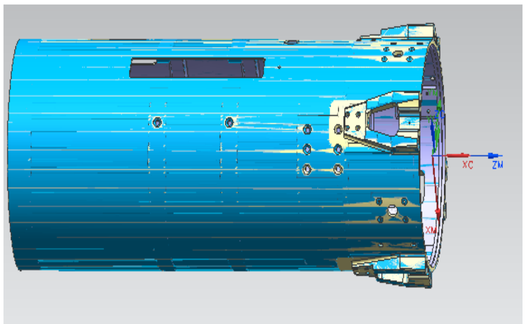
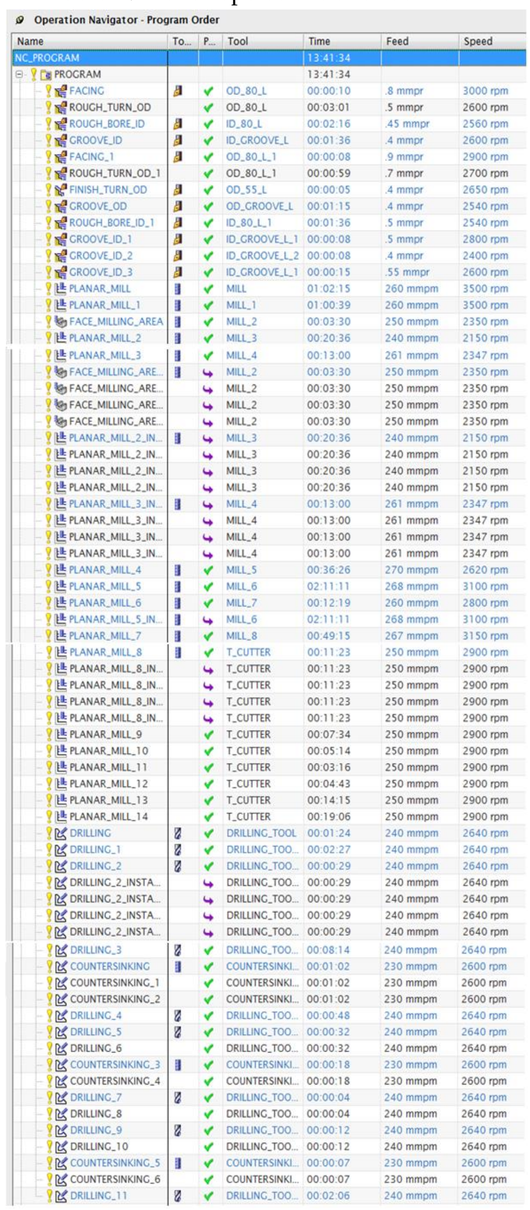


Figure 18. Final part of operation

Table 1. List of operations and tool name

Operation name	Operation type	Tool name
Facing	Turning/facing	Od 80 1
Rough turn od	Turning/rough turn od	Od_80_1
Rough bore _id	Turning/rough bore id	Id_80_1
Groove id	Turning/groove id	Id groove1
Facing_1	Turning/facing	Od_80_1_1
Rough_turn_od_1	Turning/rough turn od	Od_80_1_1
Finish turn od	Turning/finish turn od	Od 55 1
Groove od	Turning/groove od	Od groove1
Rough_bore_id_1	Turning/rough bore id	Id_80_1_1
Groove id 1	Turning/groove id	Id groove 1 1
Groove_id_2	Turning/groove id	Id_groove_1_2
Groove_id_3	Turning/groove id	Id_groove_1_1
Planar mill	Mill planar/planar mill	Mill
Planar_mill_1	Mill planar/planar mill	Mill_1
Face milling area	Mill planar/face milling area	Mill_2
Planar mill 2	Mill planar/planar mill	Mill 3
Planar_mill_3	Mill planar/planar mill	Mill_4
Face milling area instance	Mill planar/face milling area	Mill_2
Face milling area instance 1	Mill planar/face milling area	Mill 2
Face_milling_area_instance_2	Mill planar/face milling area	Mill_2
Face_milling_area_instance_3	Mill planar/face milling area	Mill_2
Planar mill 2 instance	Mill planar/planar mill	Mill 3
Planar_mill_2_instance_1	Mill planar/planar mill	Mill_3
Planar_mill_2_instance_2	Mill planar/planar mill	Mill_3
Planar mill 2 instance 3	Mill planar/planar mill	Mill 3
Planar_mill_3_instance	Mill planar/planar mill	Mill_4
Planar_mill_3_instance_1	Mill planar/planar mill	Mill_4
Planar mill 3 instance 2	Mill planar/planar mill	Mill 4
Planar_mill_3_instance_3	Mill planar/planar mill	Mill_4
Planar_mill_4	Mill planar/planar mill	Mill_5
Planar mill 5	Mill planar/planar mill	Mill 6
Planar_mill_6	Mill planar/planar mill	Mill_7
Planar_mill_5_instance	Mill planar/planar mill	Mill_6
Planar mill 7	Mill planar/planar mill	Mill 8
Planar_mill_8	Mill planar/planar mill	T cutter
Planar_mill_8_instance	Mill planar/planar mill	T cutter
Planar mill 8 instance 1	Mill planar/planar mill	T cutter
Planar_mill_8_instance_2	Mill planar/planar mill	T cutter
Planar_mill_8_instance_3	Mill planar/planar mill	T cutter
Planar mill 9	Mill planar/planar mill	T cutter
Planar_mill_10	Mill planar/planar mill	T cutter
Planar_mill_11	Mill planar/planar mill	T cutter
Planar mill 12	Mill planar/planar mill	T cutter
Planar mill 13	Mill planar/planar mill	T cutter
Planar_mill_14	Mill planar/planar mill	T cutter
Drilling_1	Drill/drilling	Drilling_tool_1
Drilling 2	Drill/drilling	Drilling tool 2
Drilling_2_instance	Drill/drilling	Drilling_tool_2
Drilling_2_instance_1	Drill/drilling	Drilling_tool_2
Drilling 2 instance 2	Drill/drilling	Drilling tool 2
Drilling_2_instance_3	Drill/drilling	Drilling_tool_2
Drilling_3	Drill/drilling	Drilling_tool_3
Countersinking	Drill/countersinking	Countersinking tool
Countersinking_1	Drill/countersinking	Countersinking tool
Countersinking_2	Drill/countersinking	Countersinking tool
Drilling 4	Drill/drilling	Drilling tool 4
Drilling_5	Drill/drilling	Drilling_tool_2
Drilling_6	Drill/drilling	Drilling_tool_2
Countersinking 3	Drill/countersinking	Countersinking tool 1
Countersinking_4	Drill/countersinking	Countersinking_tool_1
Drilling_7	Drill/drilling	Drilling_tool_5
Drilling 8	Drill/drilling	Drilling tool 5
Drilling_9	Drill/drilling	Drilling_tool_2
Drilling_10	Drill/drilling	Drilling_tool_2
Countersinking 5	Drill/countersinking	Countersinking tool
Countersinking_6	Drill/countersinking	Countersinking tool
Drilling 11	Drill/drilling	Drilling tool 6

Table 2. List of operations and tool name



Operation Navigator - Program Order

Name	To...	P...	Tool	Time	Feed	Speed
NC_PROGRAM				13:41:34		
PROGRAM				13:41:34		
FACING			OD_80_L	00:00:10	.8 mmpr	3000 rpm
ROUGH_TURN_OD			OD_80_L	00:03:01	.5 mmpr	2600 rpm
ROUGH_BORE_ID			ID_80_L	00:02:16	.45 mmpr	2560 rpm
GROOVE_ID			ID_GROOVE_L	00:01:36	.4 mmpr	2600 rpm
FACING_1			OD_80_L_1	00:00:08	.9 mmpr	2900 rpm
ROUGH_TURN_OD_1			OD_80_L_1	00:00:59	.7 mmpr	2700 rpm
FINISH_TURN_OD			OD_55_L	00:00:05	.4 mmpr	2650 rpm
GROOVE_OD			OD_GROOVE_L	00:01:15	.4 mmpr	2540 rpm
ROUGH_BORE_ID_1			ID_80_L_1	00:01:36	.5 mmpr	2540 rpm
GROOVE_ID_1			ID_GROOVE_L_1	00:00:08	.5 mmpr	2800 rpm
GROOVE_ID_2			ID_GROOVE_L_2	00:00:08	.4 mmpr	2400 rpm
GROOVE_ID_3			ID_GROOVE_L_1	00:00:15	.55 mmpr	2600 rpm
PLANAR_MILL			MILL	01:02:15	260 mmpm	3500 rpm
PLANAR_MILL_1			MILL_1	01:00:39	260 mmpm	3500 rpm
FACE_MILLING_AREA			MILL_2	00:03:30	250 mmpm	2350 rpm
PLANAR_MILL_2			MILL_3	00:20:36	240 mmpm	2150 rpm
PLANAR_MILL_3			MILL_4	00:13:00	261 mmpm	2347 rpm
FACE_MILLING_ARE...			MILL_2	00:03:30	250 mmpm	2350 rpm
FACE_MILLING_ARE...			MILL_2	00:03:30	250 mmpm	2350 rpm
FACE_MILLING_ARE...			MILL_2	00:03:30	250 mmpm	2350 rpm
FACE_MILLING_ARE...			MILL_2	00:03:30	250 mmpm	2350 rpm
PLANAR_MILL_2_IN...			MILL_3	00:20:36	240 mmpm	2150 rpm
PLANAR_MILL_2_IN...			MILL_3	00:20:36	240 mmpm	2150 rpm
PLANAR_MILL_2_IN...			MILL_3	00:20:36	240 mmpm	2150 rpm
PLANAR_MILL_2_IN...			MILL_3	00:20:36	240 mmpm	2150 rpm
PLANAR_MILL_3_IN...			MILL_4	00:13:00	261 mmpm	2347 rpm
PLANAR_MILL_3_IN...			MILL_4	00:13:00	261 mmpm	2347 rpm
PLANAR_MILL_3_IN...			MILL_4	00:13:00	261 mmpm	2347 rpm
PLANAR_MILL_3_IN...			MILL_4	00:13:00	261 mmpm	2347 rpm
PLANAR_MILL_4			MILL_5	00:36:26	270 mmpm	2620 rpm
PLANAR_MILL_5			MILL_6	02:11:11	268 mmpm	3100 rpm
PLANAR_MILL_6			MILL_7	00:12:19	260 mmpm	2800 rpm
PLANAR_MILL_5_IN...			MILL_6	02:11:11	268 mmpm	3100 rpm
PLANAR_MILL_7			MILL_8	00:49:15	267 mmpm	3150 rpm
PLANAR_MILL_8			T_CUTTER	00:11:23	250 mmpm	2900 rpm
PLANAR_MILL_8_IN...			T_CUTTER	00:11:23	250 mmpm	2900 rpm
PLANAR_MILL_8_IN...			T_CUTTER	00:11:23	250 mmpm	2900 rpm
PLANAR_MILL_8_IN...			T_CUTTER	00:11:23	250 mmpm	2900 rpm
PLANAR_MILL_8_IN...			T_CUTTER	00:11:23	250 mmpm	2900 rpm
PLANAR_MILL_9			T_CUTTER	00:07:34	250 mmpm	2900 rpm
PLANAR_MILL_10			T_CUTTER	00:05:14	250 mmpm	2900 rpm
PLANAR_MILL_11			T_CUTTER	00:03:16	250 mmpm	2900 rpm
PLANAR_MILL_12			T_CUTTER	00:04:43	250 mmpm	2900 rpm
PLANAR_MILL_13			T_CUTTER	00:14:15	250 mmpm	2900 rpm
PLANAR_MILL_14			T_CUTTER	00:19:06	250 mmpm	2900 rpm
DRILLING			DRILLING_TOOL	00:01:24	240 mmpm	2640 rpm
DRILLING_1			DRILLING_TOO...	00:02:27	240 mmpm	2640 rpm
DRILLING_2			DRILLING_TOO...	00:00:29	240 mmpm	2640 rpm
DRILLING_2_INSTA...			DRILLING_TOO...	00:00:29	240 mmpm	2640 rpm
DRILLING_2_INSTA...			DRILLING_TOO...	00:00:29	240 mmpm	2640 rpm
DRILLING_2_INSTA...			DRILLING_TOO...	00:00:29	240 mmpm	2640 rpm
DRILLING_2_INSTA...			DRILLING_TOO...	00:00:29	240 mmpm	2640 rpm
DRILLING_3			DRILLING_TOO...	00:08:14	240 mmpm	2640 rpm
COUNTERSINKING			COUNTERSINKI...	00:01:02	230 mmpm	2600 rpm
COUNTERSINKING_1			COUNTERSINKI...	00:01:02	230 mmpm	2600 rpm
COUNTERSINKING_2			COUNTERSINKI...	00:01:02	230 mmpm	2600 rpm
DRILLING_4			DRILLING_TOO...	00:00:48	240 mmpm	2640 rpm
DRILLING_5			DRILLING_TOO...	00:00:32	240 mmpm	2640 rpm
DRILLING_6			DRILLING_TOO...	00:00:32	240 mmpm	2640 rpm
COUNTERSINKING_3			COUNTERSINKI...	00:00:18	230 mmpm	2600 rpm
COUNTERSINKING_4			COUNTERSINKI...	00:00:18	230 mmpm	2600 rpm
DRILLING_7			DRILLING_TOO...	00:00:04	240 mmpm	2640 rpm
DRILLING_8			DRILLING_TOO...	00:00:04	240 mmpm	2640 rpm
DRILLING_9			DRILLING_TOO...	00:00:12	240 mmpm	2640 rpm
DRILLING_10			DRILLING_TOO...	00:00:12	240 mmpm	2640 rpm
COUNTERSINKING_5			COUNTERSINKI...	00:00:07	230 mmpm	2600 rpm
COUNTERSINKING_6			COUNTERSINKI...	00:00:07	230 mmpm	2600 rpm
DRILLING_11			DRILLING_TOO...	00:02:06	240 mmpm	2640 rpm

For trail three parts are manufactured with existing fixture 3jaw chuck and all the three parts are rejected in inspection.

3D MODELLING OF FIXTURE

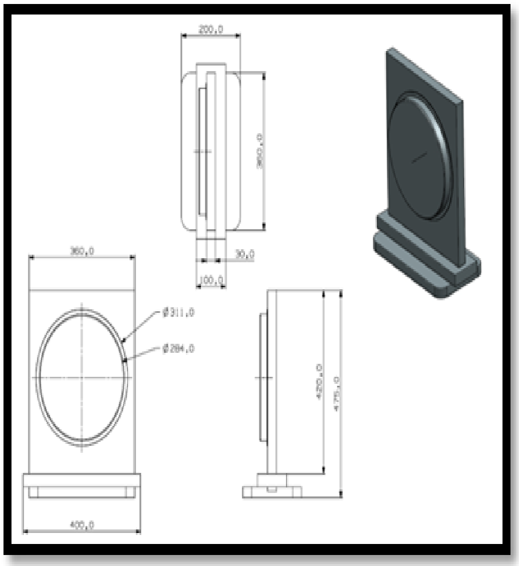


Figure 19.

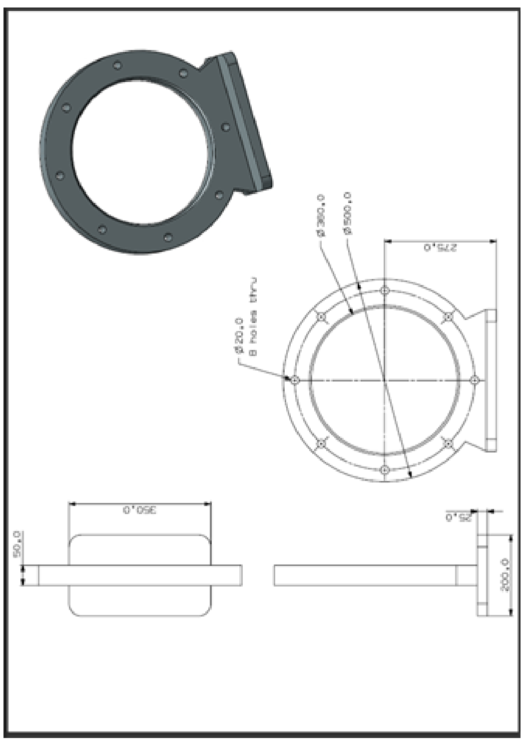


Figure 20. 2D drawing of fixture part

Fixture assembly

Assembly of fixture after completing turning operations

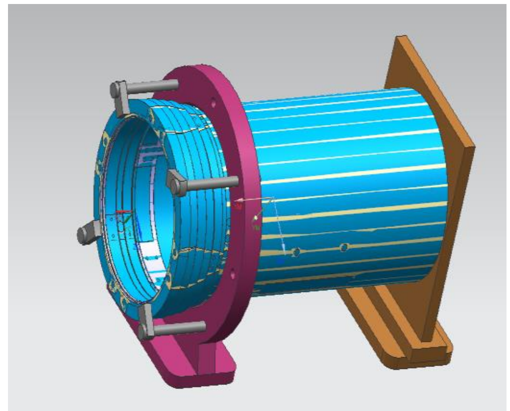
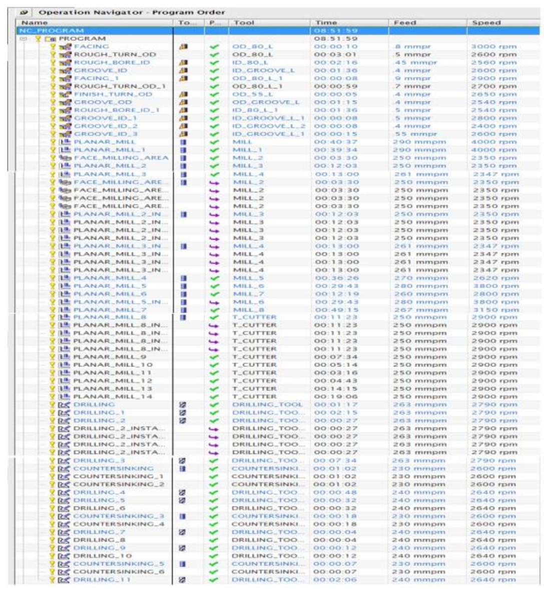


Figure 21.

The manufacturing process of missile shield on CNC machine using designed fixture.



Operation Navigator - Program Order

Name	To...	P...	Tool	Time	Feed	Speed
NC_PROGRAM				08:51:59		
PROGRAM				08:51:59		
FACING			OD_80_L	00:00:10	.8 mmpr	3000 rpm
ROUGH_TURN_OD			OD_80_L	00:03:01	.5 mmpr	2600 rpm
ROUGH_BORE_ID			ID_80_L	00:02:16	.45 mmpr	2560 rpm
GROOVE_ID			ID_GROOVE_L	00:01:36	.4 mmpr	2600 rpm
FACING_1			OD_80_L_1	00:00:08	.9 mmpr	2900 rpm
ROUGH_TURN_OD_1			OD_80_L_1	00:00:59	.7 mmpr	2700 rpm
FINISH_TURN_OD			OD_55_L	00:00:05	.4 mmpr	2650 rpm
GROOVE_OD			OD_GROOVE_L	00:01:15	.4 mmpr	2540 rpm
ROUGH_BORE_ID_1			ID_80_L_1	00:01:36	.5 mmpr	2540 rpm
GROOVE_ID_1			ID_GROOVE_L_1	00:00:08	.5 mmpr	2800 rpm
GROOVE_ID_2			ID_GROOVE_L_2	00:00:08	.4 mmpr	2400 rpm
GROOVE_ID_3			ID_GROOVE_L_1	00:00:15	.55 mmpr	2600 rpm
PLANAR_MILL			MILL	00:40:37	290 mmpm	4000 rpm
PLANAR_MILL_1			MILL_1	00:39:34	290 mmpm	4000 rpm
FACE_MILLING_AREA			MILL_2	00:03:30	250 mmpm	2350 rpm
PLANAR_MILL_2			MILL_3	00:12:03	250 mmpm	2350 rpm
PLANAR_MILL_3			MILL_4	00:13:00	261 mmpm	2347 rpm
FACE_MILLING_ARE...			MILL_2	00:03:30	250 mmpm	2350 rpm
FACE_MILLING_ARE...			MILL_2	00:03:30	250 mmpm	2350 rpm
FACE_MILLING_ARE...			MILL_2	00:03:30	250 mmpm	2350 rpm
FACE_MILLING_ARE...			MILL_2	00:03:30	250 mmpm	2350 rpm
PLANAR_MILL_2_IN...			MILL_3	00:12:03	250 mmpm	2350 rpm
PLANAR_MILL_2_IN...			MILL_3	00:12:03	250 mmpm	2350 rpm
PLANAR_MILL_2_IN...			MILL_3	00:12:03	250 mmpm	2350 rpm
PLANAR_MILL_2_IN...			MILL_3	00:12:03	250 mmpm	2350 rpm
PLANAR_MILL_3_IN...			MILL_4	00:13:00	261 mmpm	2347 rpm
PLANAR_MILL_3_IN...			MILL_4	00:13:00	261 mmpm	2347 rpm
PLANAR_MILL_3_IN...			MILL_4	00:13:00	261 mmpm	2347 rpm
PLANAR_MILL_3_IN...			MILL_4	00:13:00	261 mmpm	2347 rpm
PLANAR_MILL_4			MILL_5	00:36:26	270 mmpm	2620 rpm
PLANAR_MILL_5			MILL_6	00:29:43	280 mmpm	3800 rpm
PLANAR_MILL_6			MILL_7	00:12:19	260 mmpm	2800 rpm
PLANAR_MILL_5_IN...			MILL_6	00:29:43	280 mmpm	3800 rpm
PLANAR_MILL_7			MILL_8	00:49:15	267 mmpm	3150 rpm
PLANAR_MILL_8			T_CUTTER	00:11:23	250 mmpm	2900 rpm
PLANAR_MILL_8_IN...			T_CUTTER	00:11:23	250 mmpm	2900 rpm
PLANAR_MILL_8_IN...			T_CUTTER	00:11:23	250 mmpm	2900 rpm
PLANAR_MILL_8_IN...			T_CUTTER	00:11:23	250 mmpm	2900 rpm
PLANAR_MILL_8_IN...			T_CUTTER	00:11:23	250 mmpm	2900 rpm
PLANAR_MILL_9			T_CUTTER	00:07:34	250 mmpm	2900 rpm
PLANAR_MILL_10			T_CUTTER	00:05:14	250 mmpm	2900 rpm
PLANAR_MILL_11			T_CUTTER	00:03:16	250 mmpm	2900 rpm
PLANAR_MILL_12			T_CUTTER	00:04:43	250 mmpm	2900 rpm
PLANAR_MILL_13			T_CUTTER	00:14:15	250 mmpm	2900 rpm
PLANAR_MILL_14			T_CUTTER	00:19:06	250 mmpm	2900 rpm
DRILLING			DRILLING_TOOL	00:01:17	263 mmpm	2790 rpm
DRILLING_1			DRILLING_TOO...	00:02:15	263 mmpm	2790 rpm
DRILLING_2			DRILLING_TOO...	00:00:27	263 mmpm	2790 rpm
DRILLING_2_INSTA...			DRILLING_TOO...	00:00:27	263 mmpm	2790 rpm
DRILLING_2_INSTA...			DRILLING_TOO...	00:00:27	263 mmpm	2790 rpm
DRILLING_2_INSTA...			DRILLING_TOO...	00:00:27	263 mmpm	2790 rpm
DRILLING_2_INSTA...			DRILLING_TOO...	00:00:27	263 mmpm	2790 rpm
DRILLING_3			DRILLING_TOO...	00:07:34	263 mmpm	2790 rpm
COUNTERSINKING			COUNTERSINKI...	00:01:02	230 mmpm	2600 rpm
COUNTERSINKING_1			COUNTERSINKI...	00:01:02	230 mmpm	2600 rpm
COUNTERSINKING_2			COUNTERSINKI...	00:01:02	230 mmpm	2600 rpm
DRILLING_4			DRILLING_TOO...	00:00:48	240 mmpm	2640 rpm
DRILLING_5			DRILLING_TOO...	00:00:32	240 mmpm	2640 rpm
DRILLING_6			DRILLING_TOO...	00:00:32	240 mmpm	2640 rpm
COUNTERSINKING_3			COUNTERSINKI...	00:00:18	230 mmpm	2600 rpm
COUNTERSINKING_4			COUNTERSINKI...	00:00:18	230 mmpm	2600 rpm
DRILLING_7			DRILLING_TOO...	00:00:04	240 mmpm	2640 rpm
DRILLING_8			DRILLING_TOO...	00:00:04	240 mmpm	2640 rpm
DRILLING_9			DRILLING_TOO...	00:00:12	240 mmpm	2640 rpm
DRILLING_10			DRILLING_TOO...	00:00:12	240 mmpm	2640 rpm
COUNTERSINKING_5			COUNTERSINKI...	00:00:07	230 mmpm	2600 rpm
COUNTERSINKING_6			COUNTERSINKI...	00:00:07	230 mmpm	2600 rpm
DRILLING_11			DRILLING_TOO...	00:02:06	240 mmpm	2640 rpm

Figure 22.

Quality Control Process Chart – missile shield

Opn	Process Name	Planned Machine	Quality Instrument	Quantum of Check	Corrective Action Remarks	No.of Parts Inspected	No .of Parts rework	No .of Parts rejected
10	Cutting Cylinders	Power Saw	Vernier	100%		450	0	0
20	REFERENCE MILL	Convntn -Mill	Vernier	100%		450	0	0
30	Turning Set_up_1	Morisikei 4_ax	Vernier, Radius guages, Micrometer, Height guage.	100%	If rejected material will be scrapped	450	0	0
40	Turning Set_up_2	Morisikei 4_ax	Vernier, Radius guages, Micrometer, Height guage.	100%	If rejected material will be scrapped	450	0	0
50	Milling	DMG_5 ax	Vernier, Radius guages, Micrometer, Height guage.	100%	If rejected material will be scrapped	450	5	0
70	Packing	Pack with bubble cover	By Packing Process	100%		445		

Figure 23. QC process chart

V. RESULTS

Manufacturing of missile shield without fixture

Time taken to manufacture a single component without fixture on CNC machine = 13hr 41min 34sec=822min
If the time in seconds is above 30 then it is taken as 1min, if it is below 30 then it is exception
Manufacturing cost of CNC machine per hour = 1200rs/hr
Manufacturing cost of single missile shield =(1200/60)*822= 16440rs

Direct Labour Cost = Tm * Man Hour Rate Rs.
Man Hour Rate = 500 Rs.
Tm= machining time
Tm =(822/60) hours= 13.7hrs
Tm = 13.7*500= 6850 Rs.

machining type	time required to machining	machine cost/hr	raw material cost- r	labour cost – l	manufacturing cost –m	total cost of part (r+l+m)
milling machine	13hr 41min 34sec	1200	1040	6850	16440	24330

Table 3.

Total cost of part =raw material cost + labour cost +manufacturing cost =
1040+6850+16440= 24330rs

Manufacturing of Missile shield with fixture

Time taken to manufacture a single component with fixture on CNC machine = 8hr 51min 59sec=532min

If the time in seconds is above 30 then it is taken as 1min, if it is below 30 then it is exception
Manufacturing cost of CNC machine per hour = 1200rs
Machining cost per piece (machining cost per min x machining time in min)= (1200/60)*532= 10640rs
Manufacturing cost of single missile shield= 10640rs
Direct Labour Cost = Tm * Man Hour Rate Rs.
Man Hour Rate = 500 Rs.
Tm= machining time
Tm =(532/60) hrs= 8.9hrs

Direct Labour Cost = 8.9*500= 4450 Rs.

Table 4. Cost of estimation

Machining type	Time required to machining	Machine cost/hr	Raw material cost	Labour Cost	Manufacturing Cost	Total cost of part
Milling machine	8hr 51min 59sec	1200	1040	4450	10640	16130

Graphical representation

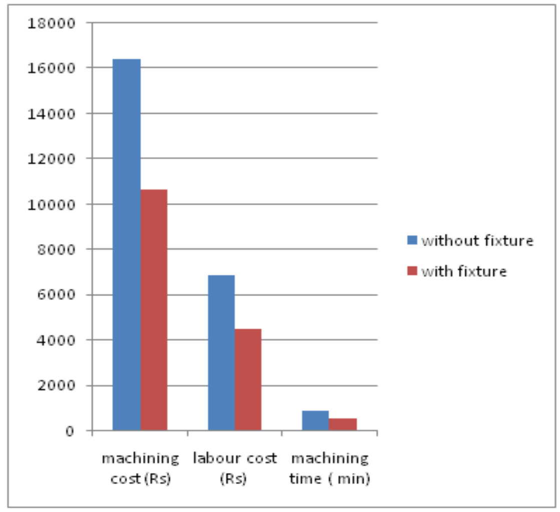


Figure 24.

VI. CONCLUSION

It is complicated to manufacture missile shield with 3-jaw chuck because it cannot hold the part rigidly for machining slots around the missile shield. The number of parts is rejected. Manufacturing time, labour cost, manufacturing cost was reduced Using designed fixture. Inspection charts are shown in report Graphical representation of reduction of time and cost are in and shown in results. There is a drastic reduction of reworks and rejection rate using designed fixture.

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