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Design of a Fixture using Reverse Engineering and CAD/CAM Approach

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***Abstract:*-- The machine tool industry has gone through tremendous changes since its inception. CNC machine with proper fixtures has the capacity to fill this gap. This has excited this research work on design and development of fixture for CNC. Manufacturing processes are commonly affected by the low stiffness of the components limiting the quality and precision of the final product. Precision is one of the most important issues in the machining process, and the main cause for rejection of the part is due to static deformation and the dynamic vibrations. The static deformation is mainly affected by two factors: deformation due to clamping force, and geometrical distortions due to material removal. This paper presents an analysis to manufacture fixture, using reverse engineering, for sheet metal operation. These fixtures are made by incorporating additional features in the existing fixture to suit for sheet metal machining operation. For design of fixture, computer aided design by Fusion 360 and manufacturing by CNC milling machine is used.**

Index Terms:- Reverse Engineering, CAD/CAM approach, Fixture for sheet metal operation

I. INTRODUCTION

Fixtures are widely used in the industries. Fixture design has direct impact on the quality, cost and productivity of the product. A fixture is designed and manufactured which help of computer aided design softwares and CNC machines. Some research has been reported in the field of computer aided fixture design such that fixtures can be designed and manufactured using reverse engineering for real world industrial components. Fixture are required for all machines whether it s horizontal and vertical CNC milling machine or turning machine. It is very challenging to design fixtures for sheet metals and light components that need to be machined in CNC milling machines because these components should be able to take the cutting forces exerted by the tool on to the work piece. Particularly light weight components are used in aeronautical industry.The aeronautic industry is mainly concerned with the weight of the component. Some time they need to machine materials with low stiffness. The accuracy of low stiffness components are affected by forces occurred during machining, as they can easily lead to deformation of the weak and flexible component. The precision is one of the most important parameters in the machining of aeronautical components. Part dimensions are affected by the geometrical distortions that occur during machining. And distortion is a major cause of the rejection of the components. Around 40% of the parts get rejected due to issues related to fixture design, and out of total cost of manufacturing, fixture costs only 10-20 %. Fixture is a key element to lower the geometrical deformation caused due to external loads during machining processes. The fixture will provide an accurate positioning to the work piece in the work space and rigidly holds and supports the component to endure the machining forces. The importance of the fixture is illustrated by its impact in the performance of the machining.

1.1 Fixtures in Manufacturing

Fixture is used to hold the work piece within specification. They are used in testing, assembly, welding, machining (Turning, milling, grinding). Some of the real world fixture design cases in manufacturing are shown in Figure-1 below.

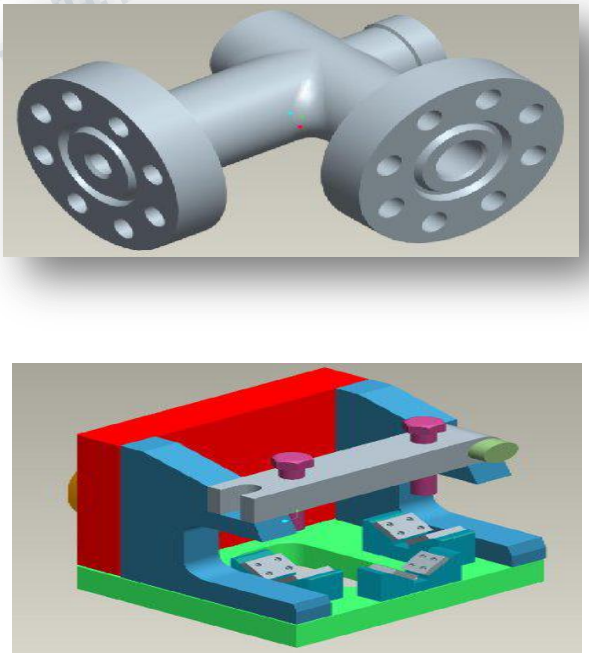

Figure-1: Some of the fixtures used in manufacturing

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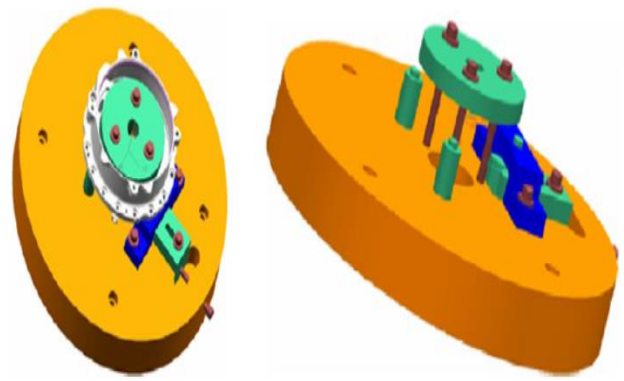
In fixture design, geometrical feature of the component needs to be made. Location & clamping of set up fixture is accomplished by using three V-blocks and latch clamps. Work holding with one touch clamps is used in machining fixture of air-craft. Some more fixtures are shown in Figure-2.



There is a large difference between welding fixtures and CNC machining fixtures. Some of them are explained below:
• Work piece in welding is usually assembly of many parts, but in machining the part being machined is a single part.
• Accuracy needed in welding assembly is usually less than in machining.
• Forces incurred during operation in welding is less whereas during machining, it is very large.
• Thermal reactions are there in welding whereas no change in grain structure is there in machining

1.2 Classification of fixtures

Fixtures can be:
• Dedicated fixture: Dedicated fixture is made for machining of single component only or any operation of any component.
• General purpose fixture: General purpose fixture can be used for multiple operations or with multiple components. General purpose fixtures are widely used in industries so that they can be adjusted to meet different features of the work piece.

2. DESIGN AND DEVELOPMENT OF FIXTURE

2.1 Objective of this work

• Design and development of fixture for sheet metal so a to withstand the cutting forces exerted by the tool and machine, and
• Optimization of parameters (speed, feed, depth of cut, step over ratio) using Taguchi statistical methods for maximum Material Removal Rate. These parameters are used for making of fixture in CNC machine.

2.2 Design of the fixture using fusion 360

First of all fixture is designed in software fusion 360. The methodology for designing includes two stages. First the existing fixture is designed in the software. Then its dimensions and shape is modified to meet the needs of the application. The Figures 3 and 4 gives the views of fixture and the use of it after sheet metal is fixed to Table holder.

3. Manufacturing of fixture using CAD/CAM

This fixture is manufactured using Vertical Computer Numeric machine, Sinumerik 828 D. This machine understands G-codes and M-codes. G-code programming can be done manually and with the help of Computer Aided Manufacturing software.

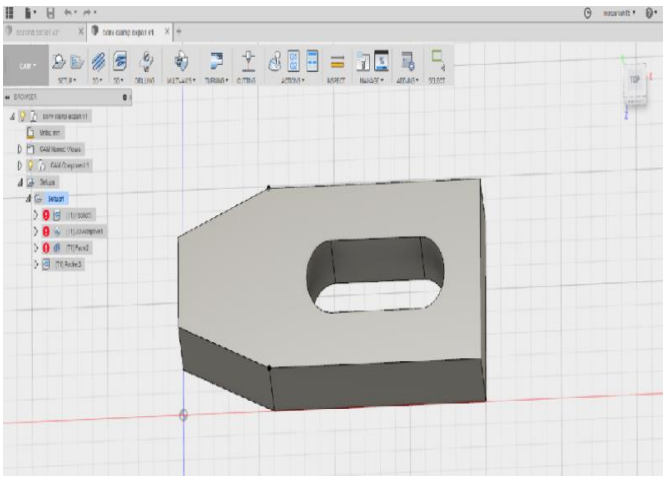


Figure-3: Design of fixture using Fusion 360

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Figure-4: Use of Fixture for sheet metal application

Fusion 360 can also be integrated CAD/CAM software in which both modeling and coding can be done. Machine converts these codes into tool path. In this stage of development, coding is done using fusion 360. Parameters (speed, feed, depth of cut, step over ratio) are entered into the CAM and tool path is generated. These parameters are optimized so that we can get maximum material removal rate (MRR). Optimization of parameters is done using Taguchi experiments. Those parameters are entered in the CAM part of the software to generate G-codes. Tool used for machining is 10 mm carbide flat end mill. Material of the fixture is high carbon steel. Other parameters required in the software to generate tool path:

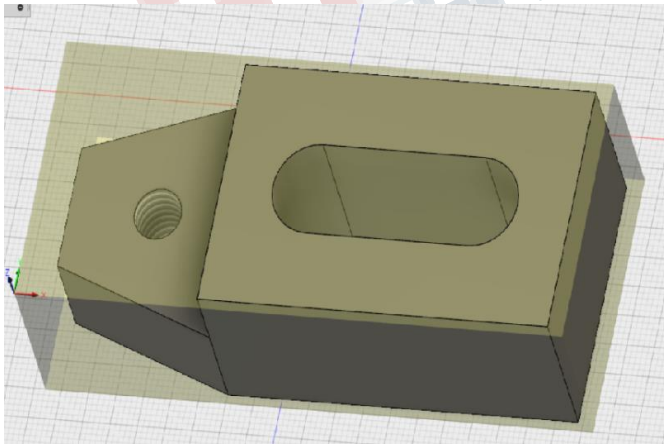
Size of the stock: 100 mm × 50 mm × 25mm

Tool type and size: 10 mm flat end mill

Tool material: Carbide

Offset point position

Type of operation: Slot cutting, pocket cutting, 2D adaptive, 2D contour.



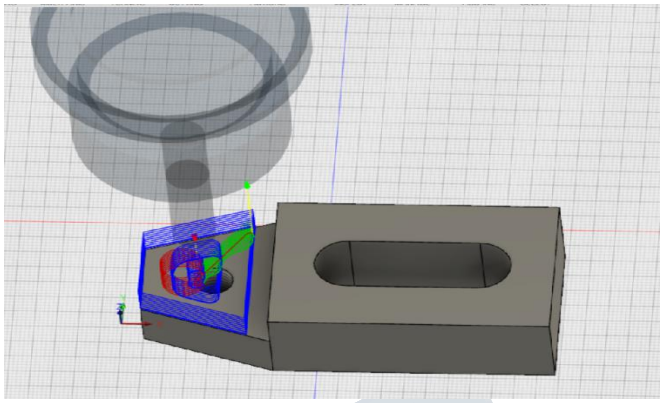
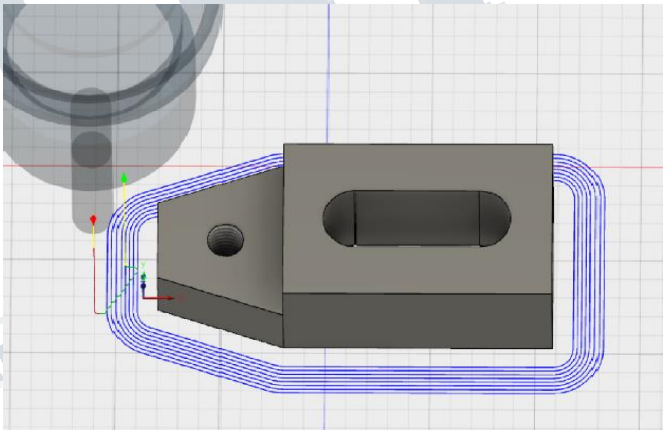


Figure-5: Stock piece used for manufacturing and Tool path for pocket cutting

Figure 5 and 6 show the stock used for manufacturing, tool path for pocket cutting, tool path for contour cutting and tool path for slot cutting.



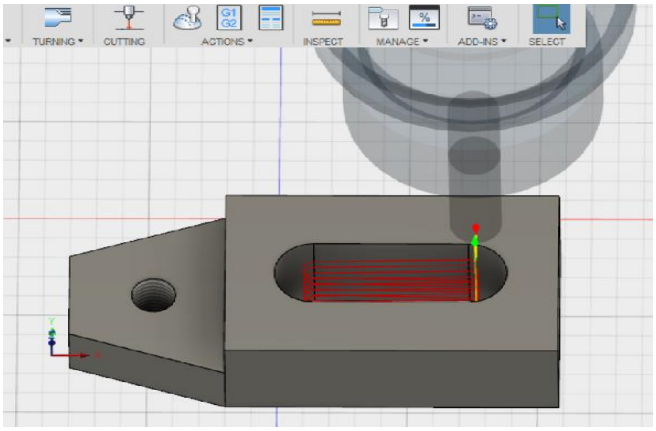


Figure-6: Tool path for contour cutting Tool path for slot cutting

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4. CONCLUSION

An integrated approach of design and manufacturing is used in this project. As other machining processes like plasma cutting, punching, gas cutting, grinding are also available in the industries for making complex shapes on 2 mm aluminum sheet. But if the precision required is high, as in aeronautical application, vertical milling machine would be best. But due to vibration the precision is being compromised. By designing proper attachments or fixtures various operations are possible in vertical milling machine. In this paper, a fixture is designed and also manufactured using optimized machining parameters. This paper sets example for not only designing but also improving productivity.

REFERENCES

1. Oscar Gonzalo, Jose Mari Searaa, Enrique Gurucetaa, Alberto Izpizuaa, Robotics and computer-integrated manufacturing, Robotics and Computer–Integrated Manufacturing 48 (2017) 209–218.

2. Lorenzo Sallesea, Niccolò Grossia, Jason Tsahalisb, Antonio Scippaa, Gianni Campatellia, Intelligent fixtures for active chatter control in milling, Procedia CIRP 55 (2016) 176 – 181

3. Jixiong Feia, Bin Lina, Juliang Xiaob, Mei Dinga, Shuai Yana, Xiaofeng Zhanga, Jin Zhanga, Investigation of moving fixture on deformation suppression during milling process of thin-walled structures, Journal of Manufacturing Processes 32 (2018) pp. 403–411.

4. Lorenzo Sallesea, Niccolò Grossia, Jason Tsahalisb, Antonio Scippaa, Gianni Campatellia, Intelligent fixtures for active chatter control in milling, Procedia CIRP 55 (2016) 176 – 181.

5. Jixiong Feia, Bin Lina,∗, Juliang Xiaob, Mei Dinga, Shuai Yana, Xiaofeng Zhanga, Jin Zhang, Investigation of moving fixture on deformation suppression duringmilling process of thin-walled structures, Journal of Manufacturing Processes 32 (2018) 403–411.