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Design and Development of Inspection Fixture by Using FDM Technology

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Abstract—*This project is about to design and manufacturing of inspection fixture for a car back seat supporting structure, which involves defined shape based on the assembly. The purpose of inspection fixture is to inspect the wire diameter, shape of frame, and fitment position in the Assembly. Inspection fixture plays key role in the mass production system. In the present fixture the inspection of the product is carried out manually, which leads to problems of misalignment and inaccuracy. This inaccuracy will increase the rejection of components. In order to minimize this error and reduce the rejection, it becomes essential to design a special purpose auxiliary attachment to the existing fixture. To design the inspection fixture, CATIA V5 R21 software is used. The aim of the project is to design and develop a prototype model by using 3D printer, to recognize how it will inspect the wire diameter and structure. By using this inspection fixture we inspect the diameter and size of wire.*

Keywords— *Inspection fixture, CATIA V5 R21, FDM, 3Dprinting, PLA*

I. INTRODUCTION

A fixture is a device for locating, holding and supporting a work piece during manufacturing operation. Fixtures are essential elements of production processes as they are required in most of the automated manufacturing, inspection, and assembly operations. Fixtures must correctly locate a work piece in a given orientation with respect to a cutting tool or measuring device, or with respect to another component, as for instance in assembly or welding. Such location must be invariant in the sense that the devices must clamp and secure the work piece in that location for a particular processing operation. There are many standard works holding devices such as jaw chucks, drill chucks, collets, etc. which are widely used in workshops and are usually kept in stock for general applications. Fixtures are normally designed for a definite operation to process a specific work piece and are designed and manufactured individually.

The parts after getting finished with the manufacturing operation have to be checked for its accuracy in shape or in dimension. That will be performed with inspection fixtures and they are extensively used in automotive industries. The fixture will be the master in shape and every part will be compared for its shape conformity. For checking the dimension, the fixture is prepared in such a way that it could accommodate the correct dimensioned parts only.

II. FIXTURE DESIGN

The three dimensional Parts of a inspection fixture designed by using CATIA V5 R21 software. The following steps show the construction of inspection fixture parts by using different tools.

The fixture is to be a special tool for holding a work piece in desire position during inspection operation. For the supporting and clamping the work piece, device is provided. Common checking, positioning, individual marking and non-uniform quality in inspection process is to be eliminated by fixture show in Fig 1: inspection fixture.

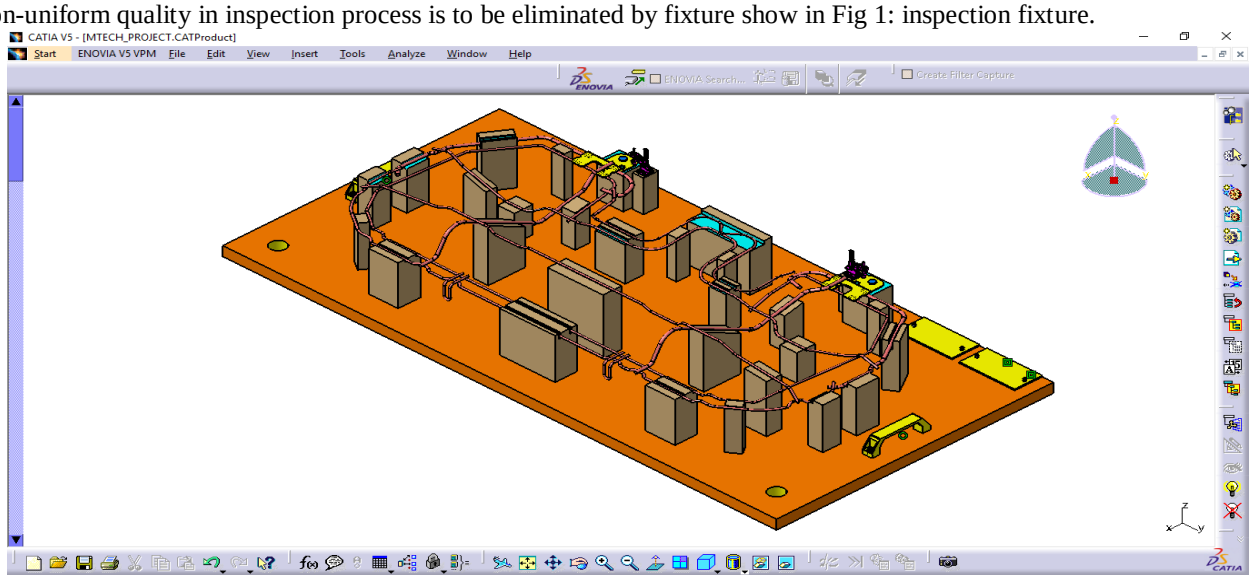

Fig 1: Inspection fixture design

This raises productivity and reduces process time. Fixture is mostly used in the industry for practical production because of their characteristic advantages. A fixture consists of a set of locators and clamps. Locators are used to determine the location and orientation of a work piece, whereas clamps exert clamping forces so that the work piece is pressed resolutely against locators. Clamping has to be appropriately planned at the stage of machining fixture design. The design of a fixture is an extremely complex and unlogical process, which require knowledge. Fixture design plays a significant role at the setup planning phase. In the present fixture the inspection of the product is carried out manually, which leads to problems of misalignment and inaccuracy. This inaccuracy will increase the rejection of components. In order to minimize this error and reduce the rejection, it becomes essential to design a special purpose auxiliary attachment to the existing fixture. By using this inspection fixture we inspect the diameter, length, and structure of wire.

A. Locators

A locator is usually a fixed component of a fixture. It is used to establish and maintain the position of a part in the fixture by constraining the movement of the Part. For work pieces of greater variability in shapes and surface conditions, a locator can also be adjustable

B. Clamps

A clamp is a force-actuating mechanism of a fixture. The forces exerted by the Clamps hold a part securely in the fixture against all other external forces.

1) Toggle clamp:

Toggle is also quick action clamps. Toggle clamp is shown in Figs.2. These can be withdrawn by considerable distance for loading and unloading of the work piece. These depend upon the movement of rigid links for their movement. These clamps are used extensively to hold the sheet metal parts in position while they are being welded or otherwise being fastened. They provide heavy clamping pressure.

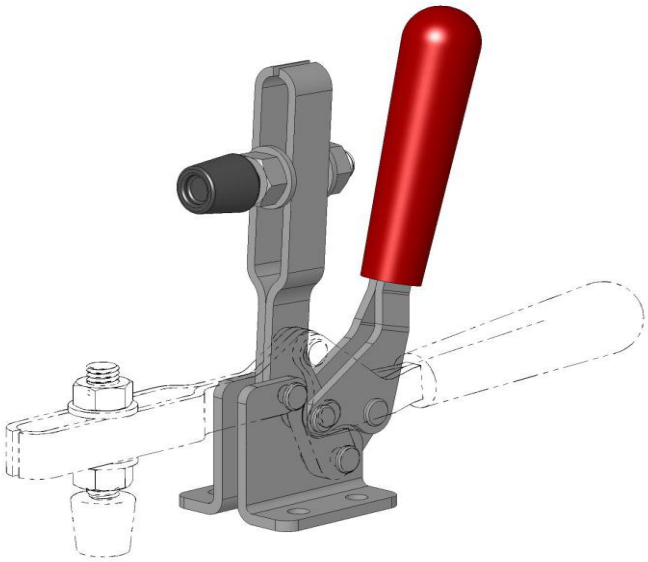

Fig 2: clamp passion

C. Supporting blocks

A support is a fixed or adjustable element of a fixture. When severe part displacement/deflection is expected under the action of imposed clamping and processing forces, supports are added and placed below the work piece so as to prevent or constrain deformation. Supports in excess of what is required for the determination of the location of the part should be compatible with the locators and clamps.

D. Dowel pins:

Dowel pins are often used as precise locating devices in machinery. Steel dowel pins are machine to tight tolerances, as are the corresponding holes, which are typically reamed. A dowel pin may have a smaller diameter than its hole so that it freely slips in or a larger diameter so that it must be pressed into its hole (an interference fit).

Fig 3: Dowel pins

III. INTRODUCTION TO RAPID PROTOTYPING

Prototype making is the one of the most important step in finalizing a design of a product before going to mass production. In olden days prototyping is done by skilled craftsman by manually it is an old practice. Second stage of prototyping is started around 1970, where soft prototype is modelled by 3D cures and surfaces and tested them in virtual environment conditions. 3rd and latest technology is Rapid prototyping which is denoted simply by symbol "RP". Rapid prototyping is layer by layer depositions process, just like arranging the Lego blocks one over the other. Rapid prototyping is started early in the year 1980 because of enormous growth in CAD/CAM technology. The historical development is shown in below table 1

Table 1:Historical Development of RP

YEAR OF INCEPTION	TECHNOLOGY
1770	Mechanization
1946	First computer
1952	First numerical control (NC) machine tool
1960	First commercial laser
1961	First commercial robot
1963	First interactive graphics system(early version of computer aided design)
1988	First commercial rapid prototyping system

3.1. BASIC PRINCIPLE INVOLVED IN RAPID PROTOTYPING

Rapid prototyping is an additive manufacturing where material is going add to layer by layer according to one program given in the form of G-codes. In this process material is going to deposit on pervious layer until final shape of the model is obtained. Whereas lathe, Milling, grinding comes under the metal removal process in which metal is going to remove in small chips until final shape is obtained. In commercial Rapid prototyping machines material is deposited consciously in X-Y planes where Z axis moment is controlled by bed height , the bed is going downwards according the program and next layer is going to deposit on pervious layer this process is continues until final shape of the model is reached . RP can be classified broadly in to two types

1. Mathematical layer information.

2. Generation of physical layer model.

The chain of RP system is shown in fig 3

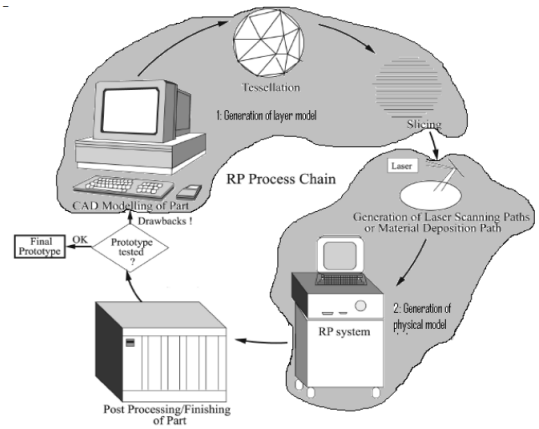

Fig 4: Fundamental steps involved in RP process.

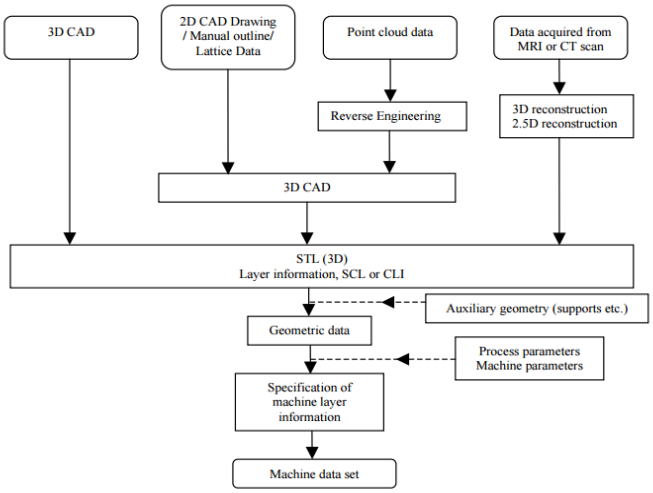

Fig 5: Process of Rapid Prototype

3.2Fused deposition modelling

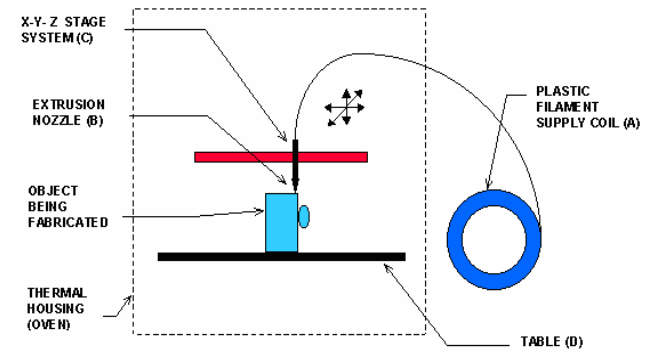

Fig 6: Basic construction of FDM machine

FDM is the most widely used RP technique used for producing 3D models. The basic construction of machine is as shown in fig.6. In FDM machine a plastic filament of standard Dia 1.75mm is used. For industrial grade the filament Dia is 3 mm. these filament is heated in nozzle, the extruder deposits these melted filament into layer by layer form as per the program given to system.

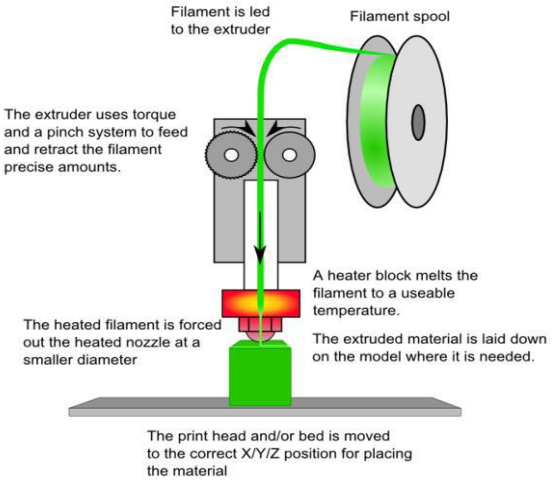

Fig 7: FDM process

Extruder is moves in both X and Y directions and Z directions is controlled by bed height. After completion of each layer the bed moves down up to the completion entire model. While working with FDM over hanging parts should be given support, because it can't print the model in air, so a support structure is generated from base. After completion of printing entire model the supports may remove by hand or dipped into some solutions to remove supports.

3.3 3d printing methods and material

Additive manufacturing is the process in which material is going to deposit layer by layer to form the required tangible product. Additive manufacturing is also called as 3D printing. 3D printing is boon for prototyping industry. These additive manufacturing is going to be the 3rd industrial revolution because 3D printing has new & expanding technical social & economic impact. Particularly in prototyping .3D printing allows mass customization in industries like automobile, healthcare, aerospace education, personalized gifts & consumer parts. It allows test the designed parts physically in very less time and allows designers and artists for producing unique and creative parts. Prototyping is the leading one which uses 3D printing.3D printing machines that producing physical objects layer by layer to form the required 3D model. It can make physical objects according to design, the design file may be created in modelling Software's like CATIA, PRO-E,SOLIDWORKS, AUTOCAD etc. then these design file is going to convert into STL format , according

IV. FABRICATION OF FDM INSPECTION FIXTURE

Inspection fixture is designed according resting points, measuring points &3-2-1 principle standards, for that designed model in CATIA V5 R21, then these model is saved in STL format. These STL file is imported into Fracktory software and divided into number of layers this process is called slicing. According to code generated in Fracktory software the 3D printer is going to print the part as show in fig 7.

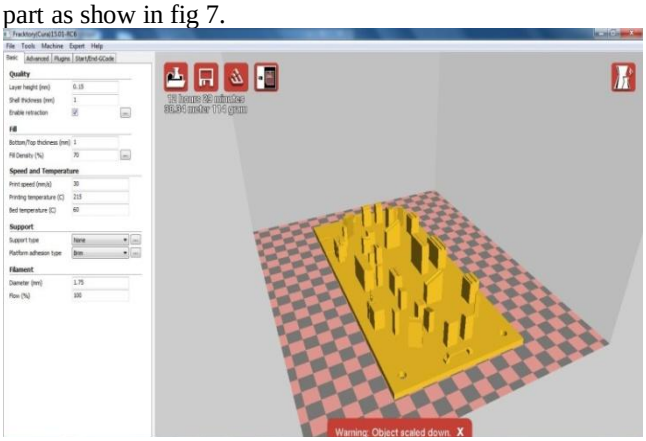

Fig 8: STL file imported to fractory software

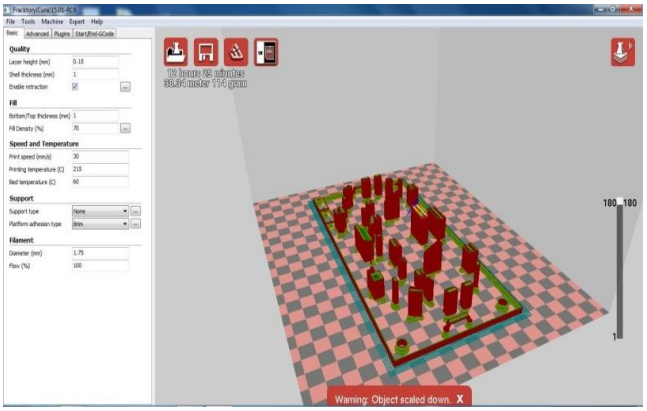

FIG 9: Slicing the STL file (inspection fixture

4.1IMPORTANT SETTINGS USED FOR PRINTING THE INSPECTION FIXTURE

Quality	
Layer height (mm)	0.2
Shell thickness (mm)	.8
Enable retraction	☑ ...
Fill	
Bottom/Top thickness (mm)	.8
Fill Density (%)	100 ...
Speed and Temperature	
Print speed (mm/s)	60
Printing temperature (C)	235
Bed temperature (C)	110
Support	
Support type	Everywhere ...
Platform adhesion type	None ...
Filament	
Diameter (mm)	1.75
Flow (%)	100.0

Fig 10: Basic settings used for printing inspection fixture

Machine	
Nozzle size (mm)	0.4
Retraction	
Speed (mm/s)	50.0
Distance (mm)	2.5
Quality	
Initial layer thickness (mm)	0.3
Initial layer line width (%)	200
Cut off object bottom (mm)	0
Dual extrusion overlap (mm)	0.15
Speed	
Travel speed (mm/s)	150
Bottom layer speed (mm/s)	20
Infill speed (mm/s)	40
Top/bottom speed (mm/s)	30
Outer shell speed (mm/s)	20
Inner shell speed (mm/s)	30
Cool	
Minimal layer time (sec)	5
Enable cooling fan	☐ ...

Fig 11: Advanced settings used for printing inspection fixture

V. PROBLEM

In the present fixture the inspection of the product is carried out manually, which leads to problems of misalignment and inaccuracy. This inaccuracy will increase the rejection of components. In order to minimize this error and reduce the rejection, it becomes essential to design a special purpose auxiliary attachment to the existing fixture. This improves the capability of the inspection fixture. The manufacturing of inspection fixture more expensive after complete of manufacturing parts some problems like miss alignments, dimensional tolerance, inaccuracy so avoiding this problem first take prototype modal by seeing this prototype manufacturer easily understand how to proceed in mft process and also avoid the miss alignment problems .

VI. WORKING PROCESS

FDM 3D printed parts have very different structural responses than traditional Materials. These structural responses are mainly due to parameters like layer thickness, infill density, grid shape, etc. in 3D printed model. Therefore, for an engineer to properly design a FDM parts he must understand how to construct a model in Fractory software. A fundamental understanding the structure of FDM part will allow the designer to design complex inspection fixture parts that match or exceed the performance of tradition parts. Actually fixture is made by using aluminium alloys and steel alloys, Instead of that we used PLA material , The stronger and lighter parts will lead safe and more efficient in working conditions.

In this project a prototype of inspection fixture is fabricated by using 3D printer. For the fabrication of inspection fixture it took around 8 hours to complete the printing, Consumed 27 meters of 1.75 mm diameter filament. And the inspection weight is just 100 grams. The build volume of inspection fixture is 99*198*27.

VII. RESULT AND DISCUSSIONS

A soldering wire (different alloys) with Dia of 1mm is bent in the shape of car back seat supporting wire. By using soldering machine the bent copper wire is soldered. In this project inspection fixture and car back supporting wire are modelled in CATIA and a prototype fabricated. The objective of this project is to model the inspection fixture to show the process of inspection carried out for checking the car back seat supporting wire. The bent wire is placed on fixture to inspect the length, width, shape, Dia, structure of wire. So, this paper presents the solution in the form of a special purpose 'Inspection Fixture', which can be useful for checking the structure of a component up to the desired tolerance with increased precision. Thus increasing the productivity and required skill for inspection is reduced. This prototype modal of PLA material is successful then the fixture can fabricate by using steel and aluminium material with original dimensions.

VIII. CONCLUSION

In this project, a design the inspection fixture and develop a prototype model by using 3D printer for measuring the car back seat supporting wire. The definition of the geometry, dimensions and dimensional tolerances, geometric tolerances, finish tolerances and length, Dia, structure of a wire, etc .planning to inspection operations.

The design of this inspection fixture enhances the efficiency and reliability of the system and the outcome is more appreciable. To reduce the cycle time required for checking the structure of a particular component, this approach is Useful. The proposed fixture will minimize the inspection period.

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