Design of Manufacturing a Part

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Abstract: **The paper seeks to manufacture a part for mass communication (fig I.2) with low cost, less complication and more quality by reducing the labours and skill level, increasing the speed of the process, and without using any sensors**

Keywords: Automation, artisan, manufacturing, fixture

I.INTRODUCTION

In the ongoing industrial development, in the manufacturing sector seeks towards the automation of machining sequence to reduce the labour cost, energy usage, reduce wastage and to improve the quality. But in many cases complete automation becomes reluctant because the industry has to install many sensors and computers which lead to chaos. So it is ideal to go with semi-automation with the minimum usage of labour and not using the sensors and computers, CNC lathe and programming. By making a labour to do a same work repeatedly process will require only less numbered artisan labours which makes the less labour cost for the product. The project concerns with design the best manufacturing method for the the following product (fig I.2) from the given raw material (fig I.1). The part is used in the mass communication technology.

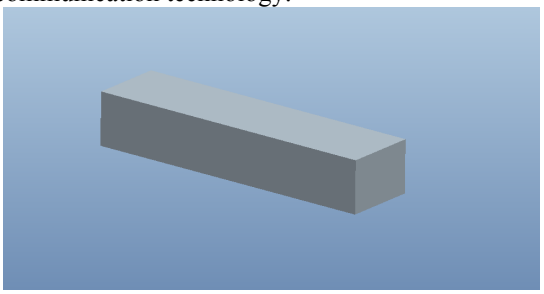

Fig I.1 Raw Material(8" x 4" x 1" cuboid)

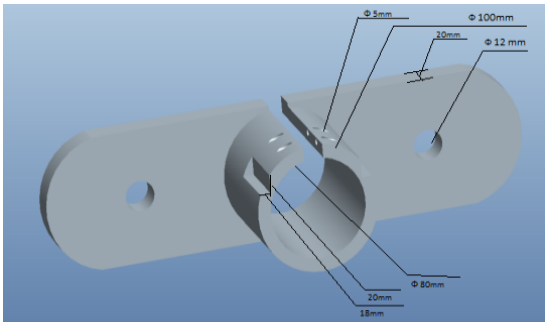

Fig I.2 Final Product with dimensions

II. RESEARCH METHOD

The research concerns with the making a manufacturing sequence of machining a part from is raw material as shown above processes fast, using artisan labours, without doing measurements at any step, with high accuracy, without using sensors. This can be achieved by making the standard fixture, standard table under each machine, making each cut dependant on other and making it dependant to the walls. So that all the process will be at the right position which ensures the accuracy and making the measurement at any step and skilled labours are not required.

III. CHALLENGES OF THE DESIGN

There are many challenges involved in designing the best manufacturing sequence under above conditions. The important challenges are

(i) Maintaining the precision,
(ii) Making the part without making any measurements at any place of manufacturing,
(iii) Using the artisan labours,
(iv) Minimizing the time,
(v) Maximizing the accuracy,
(vi) Making fixtures which are capable of aligning the part to the correct measurement.

IV. STEPS FOR MAKING THE SEQUENCE

Step 1: Collection of data Collection of data includes dimensions of the product, dimensions of the raw material, Material of the product, precision required, and processes involved getting the final product. The raw material is the 8"x4"x1" cuboid. The dimension of the final product is shown in fig. The material is regular steel (C1010) and the required precision is 0.001mm. The processes involved are Center hole, side holes, side ears, cylindrical projection, center slot and side slot.

Step 2: Selection of machining Process As per the required product the required machining process are vertical drilling, vertical milling and shaper machines[6]

(i) Classic Lathe
(ii) Vertical drilling machine

(iii) Vertical milling machine
(iv) Shaper

Step 3: Sequence of machining process choosing the sequence of the process plays the important role to make the design more effective and ideal product. I have taken the sequence to depend on following

(i) One process should not disturb the precision of another finished work
(ii) Sequence of the process should have more precision on dimension
(iii) Sequence should consume less time , less labour, less skill

So the selected sequence is given by step by step

(i) Drilling center hole and side holes by using vertical drilling machine
(ii) Cutting the cylindrical projection using classic lathe
(iii) Cutting center slot and side slot using shaper machine
(iv) Cutting the side curves using vertical milling machine

Step4: Designing of fixtures Design of fixture plays a main role in manufacturing. Fixture decides the measurement, tolerance and precision of the product. We followed the idea to use the same fixture for multiple processes. Make the fixture to travel along with the product is the idea used here to make the process faster. For the process of drilling the self-centring bench vice[6] is used. For the cylindrical projection by self-centerd three jaw chuck is used and for all other processes a newly designed fixture which is a combination of three jaw chuck and the bench vice as shown in figIV.1. The material of the fixture is cast iron [1].

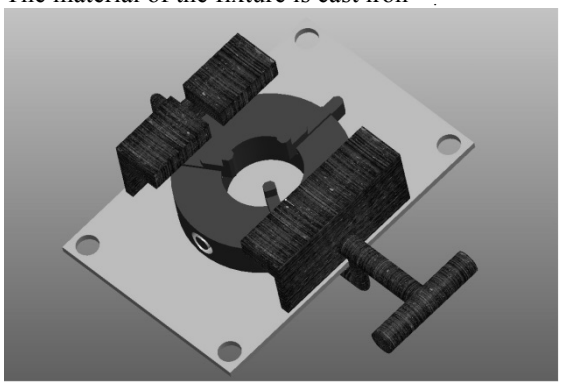

Fig IV.1 Fixture for shaping, milling and drilling

Step5: Labour usage One of the targets of the project is to decrease the required skilled labour for the production. For the high rated mass production one artisan labour is required for each machine i.e., If we use 2 shapers, 2 drilling, 2 lathe, 1 milling[8] machine the number of labour required will be 7[3].

V. EXPLANATION/DISCUSSION OF EACH PROCESS

The raw material of the part is the cuboid of 8" x 4" x 1"

Process 1: The first process is the *drilling* in the center of the cuboid. For this process the *self-centerd bench-vice* is used as the fixture (fig). The fixture will be fixed to the table of the drilling machine and its fixed exactly center of the table so that the driller comes to touch exactly at center of the raw material's top face. By placing the work piece and pulling the pin, work piece is aligned exactly to the center so no measurement is required. As the size of the drill bit is same as the required hole so no radius measurement is needed.

Works of worker:

(i) Place the work piece inside the arms of the bench-vice
(ii) Pull the pin so the arm closes and grips the work piece.
(iii) Switch ON the driller.
(iv) Move it down
(v) When the whole got through, reverse the direction and pull up
(vi) Remove the work piece

Process 2: The second process is the *Turning* using Lathe. The fixture used is the *three jaw self-centerd chuck*[7] where the gripper is in the outside. So the work piece is placed where the previously drilled hole is gripped by the chuck jaw[4]. The maximum feed that can be moved from outside to inside is the outer radius of the circular projection. The maximum linear movement is the length of the projection.

Works by worker:

(i) Place the work piece in the chuck
(ii) Tighten the jaws with the key
(iii) Switch ON the machine
(iv) Give feed as maximum possible
(v) Switch OFF the machine and remove the part

After this process the work piece is fixed to the fixture shown in fig(IV.1) and for all other process it serves as the fixture

Process 3: The third process is the process of *shaping*[10]. Part along with the fixture reaches the shaper station. The fixture is placed in the table as like the four columns enters into the holes in the corners of the fixture. The shaper is allowed to cut the center slot then the work piece is moved by pushing a lever the side slot is cut and then the lever is pulled to cut the second side slot.

Works by worker:

(i) Place the work piece along with the fixture in the shaper table
(ii) Switch ON the machine

(iii) (After middle slot is completed)Stop the feed
(iv) Push the lever (so the part set to the next slot position) Start the feed
(v) (After completion of slot) Stop the feed
(vi) Pull lever double time (Part set to second side slot position) start the feed.
(vii) (After completion of slot) Remove the work piece along with the fixture

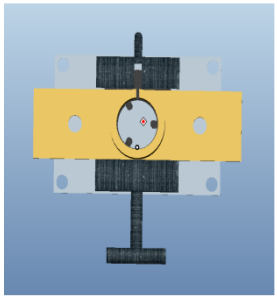

Fig3.1: Position of work piece along with fixture

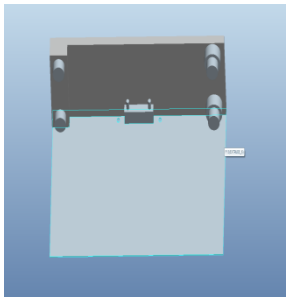

Fig3.2: Table for Fixture

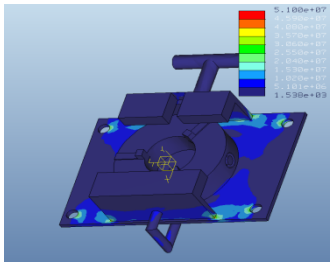

Fig3.3: FEA analysis of fixture while cutting

In the figure the holes in the fixture fits inside the column of the table. The lever is behind table. There is a lock nut arrangement in the table the lock nut enters into the next hole and grips it. The holes are pre-made in the length between the slots.

Process 4: The fourth process is the *milling*. Place the part with fixture flat over the table. Here the table is the round table so the cut can be done radially in pre-fixed angle. Similar to previous machining the table is moved to next position to cut the curvature at the other end.

Works by worker:

(i) Place the work piece along with the fixture over the turn table
(ii) Switch On the machine
(iii) After cutting is done switch OFF and push the lever
(iv) Again switch ON the machine
(v) After cutting is done in other switch OFF the machine and remove the work piece.

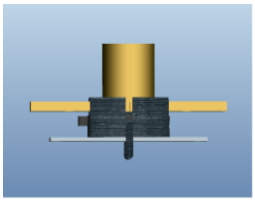

Fig 4.1: Position for milling

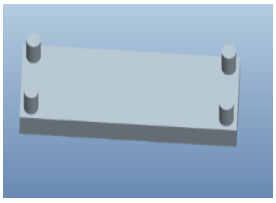

Fig 4.2: Table for milling

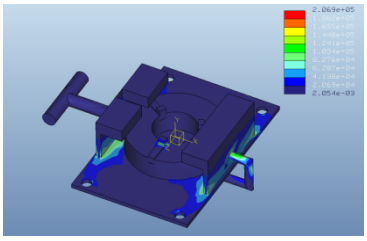

Fig 4.3 FEA of fixture while cutting

The finite element analysis shows the results due to forces during the milling process

Process 5: The fifth and last process is the *drilling* in the ears of the part[10].The same part with fixture is put over the table as shown below and drilled at a point then pushed to other side then drill[8] other hole.

Works by worker

(i) Fix the fixture in the table
(ii) Switch ON the machine
(iii) After cutting is done switch OFF and push the lever
(iv) Again switch ON the machine
(v) After cutting is done Switch OFF the machine and remove the work piece.

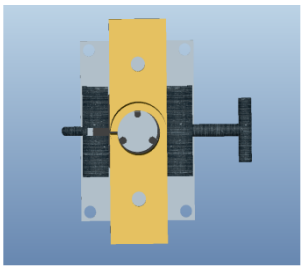

Fig5.1: Position for Drilling

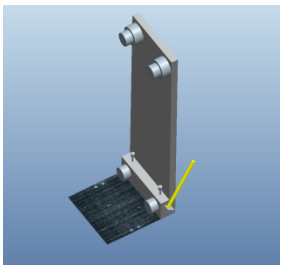

Fig5.2: Table for Drilling

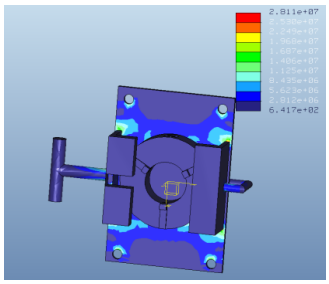

Fig5.3: FEA of Fixture while drilling

The rod in yellow is the lever. When it is pulled it can be set to two positions. The distance between two holes in the table is the distance between two holes of the product.

VI. INFERENCE FROM THE FEA RESULTS

The fig(3.3), fig (4.3), fig (5.3) shows that the designed fixture is feasible for doing all three process without failure for the selected material.

VII. CONCLUSION

Industrial manufacturing plays a main role in determining the cost of the product, so an engineer has to design the best way to manufacture a product. Industry can manufacture a product without any need for measurement at any point of time. So for a manufacturing without any technical assistance does not want any skilled labours. By calculating the time taken at each station and installing the number of machines accordingly. This may be the best way to manufacture this part with less number of labours, cheapest and with high quality. The results from the FEA analysis shows that the fixture is feasible for doing the processes without any damage for number of cycles.

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