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Design and Development of Fixture for Skid Sole of Rotavator

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Abstract - *Fixtures play an important role in manufacturing. Its function is to arrange the material in a definite position, so the machine tool is able to weld the required path on the workpiece. The case study of this research is conducted in Jadhao Layland. One high demand product is "Rotavators" which is the focus of this research. The existing problem of product setup time is too long. Four techniques of setup time reduction were introduced in this research is just-in-time (JIT).*

***Key Words*: Fixture, product Quality, Improve Accuracy, Save time**

1. INTRODUCTION

A fixture is a mechanism used in manufacturing to hold a work piece, position it correctly with respect to a machine tool, and support it during machining. Fixture is a device for locating, holding and supporting a work piece during a 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 .They are normally designed for a definite operation to process a specific work piece and are designed and manufactured individually. Widely used in manufacturing, fixtures have a direct impact upon product quality, productivity and cost.

Generally, the costs associated with fixture design and manufacture can account for 10%–20% of the total cost of a manufacturing system. Approximately 40% of rejected parts are due to dimensioning errors that are attributed to poor fixture design. Fixture design work is also tedious and time-consuming. Traditionally, the design and manufacture of a fixture can take several days or even longer to complete when human experience in fixture design is utilized. And a good fixture design is often based on the designer's experience, his understanding of the products, and a try-and-error process. Therefore, with the increasingly intense global competition which pushes every manufacturer in industry to make the best effort to sharpen its competitiveness by enhancing the product's quality, squeezing the production costs and reducing the lead time. There is a strong desire for the upgrading of fixture design with the hope of making sound fixture design more efficiently and at a lower cost.

1.1 Elements of Fixtures

Generally, all fixtures consist of the following elements:

1. 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.

2. 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 acting on to the component.

3. Supports

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.

2. Fixture Design Procedure

In the design of a fixture, a definite sequence of design stages is involved. They can be grouped into three broad stages of design development.

- **Stage one** deals with information gathering and analysis, which includes study of the component which includes the shape of the component, size of the component, geometrical shape required, locating faces and clamping faces. Determination of setup work piece orientation and position.
- **Stage two** involves product analysis such as the study of design specifications, process planning, examining the processing equipment's and considering operators safety and ease of use. Determination of clamping and locating position. In this stage all critical dimensions and feasible datum areas are examined in detail and layout of fixture is done.
- **Stage three** involves design of fixture elements such as structure of the fixture body frame,

locators, baseplate, clamping and tool guiding arrangement.

- **Stage four** deals with final design and verification, assembly of the fixture elements, evaluation of the design, incorporating the design changes if any required and completion of design.

Work piece SOLID WORKS model

Machining Information

Design requirement

Set up Planning:

Determine numbers of setups.
Determine the work piece orientation and position.
Determine machining datum features and locating surfaces.

Fixture Planning:

Determine locating position.

Determine clamping surface.

Determine clamping position.

Unit Design:

Generate base plate design.

Generate locating designs.

Generate clamping unit designs

Verification:

Perform location accuracy verification.

Perform stiffness verification.

Perform cost, weight verification.

Perform fixture accessibility.

Finished Setup Plan

Fixture Design

Material Listing

3. Fixture Functional Requirements

From a layout point of view, fixtures have six basic functional requirements:

(1) Stable resting, (2) accurate localization, (3) support reinforcement, (4) stable clamping, (5) quality performance.

The functions have strong precedence conditions. The first five functions are required at the fixturing stage, and sequentially. When a workpiece is placed into a fixture, it must first assume a stable resting against the gravity. Then, the locators should provide accurate localization. Next, supports are moved in place, and finally clamps are activated for the part immobilization (force-closure). The part location must be maintained in the process of instantiating clamps without workpiece lift-off. The performance of the fixture is ultimately defined as workpiece geometric error during the manufacturing stage. The geometric error is mainly determined by the fixture localization accuracy and the workpiece static and elastic deformation during manufacturing. There are additional constraints to be satisfied such as interference-free and easy loading and unloading.

4. Design Considerations in Fixtures

a. The main frame of fixture must be strong enough so that deflection of the fixture is minimum as possible. This deflection of fixture is caused because of forces of cutting, clamping of the workpiece or clamping to the machine table. The main frame of the fixture should have the mass to prevent vibration and chatter.

b. Frames may be built from simple sections so that frames may be fastened with screws or welded whenever necessary. Those parts of the frame that remain permanently with the fixture may be welded. Those parts that need frequent changing may be held with the screws. In the situation, where the body of fixture has complex shape, it may be cast from good grade of cast iron.

c. Clamping should be fast enough and require least amount of effort.

d. Clamps should be arranged so that they are readily available and may be easily removed.

e. Clamps should be supported with springs so that clamps are held against the bolt head wherever possible.

f. If the clamp is to swing off the work, it should be permitted to swing as far as it is necessary for removal of the workpiece.

g. All clamps should be easily visible to the operator and easily accessible for cleaning, positioning or tightening.

h. Provision should be made for easy disposal of chip so that storage of chips doesn‟t interfere with the operation and that their removal during the operation doesn‟t interfere with the cutting process.

i. All clamps and support points that need to be adjusted with a wrench should be of same size. All clamps and adjustable support points should be capable of being operated from the fronts of the fixture.

j. Work piece should be stable when it is placed in fixture. If the work piece is rough, three fixed support points should be used. If work piece is smooth, more than three fixed support points may be used. Support point should be placed as farthest as possible from each other.

k. The three support points should circumscribe the centre of gravity of the workpiece.

l. The surface area of contact of support should be as small as possible without causing damage to the workpiece. This damage is due to the clamping or work forces.

The importance of fixture design automation is emphasized by Djordje Vukelic [3]. General structure of the automated design system shown in fig. with a highlight on the fixture design.

Now in a Jadhao Leyland Company they manufacture rotavators which is used in Agriculture. One part of rotavator is skid sole of Rotavator which is assembled by Robotic Welding with the help of fixture.

Fig -1: Rotavator

Fig -2: Skid Sole of Rotavator

5. Existing fixture in Jadhao Leyland Company

Fig -3: existing fixture in company

Skid sole of Rotavator assembly there are four parts that assemble by robotic welding. So in this fixture there are **eight clamps** to fixed this four parts of skid sole of rotavator. (as shown in fig.) So there is long duration to fix the components for welding. and Accuracy is not proper. Skilled operator required for adjustment of parts for welding to assembly of skid sole of Rotavator.

After design and development of this fixture we reduce five clamps in fixture (shown in fig.). Now in this fixture assemble all parts on **three clamps** only. It reduces time, increase accuracy and here semi-skilled operator required.

Design of existing fixture in Jadhao Leyland

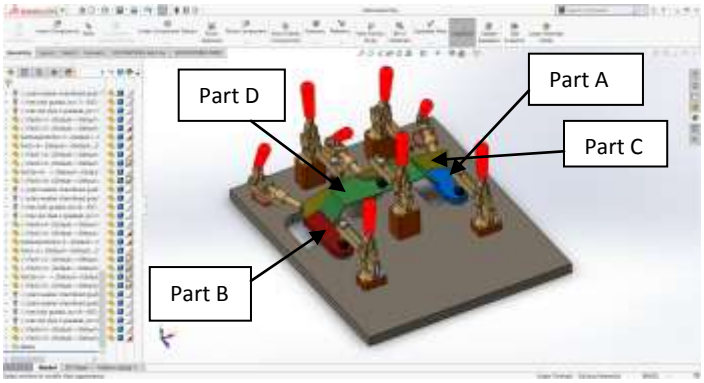

Fig -4: Design of existing fixture in company

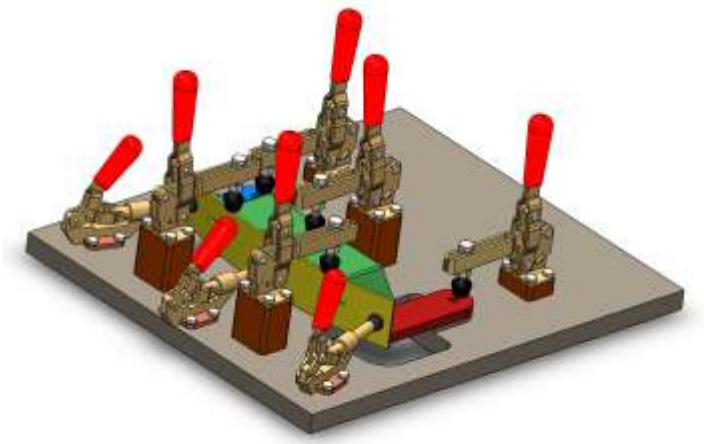

Fig -5: Design of existing fixture in company

Existing fixture in company to fix all parts procedure is:

Step 1:

First step of this fixture is first they put part A on rack then fixed it by pressing clamp. Thickness of this part is 15 mm and material of part is C.I.

Step 2:

Second step of this fixture is put part B on rack then again fixed by pressing clamp. Thickness of this part is 15 mm and material of part is C.I.

Step 3:

Third step of this fixture is put part C on fixture and fixed it by five push pull clamps one by one. Thickness of this part is 5 mm and material of part is C.I.

Step 4:

Final step of this fixture is put part D on part A and B and fixed it by pressing clamp. Thickness of this part is 2 mm and material of part is C.I

6. After Design and Development of fixture

After Design and Development of fixture five clamps are reduced. Now design of fixture is

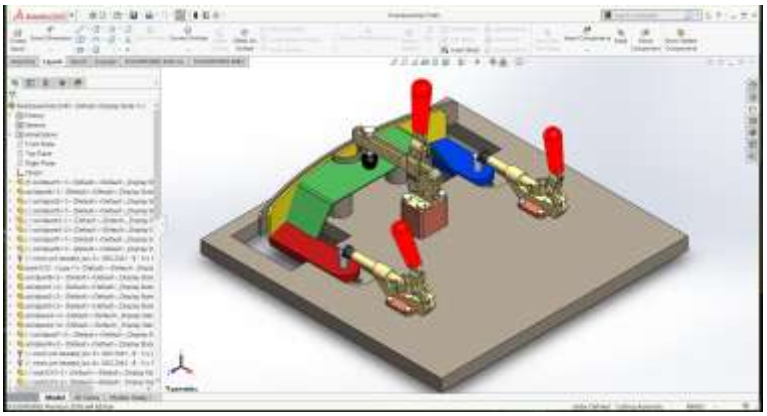

Fig -6: After Development of this fixture

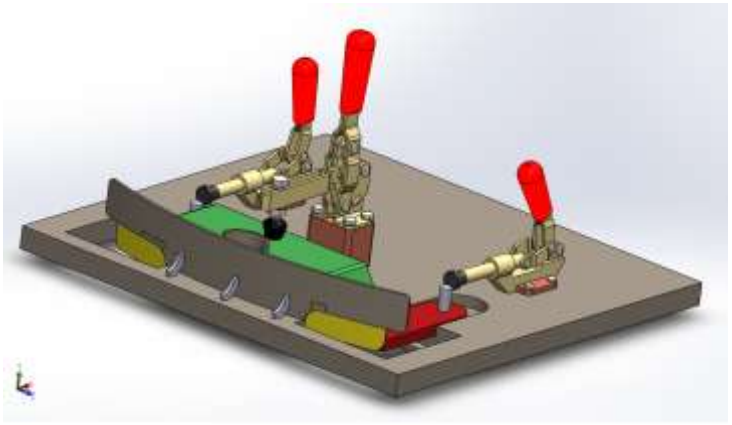

Fig -7: After Development of this fixture

Step 1:

First step of this fixture is first put part C in front of back rest plate and it is fixed by embossing of back rest plate.

Step 2:

Second step of this fixture is put part A part B on rack and apply the push pull clamp then part A and part B slides and joined to part C.

Step 3:

Final step of this fixture is put part D on part A and B and fixed it by pressing clamp.

7. CONCLUSION

It reduces or sometimes eliminates the efforts of marking, measuring and setting of workpiece on a machine and maintains the accuracy of performance. The workpiece and tool are relatively located at their exact positions before the

operation automatically within negligible time. So it reduces product cycle time. Variability of dimension in mass production is very low so manufacturing processes supported by use of fixtures maintain a consistent quality. Due to low variability in dimension assembly operation becomes easy, low rejection due to less defective production is observed. It reduces the production cycle time so increases production capacity. Operators working become comfortable as his efforts in setting the work piece can be eliminated. Semi-skilled operators can be assigned the work so it saves the cost of manpower also. There is no need to examine the quality of product provided that quality of employed fixtures is ensured.

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