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Working of Machine Fixture for the Shifting Fork for Minimum Cycle Time for Machining Operations in Vertical Machining Center

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Abstract

The main purpose of the research paper is to explain the working of the machining fixture for a component named Shifting Fork on a "CNC Vertical Machining Center (VMC)" ,optimize the cycle time and determine the dimensions of tools for machining operation done on component. The main requirement of the fixture is to hold the work piece during machining operations and to produce uniform products.The component is a raw material which is of the Die casting Aluminium. The number of operations performed on the component are six such as boring , slotting , chamfering , drilling, reaming & facing. Firstly four operation are done on component at a time than after revolving the turning table to 90^0another three operation are carried out . All operations are done in one fixture.

KEY WORDS*-Shifting fork; Cycle time; Working; Machine; Fixture; Machining; Operation; Tools*

I. INTRODUCTION

It is a matter of common knowledge that the use of fixture eliminates the human effort in holding the work pieces during the machining operations, due to which safety of the workers is enhanced. Fixture is very essential for the precise location of the work piece. Locating work pieces ensure the geometrical stability of the work piece.

The Cycle time is an important parameter with respect to manufacturing prospect. It determines the time involved in manufacturing a product involving the time spent in loading the job on it, setting as well as changing the tools, machining operations and unloading the job.

Working of machine fixture can be defined in many ways. Some of them are as follows:

- Machine fixture mainly works on 3-2-1 principle .
- Working of machine fixture includes workpiece and tool where they both are relatively located at their exact positions earlier than the operation automatically within slender time. So it decreases product cycle time.
- Working of machine fixture has characteristics to reduce product cycle time so enlarges production capacity. Concurrently working by more than additional tool on the same workpiece is possible.

II. DETAIL DESCRIPTION

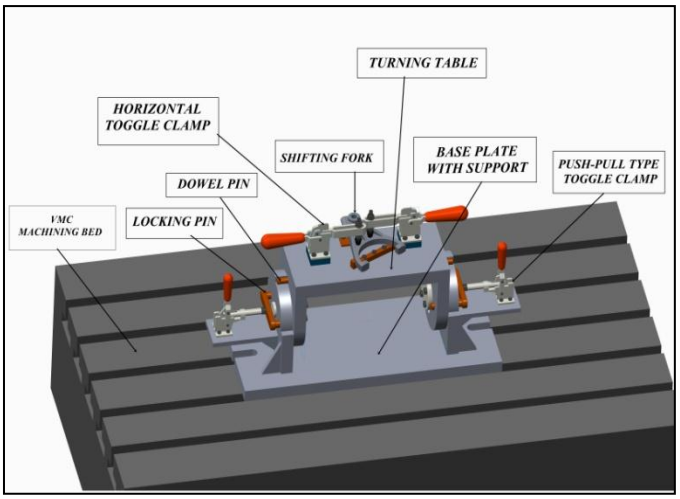

Fig. 1 The detail assembly of Machine Fixture.

The Fig.1 itself signifies the labelling of various object used to make a component. List of the object labelled are :

- Shifting fork
- Turning table
- Base plate with support
- Horizontal toggle clamp
- Push-pull type toggle clamp
- Vertical Machining Bed (VMC)
- Dowel pin
- Locking pin

Different object are arranged in proper sequence so that finished part can be obtained and no wear and tool damage is judge while doing machining operation. Accuracy and its material reliability makes the component highly precision.

III. WORKING OF MACHINE FIXTURE IN V.M.C.

Procedure to carry out whole working of a machine fixture is done in Vertical Machining Center (VMC). Working has been explained as per sequence of operations done on the

component named shifting fork. Mainly steps are opted to execute the operation and collectively understand the working procedure. The following are the step by step procedure being mentioned below:

3.1. Step 1

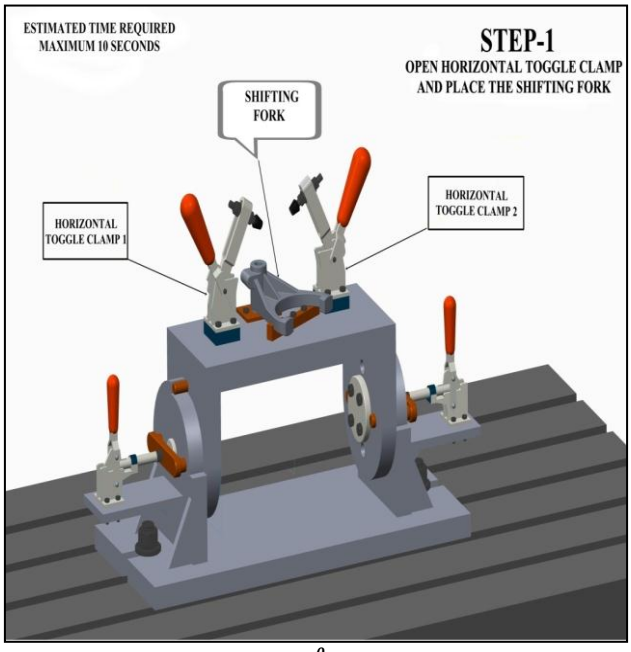

Fig. 2 Machine fixture at 0^0 degree position where two horizontal toggle clamps are open and allow the component to be placed

This Fig. 2 represents that two horizontal toggle clamps are mounted on the turning table at 0^0 and they are in open position and the rubber pads are mounted at the end of toggle clamp for supporting the shifting fork to reduce the vibration and absorbs the shock while machining operation. Similarly place the shifting fork on turning table as per the predefined position.

3.2. Step 2

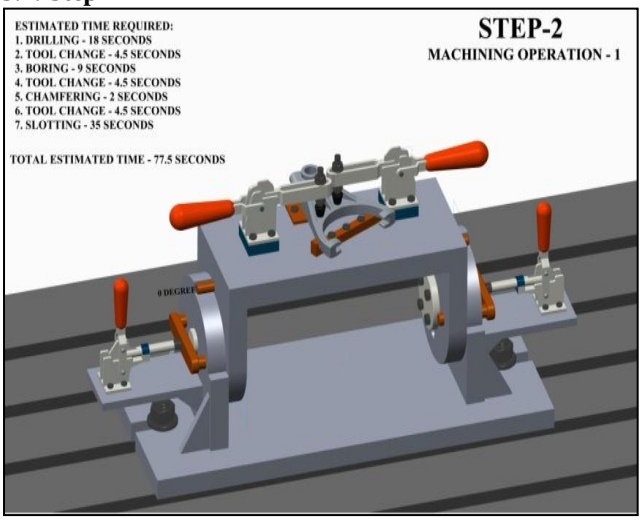

Fig. 3 Machining operation -1 done on component

Fig.3 represents that the component is placed on the two supports provided to restrict the movement of the turning table . Two supports are provided for the fork-head and fork-leg. Now component is held firmly by closing the horizontal toggle clamps. Mainly there are four operations done in one position of turning table which is at 0^0 such as drilling, boring , chamfering ,and slotting. The sequence of operation followed during machining work i.e. 1) Drilling, 2) Boring ,3) Chamfering, 4)Slotting. The order of operation is appropriate and sufficient. Note that while machining all parts are fitted firmly and gently so that no damage is carried out and to avoid accident.

3.3.Step 3

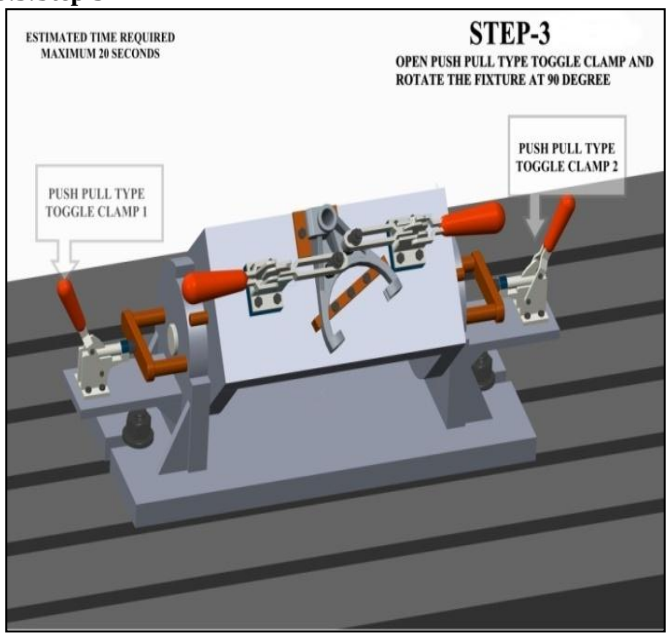

Fig. 4 Machine fixture is allow to rotate at 90^0 for machining operation -2

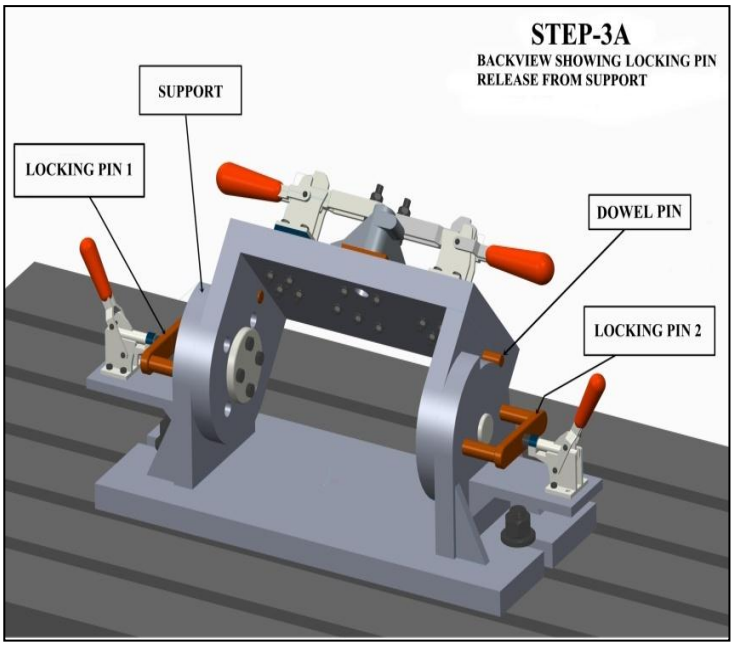

Fig. 5 Locking pin attached with push pull type toggle clamp is release from actual position by opening the clamp

In this step there are two push-pull type toggle clamps are fitted at extended surface provided from supports as shown in Fig. 4 and Fig. 5 .This clamps are helpful for rotating the turning table as per need. So handle of both the clamps as operated at time and gradual movement of turning table is carried out. Pressing the handle of clamps and making dowel pin in a position to unlock from the turning table so that it can rotate upto90^0 , for this situation one stopper is provided at locking pin so the locking pin attach with toggle clamp do not go outwards directly from turning table. Operator can easily understand the assembly without need of any guidance and no other human skills are required.

3.4.Step 4

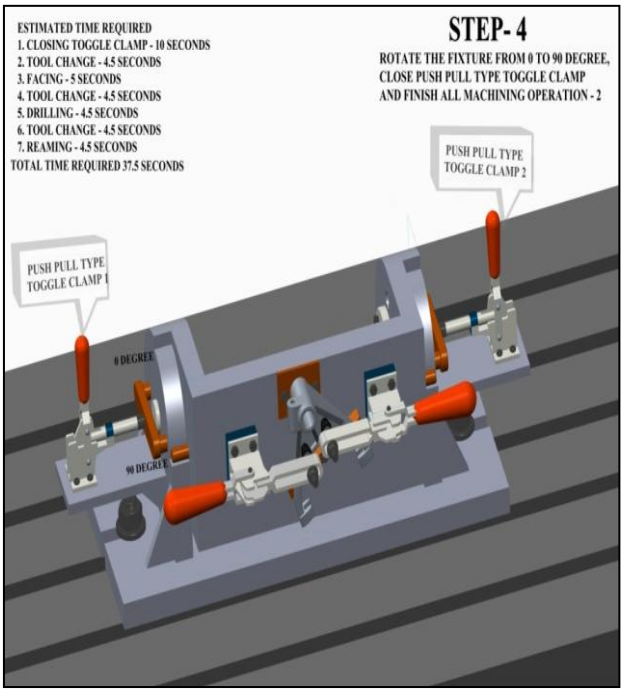

Fig. 6 Machining operation-2 done on component

This figure represents that, turning table is at 90^0 without changing the position of shifting fork. Turning table revolving from 0^0 to 90^0 and dowel pin touches to the end point of the 90^0. Shifting fork is at vertical position. Push-pull type toggle clamp is made to lock the turning table by pressing handle of it . Now machining operation are carried out on this component while selecting the proper tool as per requirement of operation , mainly three tools are selected namely as face milling cutter, small diameter drill, reamer tool etc. Using this tool common machining operation are identified as Facing, Drilling, and Reaming. The order of this operation are performed in a manner such as: 1) Facing, 2) Drilling, 3) Reaming respectively. While machining care should be taken out that door of VMC should be closed condition and no extra activity be done near by it ,due to which machine do not get heated up and remotely sense the circulated warm air.

3.5.Step 5

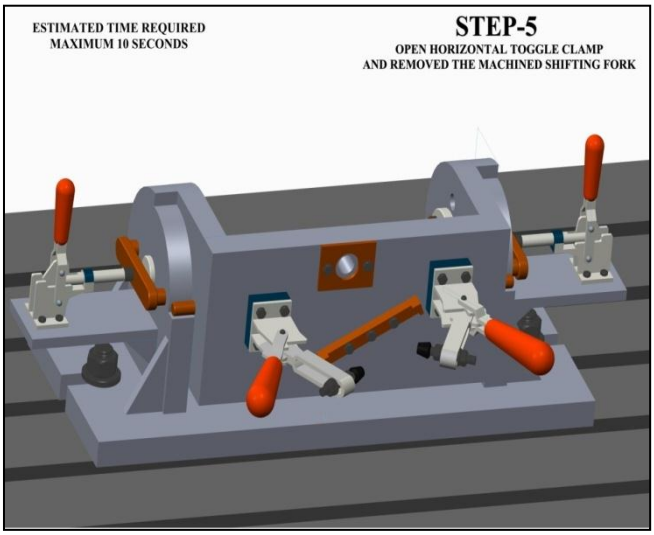

Fig. 7 Machined component name shifting fork is obtained

This figure represents that after completing the machining operation allow the horizontal toggle clamps to unlock by pressing the handle and remove the machined component named shifting fork from its position and put a new similar component in it. Repeat the procedure till production of component named shifting fork is achieved.

The next cycle is reverse to the above explained cycle. This cycle will start from 90o position and operations part-2 are done and then the table is turned to 0o and operations part-1 are done.

IV. MACHINING OPERATIONS

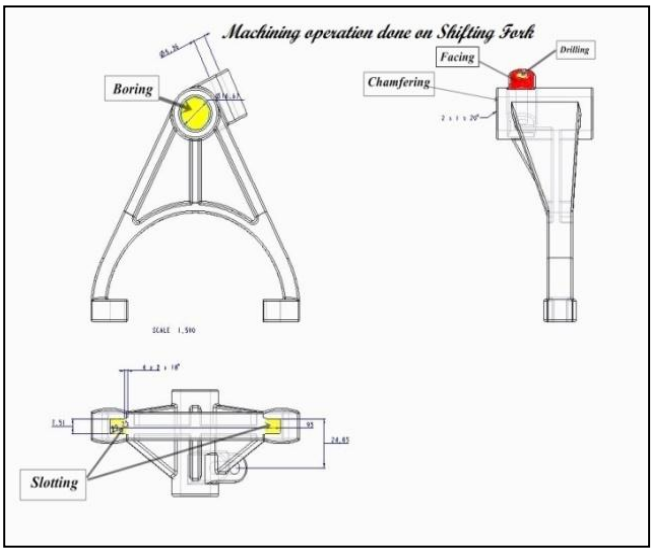

Fig. 8 Machining operation

Different Machining operation done on shifting fork is shown in (Fig. 8).Mainly list of operation followed are:
1) Drilling
2)Boring
3) Facing
4)Slotting
5)Chamfering
6)Reaming

4.1. Machine tool

A machine tool is a non-portable power operated and reasonably valued device or system of device in which energy is expended to produce jobs of desired size, shape and surface finish by removing excess material from the preformed blanks in the form of chips with the help of cutting tools moved past the work surface[1].

V.TOOLS USED FOR MACHINING

List of tools used for machining operation are:

5.1.Drilltool:

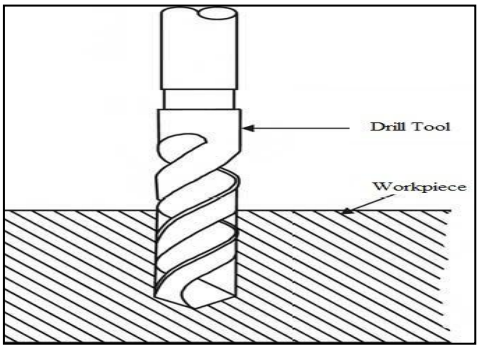

Fig. 9 Drill tool with larger diameter *[6]*

A drill is a tool fitted with a cutting tool attachment or driving tool attachment, usually a drill bit or driver bit, used for boring holes in various materials or fastening various materials together with the use of fasteners[2].

5.2. Boring tool:

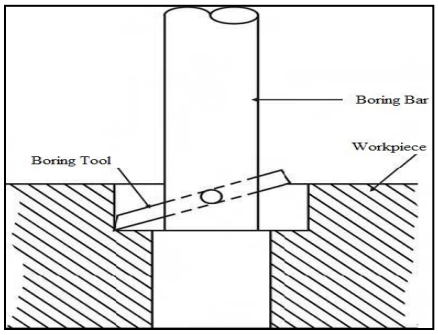

Fig.10Boring bar*[6]*

A boring bar is a tool used in metalworking and woodworking. Boring can be done on mills, lathes or drill press machines, either with a boring head or with just a boring tool[2].

5.3.Chamfer tool:

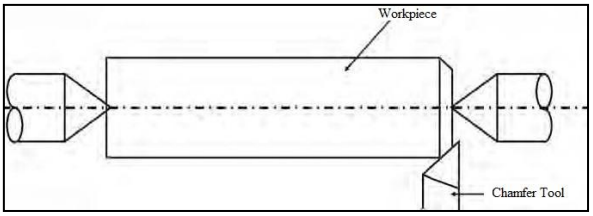

Fig.11Chamfer tool*[6]*

Chamfer is a term commonly used in mechanical engineering. Special tools such as chamfer mills and chamfer planes are available[2].

5.4. T- slot cutter tool:

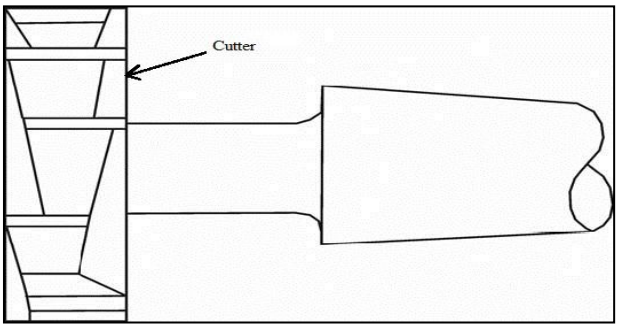

Fig.12 T-slot cutter*[6]*

This tool is helpful for cutting at the edge of Shifting Fork. Removal of material in the form of chips by a relative movement of at least one tool with a exact dimensions defined for cutting edge relative to a workpiece along a non-circular path.

5.5. Face milling cutter:

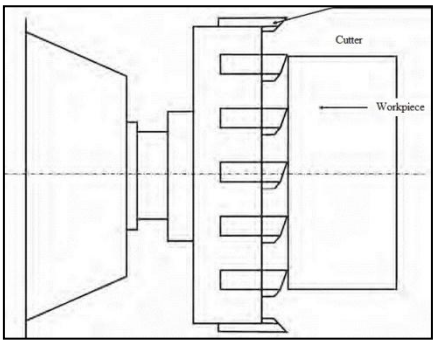

Fig.13 Face milling cutter*[6]*

Performance of face milling cutter for milling of stainless, high temperature alloys and non-ferrous materials. Used in rough and finish milling operations.

5.6. Reamer tool:

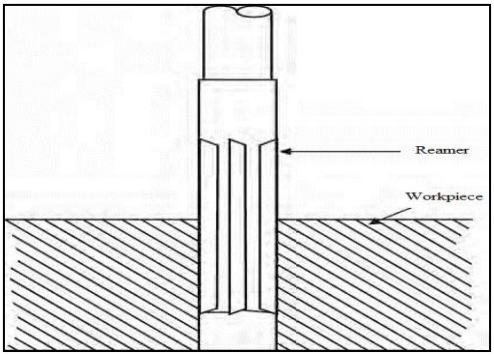

Fig. 14 Reamer tool*[6]*

A reamer is a type of rotary cutting tool used in metalworking. Precision reamers are designed to enlarge the size of a previously formed hole by a small amount but with a high degree of accuracy to leave smooth sides[2].

VI. TOOL DETAILS

6.1.Tool material

All the cutting tools used for machining operation are of cemented carbide tool. These carbide and coated carbide tools cut about 3 to 5 times faster than high-speed steels. Cemented carbide is a powder metal product consisting of fine carbide particles cemented together with a binder of cobalt. The major categories of hard carbide include tungsten carbide (WC), titanium carbide (TiC), tantalum carbide (TaC), and niobium carbide. Each type of carbide affects the cutting tool's characteristics differently. For example, a higher tungsten content increases wear resistance, but reduces tool strength. A higher percentage of cobalt binder increases strength, but lowers the wear resistance[3].

6.2.Characteristics of cemented carbides

- Speeds up to 300 fpm are common on mild steels.
- Hot hardness properties are very good.
- Coolants and lubricants can be used to increase tool life, but are not required.
- Special alloys are needed to cut steel.

6.3. Tool dimensions with obtained cycle time

Table 1. Information about Tools and its Dimensions

Operations	Tools	Dimensions	Feed Rate (mm/min)	Cycle Time (Seconds)
Boring	Drill	Ø16.5, O.L.-140, F.L.-79.722	200	18
	Boring bar	Ø16.67, O.L.-140, θ-90^0	400	9
Chamfering	Chamfer	Ø19.05,L-101.6, θ-20^0	400	2
Slotting	T-Slot cutter	W7.5, Ø35, O.L.-60	650	35
Facing	Face Milling cutter	Ø20, H-16	400	5
Drilling	Drill	Ø6.2, O.L.-80, F.L.-44	200	4.5
	Reamer	Ø6.36, O.L.-76.2, F.L.-25.4	400	4.5

Where,
Ø = Diameter
O.L. = Overall length
F.L. = Flute length
H = Height
θ = Angle

6.4. Qualified Tools

Tool which fits into a location on the machine, where its cutting edge is accurately positioned within close limits relative to a specified datum on the tool holder or slide, is known as qualified tool. The cutting tools satisfy the following requirements:
(a) Tools need not be measured individually.
(b) No presetting device is used.
(c) The dimensions of the tool holder which are fixed and known.
(d) Set up time is reduced.
(e) Control dimensions of the tool are nominal and fixed.
(f) Higher control on resharpening e.g. drills, reamers.
(g) Cutter for better size control e.g. end mills, teamers.
(h) Chip breaking facilities incorporated in tool.
(i) Improved designs[4].

VII. CYCLE TIME

7.1. Brief about Cycle Time

Cycle time is the total time from the starting to the ending of your process, as defined by you and your customer. Cycletime includes process time, during which a moduleis acted upon to bring it nearer to an output, and

delay time, during which a module of work is spent waiting to take the next action.

7.2.Prediction of Cycle time

Cycle time management and reduction (CTM) is the manufacturing philosophy that follows TQM and JIT. CTM seeks to reduce the total time required to perform all the activities that occur during order processing, design, supply management, production and distribution of a product or service[5].

Three models are developed for supporting CTM — a simple stochastic model, a Markov chain model and a queuing model. The reengineering approach is also reviewed. The models must be fitted to the manufacturing environment in which they will be used. Three manufacturing environments — make to order, assemble to order and make to stock — are described. When a CTM model is applied to a manufacturing environment it identifies the activities that represent the largest components of cycle time. Those activities are then targeted for cycle time reduction[5].

7.3. Cycle time in manufacturing the component

Minimum cycle time obtained while performing machining operation in Vertical Machining Centre (VMC) is2.52 minutes. All parameters such as tool changing time , clamping and unclamping of component, machining operation, etc. are taken into consideration and made effective work to achieve a particular machined component named shifting fork at a particular time. Mass production is made to achieve specific target at any cost.

Table 2. Cycle Time obtained from Machining Operation

Activities	Cycle Time (Seconds)
Unclamping and clamping	40
Tool Changing	31.5
Machining operations	78
Total time	149.5

VIII. PURPOSE

The purpose of this paper is to present an innovative approach for identification of machining fixtures, and their elements in an assembly and disassembly process. To achieve minimum cycle time for component named shifting fork.

IX. CONCLUSION

In this study, working of machine fixture and predicting cycle time for component made of Aluminium material was developed. Given the accuracy that was achieved it is safe to conclude that the assembly of fixture is suitable for such application. It was found that cycle time prediction correlates very well with the experimental results. And machining tools delivers the precision of surface of shifting fork. Given working obtained by the fixture assembly was designed on pattern that involves increasing the cutting rule during machining. Maximum cutting rule parameters (cutting depth for beginning and advanced) will be equal to the acceptable level of vibration. Dimensions of the tool are customising on basis of requirement.

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