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A Detailed Review on Design and Development of Fixture for Knuckle Pin Drill Operation

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Abstract: *Fixture is designed and developed to hold and support component to ensure that each is machined with accuracy. A fixture can be designed for particular job. Applicationsof Fixture is required in various industries according to their purpose. This can be achieved by selecting the location of fixturing elements such as locators and clamps. Fixture set up for component is done manually hence more cycle time required for loading and unloading material. So, there is need to develop the system which can help in improving productivity and time. Fixtures reduce the operation time and increases productivity and high quality of operation is achieved.The aim of this project is to design and development of a new fixture for machining (Drilling) operation knuckle pin. on special purpose machine (SPM). CAD model will prepared by using Creo Software and analysis will be done by using ANSYS software, which can eliminate the large machining time required. And the production rate will also increase up to 20% which is quite objective. So for that, a new hydraulic fixture is designed and observed that dimensional accuracy, increased production rate up to 20% and more output per day with drilling operation. Which defines the process is satisfactory enough and validates the project.*

Keywords: *Fixture, accuracy, productivity, ANSYS, Clamps, Locators, Supports*

I. Introduction

Fixture is used to holds and supports the work securely so that required machining operations can be perform accurately. Set blocks and feeler or thickness gauges are used along with fixtures to reference the cutter to the work-piece. A fixture should be securely fastened on the table of the machine upon which the work is done. Though largely used on milling machines, fixtures are also to do this, a fixture is designed and built to hold, support, and locate every part to ensure that each is drilled or machined within the specified limits. The difference is in the way the tool is guided to the work-piece. Fixtures vary in design from relatively simple tools to expensive, complicated devices. Fixtures also help to simplify metalworking operations performed on special equipment.

Fixture design plays an important role in the setup planning stage. Proper fixture design is difficult for developing product quality in different terms of accuracy, surface finish and precision of the machined parts. The costs associated with fixturing can account for 10–20% of the total cost of a manufacturing system. These costs relate not only to fixture manufacture, assembly, and operation, but also to their design. The costs associated with fixturing can account for 10–20% of the total cost of a manufacturing system. These costs relate not only to fixture manufacture, assembly, and operation, but also to their design.

II. Literature Review

R. Förstmanna; J.Wagner a; K. Kreisköther a; A. Kampker a; D. Busch concluded that the result of shorter product lifecycles and faster, more agile approaches for product development, production planning is facing the struggle of developing manufacturing resources with higher quality and greater variety in a shorter timeframe in order to reach time, cost and quality goals. The approach presented in this paper aims to provide a fixture concept which is developed with the objective of being an automatable design. By use of design rules which allow to be implemented in algorithms, the design freedom of additive manufacturing and construction kit elements, potentials for providing manufacturing resources arise. Next steps include the development of the underlying algorithms and the implementation of this approach into a software tool. Further research needs to be conducted regarding the transfer of this approach to more complex fixtures like those used for milling or

welding processes where stricter requirements make fixture design more complex. With this approach being implemented, manufacturing equipment such as fixtures will be provided in a short amount of time and be able to be reconfigured as needed in case of product design modifications.

Ossein Tohidia, Tarek AlGeddawyb concluded that Designing and fabricating fixtures is a significant portion of manufacturing costs which should be considered in lean manufacturing systems. By increasing products' varieties in today's competitive world, researchers will pay more attention to flexible fixture designs that can handle different workpieces with different geometries. In this paper, a hole pattern modular fixture was used in a mid-volume, mid variety production system in order to hold a variety of geometrically different products in a robotic assembly system. The modular cradle has a hole-pattern on its adapter plate for jigging-pins to be inserted. Rearrangement of pins enables fixing different product geometries. However, the larger the number of changed pins, the more the productions' lead time increases. In this study, to minimize the total number of pins which have to be changed to fix different parts, an optimization model was developed to determine the best locations for placing different products on the cradle and the best locations for inserting pins o fix them. This model enables the system to take all the possible parts' translations and rotations into consideration. To evaluate the performance and to prove the efficacy of the proposed models, three different numerical examples with different sizes were solved. The results state that the model can significantly reduce the number of pins' replacements, which reduces the fixture's associated time

Corrado Andreaa, Polini Wilmaa, Moroni Giovanni: This work proposes a conceptual demonstrator for robust design of fixture configuration considering the random error of the positions of the locators (due to the locator mounting on the machine table, the contact on irregular surface of the workpiece, etc.) and the form deviation on the surface in contact with the locators.

III. Fixture Design Processes

1. Setup planning: Determine no of setups, Determine the work piece orientation and positions, Determine machining datum features and locating surface
2. Fixture planning: Determine locating positions, Determine clamping surface, Determine clamping positions.
3. Unit design: Generate a unit design.
4. Validation: Trial manufacturing based on modifications

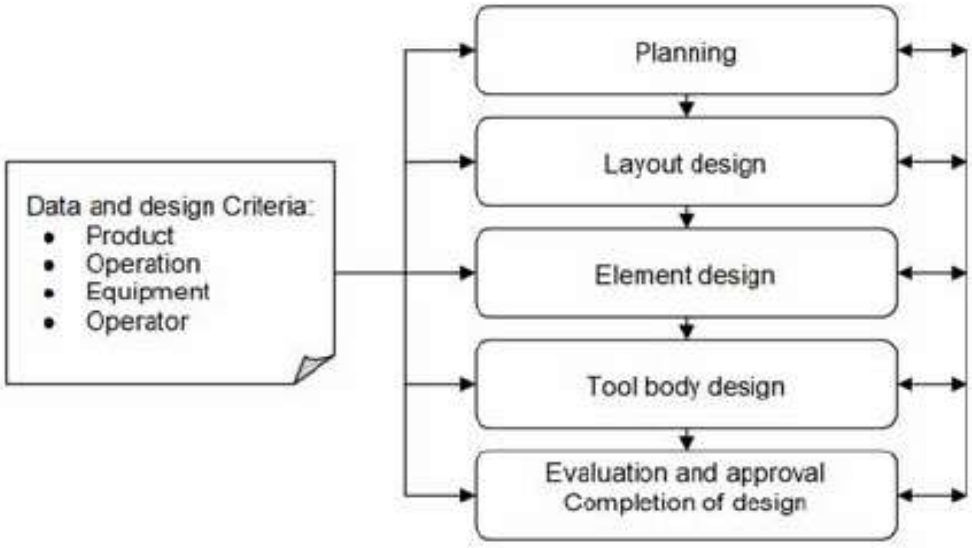

Fig-1: Fixture planning system

IV. Important Considerations While Designing Jigs And Fixtures

I. Designing of jigs and fixtures depends upon following factors:

a. Study of workpiece and finished component size and geometry.
b. Type and capacity of the machine.
c. Provision of locating devices in the machine.

d. Available clamping arrangements in the machine.
e. Available indexing devices, their accuracy.
f. Evaluation of variability in the performance results of the machine.
g. Rigidity and of the machine tool under consideration.
h. Study of ejecting devices, safety devices, etc.
i. Required level of the accuracy in the work and quality to be produced.

II. Elements of Fixtures

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, size and 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.
c) 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.
d) Fixture Body: Fixture body, or tool body, is the major structural element of a fixture. It maintains the spatial relationship between the fixture elements mentioned above, viz., locators, clamps, supports, and the machine tool on which the part is to be processed

V. Meaning of Location

The location refers to the establishment of a desired relationship between the workpiece and the jigs or fixture correctness of location directly influences the accuracy of the finished product. The jigs and fixtures are desired so that all undesirable movements of the workpiece can be restricted. Determination of the locating points and clamping of the workpiece serve to restrict movements of the component in any direction.

VI. Clamping

To restrain the completely job has clamping device is required. In clamping device workpiece hold securely strengths applied over it during the operation. Proper clamp in influence the accuracy and quality of the work done and directly cycle time

VII. Finite Element Analysis

The finite element method is numerical technique, well suited to digital computers, which can be applied to solve problems in solid mechanics, fluid mechanics, heat transfer and vibrations. The procedure to solve problems in each of these fields is similar in all finite element models of the domain (the solid in solid mechanics problems) is divided into a finite number of elements.

a. Basic Steps of Finite Element Method

- Discretization of the continuum
- Selection of key points
- Choose proper field variables
- Generating the system of equations
- Globalizing the system equations
- Solution to the system equations to obtain the unknown field variables
- Computation of element variable or secondary field variables

VIII. Introduction to Annoys

ANSYS is used to perform the following tasks.

- Apply operating loads or other design performance conditions.
- Study physical responses, such as stress levels, temperature distributions or electromagnetic fields.
- Optimize a design early in the development process to reduce production costs.

IX. Objectives

1. The objective of the project is to extends the features of VMC and SPM
2. Process planning, reducing cycle time and designing fixture for machining operation
3. Increasing productivity up to 15-20%
4. Critical component of fixture is analysed using FEA.

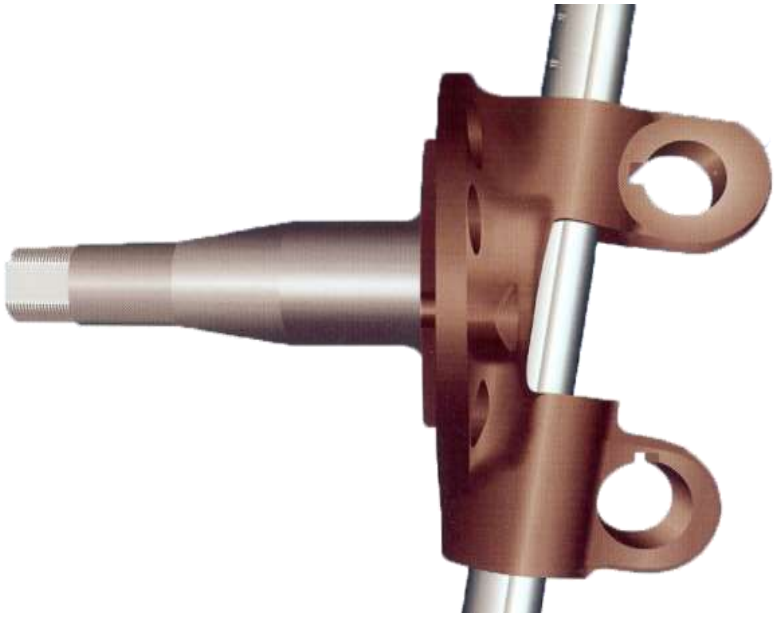

Fig 2. Knuckle-Pin Diagram

X. Scope of Work

[1] Currently we are developing such fixture for manufacturing of knuckle pin drill operation on SPM for machining axle of ASHOK LEYLAND- DOST, In which knuckle having inclination angles (9.5 to 11.5 degree) due to this angles it is time consuming to machine on VMC

[2] Due to designing this new fixture for SPM, large cycle time is reduced as compared to conventional VMC and by taking this advantage we can increase the productivity up to 20% and also product is manufactured precisely

[3] In future by just increasing the size of fixtures as per knuckle size, we can machine any vehicles axles

Fig 3. Knuckle of Ashok Leyland- DOST

XI. Conclusion

The efficiency and reliability of the fixture design is increased by the system and the result of the fixture has made more reasonable. To reduce cycle time required for loading and unloading of workpiece, this approach is useful. Modern new CAE, CAD are used in designing the systems and significant improvement can be assured. To fulfil the multi-functional and also high performance fixturing requirements design optimum approach can be used to comprehensive analyze and to determine the optimal design overall. Optimization

method based one optimal fixture layout could minimize the deformation (distortion) and uniform the most effectively.

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