# A Study On Design Of Fixture For Valve Body For VTL Machines

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**Abstract: Fixture is required in various industries according to their application. It is designed and built to hold, support and locate every component to ensure that each is drilled or machined with accuracy and manufactured individually. The fixture designing and manufacturing is considered as complex process that requires the knowledge of different areas, such as geometry, dimensions, tolerances, procedures and manufacturing processes. This paper will give brief overview about the 3-2-1 locating principle to design the fixture for complex parts and other clamping principles. This paper also gives the idea and procedure for fixture design. This paper gives the idea about the modular fixture and dedicated fixture**.

***Keywords — applications, clamping principles, locate, modular fixtures, tolerances, 3-2-1 principles.***

## I. INTRODUCTION

Over the past century, manufacturing has made considerable progress. New machine tools, high-performance cutting tools, and modern manufacturing processes enable today's industries to make parts faster and better than ever before. The work holding methods have also advanced considerably, the basic principles of clamping and locating are still the same. Mass production methods demand a fast and easy method of positioning work for accurate operations on it. Jigs and fixtures are production tools used to accurately manufacture duplicate and interchangeable parts [1]. Jigs and fixtures are specially designed so that large numbers of components can be machined or assembled identically, and to ensure interchangeability of components [1] [2] [3]. The economical production of engineering components is greatly facilitated by the provision of jigs and fixtures.

The use of a jig or fixture makes a fairly simple operation out of one which would otherwise require a lot of skill and time. Both jigs and fixtures position components accurately; and hold components rigid and prevent movement during working in order to impart greater productivity and part accuracy. Jigs and fixtures hold or grip a work piece in the predetermined.[4]

## II. LITERATURE SURVEY

1) A Review on Design of Fixtures. International Journal of Engineering Research and General Science Volume 2, Issue 2, Feb-Mar 2014 ISSN 2091-2730. S. S.Pachbhai, L. P.Raut

The requirement of the fixture is minimizing deformation of work piece. With the help of fixture operation time is considerably reduce and machining become easy. Fixture is also beneficial for reducing cycling time and increasing production rate. There are various methods of clamping used for different type of applications. The various types of location methods are

1) Flat locator
2) Jack pin locator
3) Drill bush locator
4) V- locators

2) **"**Design & Development of Rotary Fixture for CNC**",** International Journal of Engineering Science Invention ISSN, Volume 1 Issue 1 ǁ December. 2012 ǁ PP.32- 43 N. P. Maniar**,** D. P. Vakharia

The research work also proposes Computer Aided Mass Balancing Method (CAMBM) which ease fixture designer from tedious and time consuming work of finding offset

 

distance and C.G. of irregular shape parts and also solving mass balancing problem. Two alternate methods of Computer Aided Mass Balancing Method are presented and VIII Quadrant Computer Aided Mass balancing Method is found more accurate with the result of decrease in percentage error by almost 6% in comparison to IV Quadrant Computer Aided Mass Balancing Method.

### *A. Principles of location*

The principle of location is being discussed here with the help of a most popular example which is available in any of the book covering jigs and fixtures. It is important that one should understand the problem first. Any rectangular body many have three axis along x-axis, y-axis and z-axis. It can more along any of these axes or any of its movement can be released to these three axes. If the operation to be done on the cylindrical object requires restriction of the above mentioned free movements also than some more locating provisions must also be incorporated in addition to use of the V-block. It consists of two parts:

1. For the first time he evaluated varying contact forces and work piece position errors in each clamping step by using. This is done by minimizing the total complementary energy of the work piece-fixture system. The prediction proves to be rigorous and reasonable after comparing with experimental data and referenced results.

2. The optimal clamping sequence is identified based on the deflections of the work piece and minimum position error. [1]

## III. TYPES OF FIXTURES

### *1. Plate Fixtures*

Plate fixtures are constructed from a plate with a variety of locators, supports and clamps. They are the most common type of fixture because their versatility makes them adaptable to a wide range of machine tools. They are made from many different kinds of materials, which are governed only by the part being machined and the process being performed.

### *2. Angle-Plate Fixtures*

Angle-plate fixtures are a modification of plate fixtures. In this type a surface is set perpendicular to the mounting surface instead of parallel in the case of plate fixtures.

### *3. Vise-Jaw Fixtures*

Vise-jaw fixtures are modified inserts for vises designed to accommodate a particular work piece. These fixtures are the least expensive and simplest to modify. The only limitations to these types of fixtures are size of the part and capacities of available vises.

### *4. Indexing Fixtures*

Indexing fixtures are used to reference work pieces that need machining details set at prescribed spacing. Indexing fixtures must have a positive means to accurately locate and maintain the indexed position of the par ical and/or research content/depth, correctness, relevance to Journal, contributions, and readability. The full paper submissions will be chosen based on technical merit, interest, applicability, and how well they fit a coherent and balanced technical program.

### *5. Multi-Part or Multi-Station Fixtures*

Multi-part or multi-station fixtures are normally used for either machining multiple parts in a single setup, or machining individual parts in sequence with the performing different operations at each station.

### *6. Milling Fixtures*

Milling fixtures are the most common type of fixture. It includes standard vises and clamps. However, as the work piece size, shape and complexity become more sophisticated so does the fixture. Tombstones, which are commonly used on horizontal machining centers, come in a wide variety of configurations to hold multiple parts on up to four sides of the fixture. The t-slots of the machine table are standardized in size and spacing and are the primary used for holding work and fixture devices for machining. Fixtures are typically mounted to the table with a variety of accessories like clamps, jacks, t-slot bolts, straps and nuts.

### *7. Lathe Fixtures*

The same basic design principles that apply to milling fixtures also apply to lathe, or turning, fixtures, with one major difference. In most milling operations, the cutting tool rotates during machining, while with turning the part rotates. This situation creates another condition the tool designer must deal with - centrifugal, or rotational, force. Work holding devices include two to six jaw chucks and collets of varying shapes and diameters. Work may also be held between the head and tail stock of the lathe or "between centers."

### *8. Grinding Fixtures*

The two major types of grinding fixtures are available for surface grinding and cylindrical grinding. The magnetic table is the preferred work holding device on surface grinders. Cylindrical grinding is usually a secondary operation after turning. Often the same center holes used for between-centers turning may be used for grinding the part. In this case, the friction is more as compared to other processes, so fixture design must allow for coolant flow and swarf removal.

*9. Broaching Fixtures*

Broaching fixtures hold and locate the part in relation to the broaching tool. Internal and external broaching is available with the different approaches to their respective designs.

 

Internal broaching requires less clamping because the process tends to keep the part firmly seated on the fixture where as external broaching requires resistance to both pull and push forces that are exerted on the part, requiring more sophisticated fixtures. [6]

## IV. DESIGN OF FIXTURES

### *A. Important considerations*

Designing of jigs and fixtures depends upon so many factors. These factors are analyzed to get design inputs for jigs and Fixtures.

The list of such factors is mentioned below:

a. Study of work piece and finished component size and geometry.
b. Type and capacity of the machine, its extent of automation.
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. [1]

### *B. Fixture design principle*

Fixture design is one of the most important design tasks during process design for a new product development since it involves defining the locations and orientations of parts during assembly processes as well as providing physical support, which can greatly affect product dimensional variations and process yield.

1. The 3-2-1 Principle

As we know that any free body has a total of twelve degrees of freedom as below:
6 translational degrees of freedom: +X, -X, +Y, -Y, +Z, -Z 6 rotational degrees of freedom:

Clockwise around X axis (CROT-X)
Anticlockwise around X axis (ACROT-X)
Clockwise around Y axis (CROT-Y)
Anticlockwise around Y axis (ACROT-Y)
Clockwise around Z axis (CROT-Z)
Anticlockwise around Z axis (ACROT-Z)

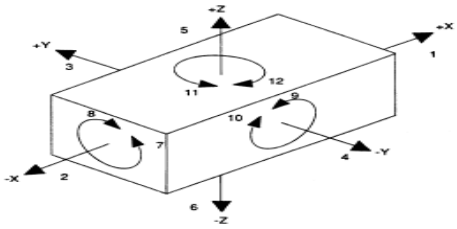


**Fig 1.Degrees of Freedom**

So we must fix all the 12 degrees of freedom except the three transitional degrees of freedom (-X, -Y and -Z) in order to locate the work piece in the fixture. Usually, supporters and locators restrict 9 degrees of freedom of the work piece need to be fixed, with the remaining 3 degrees of freedom by clamps.

Further the 3-2-1 principle is stated as below:

The work piece is rested on three non-collinear points of the bottom surface (XY), and you will be able to fix the +Z,CROT-X,ACROT-X, CROT-Y and ACROT-Y degrees of freedom. Now, rest the work piece at two points of side surface (XZ), and you will be able to fix the +Y and ACROT-Z degrees of freedom. Next, rest the work piece at one point of the adjacent surface (YZ), and you will be able to fix the +X and CROT-Z degrees of freedom. So, we can fix 9 required degrees of freedom by using the 3-2-1 principle of fixture design.[8]

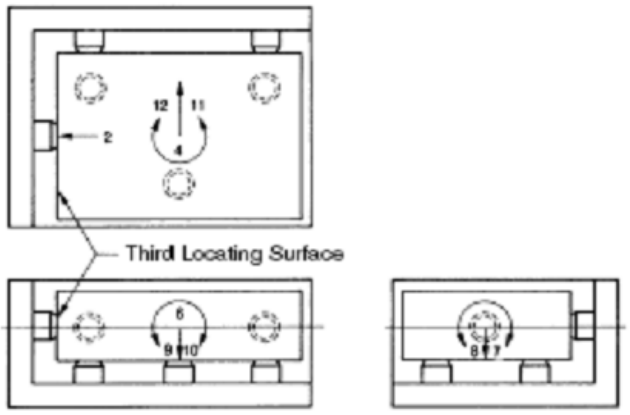


**Fig 2. 3-2-1 Principle**

### *C. Clamping principle*

Clamping is used to restrict the possible movement of a work piece usually three (-X, -Y and -Z) degrees of freedom that is not bounded by locators and supports. The general clamping principles are discussed below according to the clamping direction with respect to the work piece set up.

#### *1. Horizontal Clamping*

A horizontal clamp is applied on the "horizontal clamping face" which has not been used as the locating face. Also, the

 

clamp is located on the side of the work piece that is opposite to the second or third datum face in order to resist the locating force. If the horizontal clamping faces are non-planar faces, multiple horizontal clamps can be applied on one face to ensure the restriction of the movement.

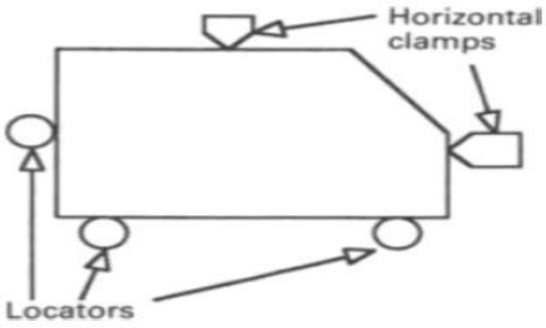


**Fig 3.Horizontal Clamping**

### *2. Vertical Clamping*

A vertical clamp is applied on the "vertical clamping face", which is a face that is the top surface of the work piece and is on the opposite side of the work piece to the first datum plane. The most rigid area is used as the clamping position to prevent cracking or bending during the machining process. So, locating the vertical clamp on the area directly above a vertical support is the most secure vertical configuration.[6]

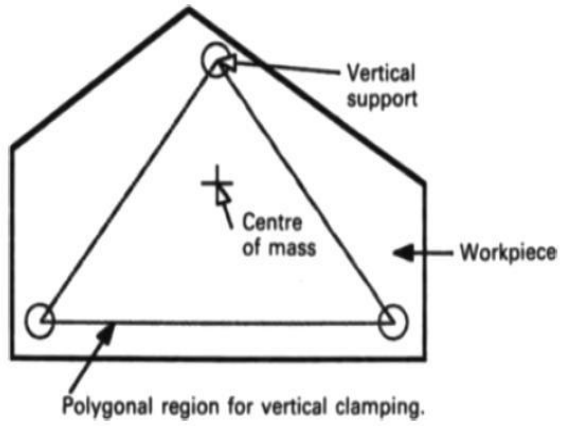


**Fig 4.Vertical Clamping**

### *D. Fixture design process*

Fixture design includes the identification of clamps, locators, and support points, and the selection of the corresponding fixture elements for their respective functions. There are four main stages within a fixture design process-

(i)Setup planning,
(ii)Fixture planning,
(iii)Fixture unit design
(iv)Verification

Setup planning determines the number of setups required to perform all the manufacturing processes, the task for each setup, e.g., the ongoing manufacturing process and work piece, orientation and position of the work piece in each setup. A setup represents the combination of processes that can be performed on the work piece by a single machine tool without having to change the position and orientation of the work piece manually.

During fixture planning, the surfaces, upon which the locators and clamps must act, as well as the actual positions of the locating and clamping points on the work piece, are identified. The number and position of locating points must be such that the work piece is adequately constrained during the manufacturing process. In the third stage of fixture design, suitable units, (i.e., the locating and clamping units, together with the base plate), are generated. Verification focuses upon ensuring that developed fixture designs (in terms of their setup plans, layout plans, and physical units) satisfy the desired requirements. Verification takes place against the tolerance, constraining, collision detection, usability, and affordability requirements. [6]

## V. CONCLUSION

We can conclude that for designing the fixture the geometry method i.e. 3-2-1 principle is very useful & is of prime importance for the complex component having various machining processes though it is the basic principle of the fixture design. To reduce the cycle time required for loading and unloading of part, the principle is useful. In addition to the principles for fixture design, CAE, CAD is used in designing the systems then significant improvement can be assured. Fixture layout and clamping forces optimization method could further minimize the deformation and uniform the deformation. An operator working becomes 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. Variability of dimensions in mass productions is very low so manufacturing processes supported by use of jigs and fixtures helps to maintain consistent quality if work.

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