Development of motor body fixture using blackboard framework approch

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Abstract:-

An approach based on blackboard frame work techniques is proposed to develop an automated fixturing system that can interpret the semantic information of features of a 3-D object, created in a computer-aided design system, and suggest the possible clamping conditions on the object. This paper reports the preliminary work that investigates the suitability of using a blackboard framework as a problem-solving model to realize such a system. This system is developed for the development of motor stator body fixture for HMC machine. With help of this system designer can easily design and manufacture new fixture for motor stator body.

Keywords: - Fixture development, Fixture principle, Black-board framework.

Introduction

A key concern for manufacturing companies is developing the ability to design and produce a variety of high quality products within short timeframes. As a result of the consumer desire for variety, batch production of products is now more the norm than mass production, which has resulted in the need for manufacturers to develop flexible manufacturing practices to achieve a rapid turnaround in product development [A-D]. Fixtures are used to rapidly, accurately, and securely position workpieces during machining such that all machined parts fall within the design specifications for that part. This accuracy facilitates the inter-changeability of parts that is prevalent in much of modern manufacturing where many different products feature common parts [E-F]. Fixture design is a complicated, experience based process which needs comprehensive qualitative knowledge about a number of design issues including workpiece configuration, manufacturing processes involved, machining environment, etc [C]. Various computer-based systems have been developed in recent years to achieve automation of the fixture design process. These systems use different knowledge sources (KSs), methodologies and system platforms to form a fixture design problem-solving model, and are able to propose feasible fixture configurations only. In a real it is expected that the embedded fixture design system should be able to deal with any generic fixture design process so that a complete automation of the overall manufacturing process is possible [I]. To achieve this, it is required to provide an appropriate fixture design environment which fosters communication between various KS (experts) Involved in the fixture design process [J-K].

Fixture development

Fig. 1 represents a typical example of a fixture in which the workpiece rests on locators that accurately locate it. Clamps hold the workpiece against the locators during machining thus securing the workpiece's location. The locating units themselves consist of the locator supporting unit and the locator that contacts the workpiece. The clamping units consist of a clamp supporting unit and a clamp that contacts the workpiece and exerts a clamping force to restrain it.

Typically the development process by which such fixtures are created has four phases: setup planning, fixture planning, unit design, and verification, as illustrated in Fig. 2. There has been a considerable amount of research conducted with regard to the development of CAFD approaches and subsequent software implementations of those tools. In particular, CAFD research has focused upon setup planning, fixture planning, and verification, in which fixture planning and verification have been closely integrated with respect to minimizing workpiece deformation by controlling the locating and clamping positions.

Recent successes in artificial intelligence (AI), together with increased availability of expert systems development tools, have spurred much interest in the application of AI techniques to develop intelligent fixture design systems. Darvishi and Gill developed a fixture design system with a rule-based knowledge representation database in the OPS5 environment. Their system attempts to utilize the existing expertise in the evolution of a logical automated approach towards the fixture design.
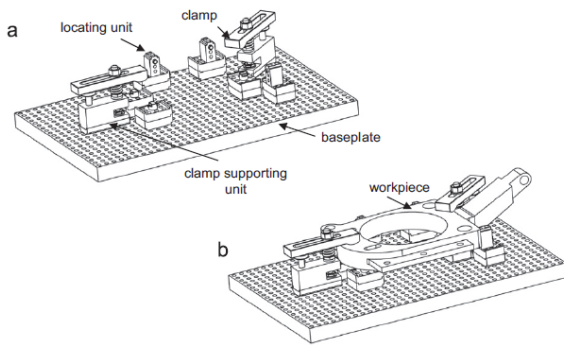
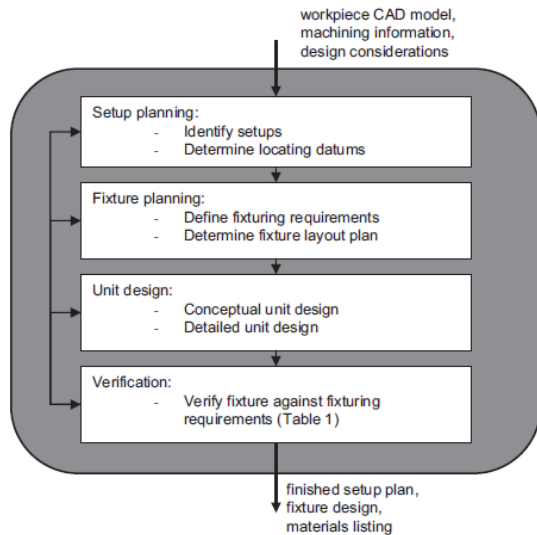Fig. 1. A typical fixture (a) without and (b) with a workpieces[2].

Fig. 2, The fixture design process[1]

Blackboard based design system

The blackboard system consists of three major components: the KSs, the blackboard data structure and the control structure. Other than the core blackboard module developed in GBB's environment, the system also consults with other supporting modules residing in ICAD's Concept Modeler and in I-DEAS as shown in Fig. 3 in its decision making processes. The different components of the system framework are described in the following subsections.

1. Knowledge sources (KSs)
2. Design heuristics.

3. Fixturing stability.
4. Processing stability
5. Fixturing accessibility.
6. Deformation.

Blackboard data structure

Referred to usually as the 'blackboard', it provides a hierarchical organization of global state data. It records and organizes the solution elements generated during the problem solving process. The KSs produce changes to the blackboard that lead incrementally to a solution, or a set of acceptable solutions, to the problem. Interaction among the KSs takes place solely through changes on the blackboard.

Fig. 2 illustrates an example of a hierarchical, blackboard data structure created in GBB. There are two basic components in the blackboard structure, spaces e.g., locations and clamps., and *units* e.g point and event. Spaces divide the whole blackboard data structure into tree-like directories for residing objects called units. The spaces and units in a blackboard structure are like directories and files in a file system. The properties of units are determined by their various attributes, or slots e.g., name, link, path, x, y, and z coordinates, etc. During the problem solving process, information resident in slots associated with objects (units) on one level serves as input to a set of KSs, which place new information on the same or other levels in turn. The objects and their properties define the vocabulary of the solution space.

Fixture layout

Fixture is the component which will locket, clamp a workpiece and retain the position of the workpiece at the time of machining. Fixtures are used to rapidly, accurately, and securely position workpieces during machining such that all machined parts fall within the design specifications for that part. Machining of Motor stator body is a very complicated process due to its wall thickness and geometry. So the development of fixture for motor stator body is needs lots of experience and knowledge about the body. As we are planning a multiple motor series machining changing one or two component in fixture assembly.

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Table 1. *Motor Body Dimensions*

Motor Body	Bore	Tolerance	Total length	Tolerance	Spigot O.D	Tolerance	Spigott Length	Tolerance	I.D.	Tolerance	I.D. length	Tolerance
ABB-315 SM	520.500	0.050	640.000	0.300	536.000	0.022	4.000	0.100	521.000	0.200	100.000	1.000
ABB-315 ML	520.500	0.050	700.000	0.300	536.000	0.022	4.000	0.100	521.000	0.200	100.000	1.000
ABB-280	445.500	0.050	612.000	0.100	460.000	0.022	4.000	0.100	446.000	0.100	135.000	1.000
Siemense 7015	389.950	0.050	495.000	0.300	395.000	0.036	10.000	0.100	391.000	0.300	28.000	1.000
Siemense 7016	434.920	0.060	555.000	0.400	440.000	0.040	10.000	0.100	436.000	0.600	28.000	1.000
Siemense 7017	489.920	0.070	625.000	0.400	495.000	0.040	11.000	0.100	491.000	0.500	32.500	1.000
CG-225	368.350	0.050	405.000	0.100	371.060	0.060	12.000	0.100				
CG-250	394.090	0.040	440.000	0.100	395.280	0.050	10.000	0.100				
CG-280	419.150	0.050	580.000	0.100	428.620	0.050	10.000	0.100				
CG-315	469.800	0.050	620.000	0.100	470.530	0.060	10.000	0.100				
BBL-280	439.980	0.070	545.000	0.250	452.000	0.060	10.000	0.100	440.200	0.500	100.000	1.000
BBL-315	499.980	0.070	790.000	0.250	512.000	0.060	8.000	0.100	500.200	0.200	135.000	1.000

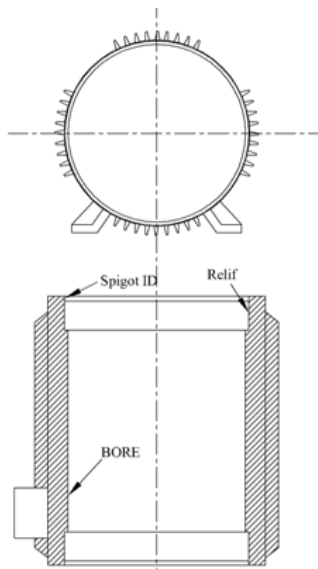*All Dimension are in mm.

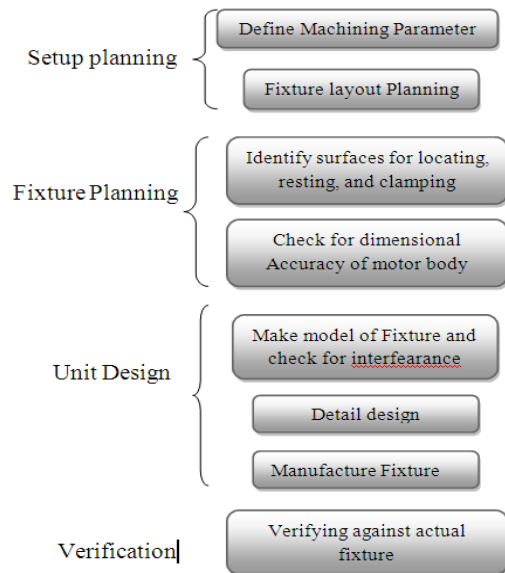*Fig. 3 Motor stator body*

Fig. 4 Fixture Development Process

Following parameter are useful for fixture design :

- Locating position
- Resting position
- Clamping position
- Machining reference position
- Accuracy of machined parts
- Material of the workpiece
- Weight of workpiece

Main surfaces of the motor stator body are as shown in the fig, which can be used for the locating, clamping and resting during HMC machining process. A steps for fixture development process is as given in the fig. 4.

From the motor body dimension as per given in the Table 1. We can easily find out the locating, resting and clamping surfaces which will give best support during machining operation.

Locating position

We are studied many motor stator body drawing for the finding such position for similar location. We have found following locating surfaces in motor body:
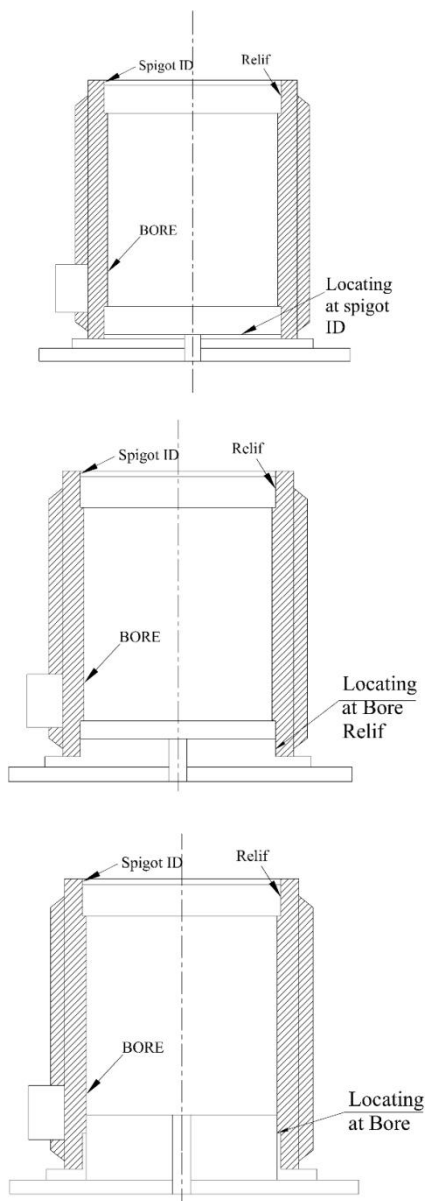
- At Spigot ID
- At finished bore
- At bore relief ID

Fig. 5. *Possible locating position*

These three surfaces we can use for location. Where in a spigot just 10 mm space available for locating and this spigot has accuracy is within 0.050mm. While finished bore has accuracy is within a 0.050um and we can us up to 100mm depth for locating. And for the bore relief is accuracy is 0.5mm and available depth is around 100mm.

Resting position
We can use a resting position as below
- Bore start
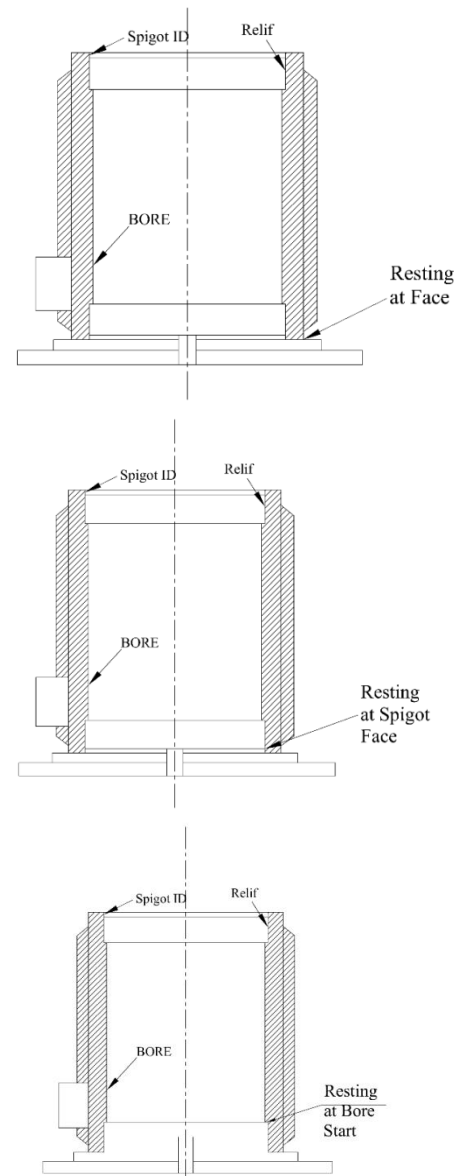- Face of motor body
- Bore Relief start

Fig 6. *Possible resting position*

This three reference can identify as the resting position. A bore start is a point where bore is starting and the thickness of that part is half of diametrically difference between bore and bore relief diameter. This thickness is very low and is about 0.5 to 5mm max. There for it isn't provide good support for the workpiece resting. Face of a motor body give good surface for resting position and it is around 50mm. so a good support is provided by the face during machining operation. A face is finished surface and it's flatness is controlled within 0.050mm. Due to large surface area in contact with fixture surface, frictional resistant helps to provide stability against cutting force. A bore relief start has very low thickness and it is about half of the diametrically difference between relief is and spigot ID which is around 10 to 15 mm maximum. Therefore that such surface area is very low to give a support to a whole motor body.

Clamping position

As per the 3-2-1 fixture principle clamping position of any component should be perpendicular to the resting position so the clamping force can be directly transferred to the resting pad. This clamping position also reduce deformation of component during clamping position. We can identify much more clamping position for motor stator body as motor body arrives but the clamping posing should not be a position where a cutting tool path is obstructed. This position can be identified by viewing the drawing. But top face is very useful for the clamping. A top surface is machined surface and it is good for the clamp resting. Upper top surface is machined so it can transfer whole lode to the resting pad without deforming the body.

Conclusion

Motor stator body is very complicated part due to its dimensional accuracy and thin wall thickness. Lots of series available in motor stator body and all are very similar to its feature configuration with dimension changes. So we can easily make fixture which can be used for multiple motor body with changing one or two component in fixture assembly. With help of blackboard approach fixture development process can be accomplish easily and within a short duration.

Referance

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