Aspects of Reconfigurable Fixtures and Barriers in Their Implementation

Vasdev Malhotra  
Associate Professor  
Department of Mechanical Engineering  
YMCA University of Science and Technology, Faridabad, Haryana

Nitin Dixit  
P.G. Scholar  
YMCA University of Science and Technology, Faridabad, Haryana

Himani Gautam  
P.G. Scholar  
YMCA University of Science and Technology, Faridabad, Haryana

Abstract

Fixture is used to hold a workpiece in the desired position and orientation during manufacturing, assembly, welding or any other machining process. Conventional fixtures need to be redesigned and remanufactured for every new product or process. So there is a need for a special workholding device like reconfigurable fixtures which can be used to hold a variety of workpieces or to hold the workpiece in different orientations. But, implementation of such fixtures is not an easy task as a number of barriers affect their implementation. The paper presents a brief introduction to the reconfigurable fixtures and barriers in the implementation of such fixtures.

Keywords: Reconfigurable Fixture, Barriers, Conventional, Implementation

I. INTRODUCTION

The main purpose of a fixture is to locate and in some cases hold a workpiece during either a machining operation or some other industrial process. Custom-oriented dedicated fixtures are not only time-consuming and costly to build, but they also do not have the flexibility to deal with parts or assemblies of different shapes and sizes. The reconfigurable fixturing system should possess the ability to accommodate parts of various shapes and sizes.[5] Therefore traditional fixtures have been required to be redesigned and remanufactured for every new product or manufacturing operation. These types of fixtures are economical in mass production only but in small batch production it results in long lead time and high manufacturing cost. Therefore for small batch production, reconfigurable fixtures are used to avoid these problems. Reconfigurable fixtures have been designed for a family of workpiece geometries and manufacturing operations. These types of fixtures are suitable for batch production and job shop environments where they can be used for different products.[2]

II. DESIGN REQUIREMENTS OF RECONFIGURABLE FIXTURES

In designing a fixture, a number of factors are considered. These factors are analysed to get design inputs for fixtures. Factors such as workpiece and finished component size and geometry, type and capacity of the machine, its extent of automation, provision of locating devices in the machine, available clamping arrangements in the machine, required level of the accuracy in the work and quality to be produced are considered while designing a fixture.[7] The additional design requirements for reconfigurable fixtures are:

- Modularity: the fixture must be composed of standard modules, which can be assembled on a baseplate
- Automatic reconfigurability: the fixture must automatically reconfigurable
- Sensory feedback controllability: the fixture components must be integrated with sensors for feedback controllability
- Programmability[2]

III. COMPONENTS OF A RECONFIGURABLE FIXTURE

A. Base Plate:

Two types of base plates are generally used hole type and T-slot type. These are used to locate the modular components of fixture in desired position.
B. Locators:
Statically positioned elements with no actuation ability, used to locate the workpiece in a desired position and orientation.

C. Clamps:
Statically positioned elements with actuation ability, used to exert the forces that securely hold the workpiece in its position.

D. Supports:
Statically positioned elements with no actuation ability, used to locally reduce the elastic deformations experienced by the workpiece due to the loads applied by the manufacturing process. They can also improve the stability of the fixture workpiece system.[3]

IV. BARRIERS IN IMPLEMENTATION OF RECONFIGURABLE FIXTURES

The implementation of reconfigurable fixtures in an industry is not an easy task; there exist a number of barriers which affect their implementation. Such factors are as follows:

A. Expensive Tooling:
Cost is always an issue in manufacturing and in the choice of equipment, and cost is included in the flexibility concept, as the system’s flexibility is dependent on how easily the system can transition from one stage to another. Various expenses associated with the Reconfigurable fixtures are designing expenses, manufacturing expenses, operation and maintenance expenses. The reconfigurable fixtures also include the use of sensors, controller and sometime method of reconfiguration also automatic i.e. to use the robot as method of reconfiguration. These all include a huge cost and thus make the system expensive.[4]

B. Type of Production:
Conventional fixtures are only capable of holding single type of workpiece, so they need to be redesigned and remanufactured for every new product or new machining process and thus are used for the mass production since they are economical in mass production. The reconfigurable fixtures consist of standard modular components like base plate, locators, and clamps so these can be reconfigured as per need of component and as per need of the process. Thus reconfigurable fixtures are best to use for small batch production because the use of conventional fixtures for small batch production cause long lead times and high fixture manufacturing cost in small batch production.[2]

C. Human Errors:
Manual settings of reconfigurable devices are generally done by pushing, pulling or tapping like clamping processes. The reconfiguration of such fixtures to an accurate position suffered from the weakness and compliance of human body. High accuracy using such a method is therefore not feasible. The manual setting of the fixture is also time consuming which leads to long setup time and thus increase the idle time of machine and decrease the production rate. Also the operator must be aware about various configuration of the fixture so as to locate the components of fixtures to different positions error free.[9]

D. Complex System:
Reconfigurable fixtures consists a variety of components such as locators, v-block, and clamps assembled on a baseplate. They are reconfigurable according to product design or manufacturing operation changes. The additional design requirements for reconfigurable fixtures are:
- Modularity
- Automatic reconfigurability
- Sensory feedback controllability
- Programmability, all these makes the reconfigurable fixture a complex system.[2]

E. Top Management Support:
Top management support is vital for any successful project completion. Top management support is needed for budgeting, for providing funding and suitable resources to project team and create conducive organization. Thus implementation of reconfigurable fixture needs top management support.

F. Difficult Operational Control:
For the working of the reconfigurable fixture there is need of separate system software by using which the operator can control the operations of fixture through a PC-based control system. This will need a data base system to store all relevant process parameters for each work piece, a graphical user interface guiding the operator through reconfiguration sequence and a series of communication interfaces to the controllers of the actuators on which the force profiles of clamps are stored. This all will require a good knowledge of software and makes the operation control difficult.[6]
G. Equipment Availability:
Available equipment determines whether the work holder is designed for single or multiple parts. A process engineer sometimes selects the equipment for required functions before the tool designer begins the design. Still, the tool designer should verify equipment choices for each operation. So to implement a reconfigurable fixture in an organization there is need of the special machine tool. Typically, equipment criteria include the following factors: types and sizes of machine tools, inspection equipment, scheduling, cutting tools, and general plant facilities. Thus the equipment consideration also affects the implementation of the reconfigurable fixture.[8]

V. CONCLUSION
In this paper we presented the aspects of reconfigurable fixtures and barriers in the implementation of reconfigurable fixtures. The management should consider all these aspects and see the barriers for the successful implementation of reconfigurable fixtures in industry.

REFERENCES