A Review on Fixture Design for Connecting Rod

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Abstract—Fixtures are widely used in industries for machining, assembly, welding and inspection. The fixture designing and manufacturing is recognized as complex process and requires the information of distinctive zones, like example, Geometries, Dimensions, Tolerances, Procedures and Manufacturing methods. This study is about the 3-2-1 principle of fixture design and the diverse methodologies which are utilized within the related fixture design and illustrated for connecting rod. This principle of the study provides for us the thought and way that what are the further steps and work plan for the fixture design for connecting rod.



Fig 1 Degrees of freedom **Keywords:** Fixture, 3-2-1 principle, Connecting rod.

I. INTRODUCTION

A Fixture is a device which used in manufacturing to hold a work piece, position it correctly with respect to a machine tool, and support it. During manufacturing operations such as machining, inspection and assembly. Fixtures provide a means to reference and align the cutting tool to the work piece but they do not guide the tool. Fixtures have direct impact upon product quality, productivity and cost. Fixture devices includes Various standard clamps, chucks, and vises, Metal plates containing dowel and or tapped locating holes or key slots and dedicated fixtures with specific design and build requirements. Fixtures accurately locate and secure a part during machining operations such that the part can be manufactured to design specifications. To achieve accurate tolerances and reduce the machining time of connecting rod associated with fixturing. Much research has been directed towards developing systems that determine an optimal fixture plan layout of connecting rod, but there is still a need to develop method that can continue to assist designers at the unit level where the key task is identifying the appropriate structure that the individual units comprising a fixture should take. The development of a fixture of connecting rod that achieves accurate tolerances and reduces the machining time. The approach taken is to consider all operational requirements of a fixture problem, and use them to guide the design of a fixture at the unit level. Case adaptation knowledge is used to guide the retrieval process. Possible adaptation strategies for modifying candidate cases are identified and then evaluated.



II. METHODOLOGY

A. Case based Reasoning

Case based reasoning describes a method that uses previous cases to explain and create solutions to new problems. CBR can be considered reasoning by analogy. Using similar past circumstances to understand and adapt to new issues. Problem solving CBR is using a previous method to help determine solutions to new problems. This is done by drawing similarities between the two cases and analyzing specific actions that lead to a beneficial outcome. Both methods are fundamentally similar in how they are executed. Shows the connection between the two types of CBR. Both methods begin with the retrieval stage, which bring forth the appropriate memory or case for analysis. Based on these memories a general solution is proposed. This is when the two CBR systems split. Interpretive CBR attempts to justify the actions based on the previous memories while problem solving attempts to adapt the previous solutions to match the current issue. Both CBR methods then criticize the proposed adapted or justified solution and evaluate it. If the evaluation is not suitable then the process is returned to the adapt/justify stage. If the outcome is suitable then the case is then stored for future use.



Fig. 3: Flow chart of interpretive and problem solving CBR

Problem solving CBR can be further broken down in the four stages, index, retrieve, adapt, and revise. Indexing is the identifying and representation of key feature within a case for storage. These features can be information such as geometry, manufacturing information, fixture design information, etc. This information is then stored in a database for retrieval. Retrieval is the method of searching the database to find similarities between the cases based on the indexed information. Adaptation is the changing of the retrieved information to best fit the new problem. The final step is revision which is the verifying of the fitness of the proposed solution and determining if the process needs to be started over again. There are many benefits to this system. A major benefit is that specific aspects of a case can be used to help determine solutions rather than having to use it in its entirety. Learning can be achieved regardless of success or failure since both failed and successful cases are stored in the database. The knowledge in the database is solely based on the number and quality of the cases. Cases can be added and removed easily from the database. CBR allows a user to learn from previous mistakes by keeping them stored and easily available. Users will also be more accepting of solutions proposed by CBR systems because the proof is completely visible in the previous case.

III. LITERATURE SURVEY

Design Evaluation and Optimization of Connecting Rod Parameters Using FEM Suraj Pal, Sunil Kumar (2012)

This paper concludes the steps in 3D modeling of connecting rod below given steps are useful to create 3D model of connecting rod using CAD software. First we choose reference plane and set dimension in mm and then we go to sketcher and then extrude these entities to design both ends of connecting rod. After that reference plane is selected again for shank of connecting road and then we extrude the entities symmetrically. Once again plane is selected for making entities of groove. At last datum plane is selected for creating small holes on piton end and then holes are made on the periphery of piston end.

Design and Development of Rotary Fixture of CNC By Chetan M. Patel and Nirav P. Maniar, D. P. Vakharia (2012)

Manufacturing industries have brought lot of revolutions in manufacturing technology, as a consequence of which several developments like CNC lathes, CNC machine centre, flexible manufacturing systems, fabrication centre, transfer machines, robotics etc. took place. Even with these advancements in the manufacturing industries, there is a continued use of jigs and fixtures in some form or the other either independently or in combination with other systems. I came to know about the concept about how to design fixture for machining process. Centering, locating, orientating, clamping and supporting can be considered the functional requirements of fixture. I have studied example of rotary fixture.

Computer Aided Fixture design: Recent research and trends by Hui Wang and Yiming (Kevin) Rong (2010)

Widely used in manufacturing, fixtures have a direct impact upon product manufacturing quality, productivity and cost, so much attention has already been paid to the research of computer aided fixture design (CAFD) and many achievements in this field have been reported. In this paper, a literature survey of computer aided fixture design and automation over the past decades proposed. First, an introduction is given on the fixture applications in industry. Then, significant works done in the CAFD field, including their approaches, requirements and working principles are discussed. Finally, some prospective research trends are also discussed.

6	Workpiece CAD model
	Machining information
Setup planning:	Design requirements
Determine number of se	etups
Determine the workpiec	e orientation and position
Determine machining da	atum features and locating surfaces
Fixture planning: Determine locating posi	tions
Determine clamping sur	faces
Determine clamping pos	sitions
Unit design: Generate baseplate desig	gn
Generate locating unit d	esigns 🖌
Generate clamping unit	designs
Verification:	
Perform location accura	cy verification
Perform stiffness verific	cation
Perform cost, weight, et	c, verification
Perform Fixturing acces	sibility
	Finished setup plan
	Fixture design
	Materials listing

The basic elements of the fixture design process

The aim of this research paper various types of fixture designs are provided. I have taken modular fixture as part of my dissertation because modular fixture allows wider flexibility by making use of standard work holding devices and components. I have also used modular fixture design process from this research paper, this process includes setup planning, fixture planning, Unit design and verification.

A Review and analysis of current computer-aided fixture design approaches by Iain Boyle, Yiming Rong and David C. Brown(2010)

A key characteristic of the modern market place is the consumer demand for variety. To respond effectively to this demand, manufacturers need to ensure that their manufacturing practices are sufficiently flexible to allow them to achieve rapid product development. Fixturing, which involves using fixtures to secure workpieces during machining so that they can be transformed into parts that meet required design specifications, is a significant contributing factor towards achieving manufacturing flexibility. To enable flexible fixturing, considerable levels of research effort have been devoted to supporting the process of fixture design through the development of computer-aided fixture design tools and approaches. This paper contains a review of these research efforts. Over seventy-five CAFD tools and approaches are reviewed in terms of the fixture design phases they support and the underlying technology upon which they are based. The primary conclusion of the review is that while significant advances have been made in supporting fixture design, there

are primarily two research issues that require further effort. The first of these is that current CAFD research is segmented in nature and there remains a need to provide more cohesive fixture design support. Secondly, a greater focus is required on supporting the detailed design of a fixture's physical structure.

Generic	Abstract sub-requirement	examples

requirement	
Physical	 The fixture must be physically capable of accommodating the workpiece geometry and weight. The fixture must allow access to the workpiece features to be machined.
Tolerance	• The fixture locating tolerances should be sufficient to satisfy part design tolerances.
Constraining	 The fixture shall ensure workpiece stability (i.e., ensure that workpiece force and moment equilibrium are maintained). The fixture shall ensure that the fixture/workpiece stiffness is sufficient to prevent deformation from occurring that could result in design tolerances not being achieved.
Affordability	 The fixture cost shall not exceed desired levels. The fixture assembly/disassembly times shall not exceed desired levels. The fixture operation time shall not exceed desired levels.
Collision prevention	 The fixture shall not cause toolpath-fixture collisions to occur. The fixture shall cause workpiece-fixture collisions to occur (other than at the designated locating and clamping positions). The fixture shall not cause fixture-fixture collisions to occur (other than at the designated fixture collisions to occur other than at the designated fixture component connection points).
Usability	 The fixture weight shall not exceed desired levels. The fixture shall not cause surface damage at the workpiece/fixture interface. The fixture shall provide tool guidance to designated workpiece features. The fixture shall ensure error-proofing (i.e., the fixture should prevent incorrect insertion of the workpiece into the fixture). The fixture shall facilitate chip shedding (i.e., the fixture should provide a means for allowing machined chips to flow away from the workpiece and fixture).

Fig. 4: Fixture requirements

This paper describes varying requirements of fixture in current industry. Like physical, tolerance, constraining, affordability, collision prevention and usability I came across the concept of six degree of freedom. This paper illustrates various approaches and methodology like case based reasoning, geometric reasoning, parametric modeling etc. I have used case based reasoning methodology and parametric modeling approach.

A Functional approach for the formalization of the fixture design process by R.Hunter, J.Rios (2005)

In the industry fixtures are used for various functions. This research paper shows how to design fixture for machining. Following are the steps for fixture design process methodology; Functional requirement, Fixture functions, Functional design, detailed design and fixture validation.

Connecting Rod Optimization for weight and cost reduction by Pravardhan S Shenoy and Ali Fatemi(2005) In this research paper I found about locations on the connecting rod where stress variation was traced over one complete engine cycle. I realized that cost was reduced by changing material of the existing forged steel connecting rod to crackable forged steel.

Linkage between quality assurance tools and machine ability criteria by S Donlinsek and J Kopac (2001)

On the bases of this research paper we can know that on the bases of experimental measurements of different tool wears and the application of proper statistical techniques, it was possible to predict the tool life and therefore the intervals of changing the tools. I studied Fishbone diagram of causes which might influence machining accuracy.



Fig. 5 Fishbone diagram of causes which might influence machining accuracy

IV. RESULTS AND DISCUSSION

While there have been efforts to fixture design by using many methods there are still some areas that could use more development. Case based reasoning research has attempted to add a reasoning method to fixture design and research conducted on Case based method has made great strides. There still is more to be done. While it is important to propose general methodologies it is also important to well define proposed methodologies to help aid the development of the research into commercial products. This is new development of fixture at Jyoti Cnc Pvt. Ltd. Until recently many industries were used to with conventional machine tools but these methods time consuming and it is hard to get geometric accuracy as well. These methods take prolonged cycle period and machining time. With arrival of cnc machine tools we can make this process way faster, but it requires rigid fixtures.

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8