DESIGN AND OPTIMIZATION OF PLASTIC COMPONENTS HOLDING FIXTURES

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ABSTRACT:
In machining fixtures, minimizing work piece deformation due to clamping and cutting forces is essential to maintain the machining accuracy. This can be achieved by selecting the optimal location of fixturing elements such as locators and clamps. Many researches in the past decades described more efficient algorithms for fixture layout optimization. This paper presents a new fixture design methodology for sheet metal assembly processes. An optimization algorithm combines finite element analysis and nonlinear programming methods to determine the optimal fixture position such that assembly variation is minimized. Tool carries the main forces that later form the final shape of the work-piece.

Keywords: *Fixture planning, modular, Fixture Design.*

1.0 INTRODUCTION:
During machining operation, fixtures are used to locate and constrain a work piece. Minimizing work piece and fixture tooling deflection due to clamping and cutting forces is critical to ensure accuracy and production quality results in the machining operation. To ensure that a work piece is manufactured according to specified dimensions and tolerances, it must be appropriately located and clamped. The quality of the plastic injection parts depends on the materials, the parts and mold design, and the parameters of the manufacturing process. Shrinkage and warpage are two common defects in the injection molding process. The injection Molding tool/die contains the core designed plate, cavity designed plate, top and bottom supported plates, channels or runners, sprue, vents, ejector and its pins, horn pins, etc. In fabrication process, the considering variables are Temperature, Time, Speed, Pressure and stroke. The gaskets are used to provide a tight fitting joint between two surfaces to prevent leakages. Assembly processes are commonly used in the production of various consumer goods. Product manufacturing can be decomposed into two steps. First, components are fabricated using different methods such as machining, casting, injection molding, or metal forming. Second, these components are assembled or joined together using welding, riveting, fastening, or other joining methods. Fabrication processes are not perfect. They introduce variation in the components. In addition, assembly processes have their own variability. As a result, the dimensional quality of the final product is influenced by both component variation and assembly process variation.

Fixtures are used to uniquely locate, support and secure the work piece in the correct orientation relative to the machine tool. Companies set up their own standards and conventions to increase designer's work efficiency, in other words, to eliminate the redundant design work by just picking up some standard components. The analysis of the design parameters and

specifications utilized in jigs and fixtures design using universal modular jigs and fixtures design system (UMJFS) is an often research topic. The features of fixtures include the type of the fixture (milling, drilling), the shape of the work piece (rectangular, cylindrical), the size and weight of the work piece (housing dimensions), and the work piece material (steel, bronze, plastic etc). Different work pieces may have different sets of fixturing requirements resulting with different design strategies. Main locating principle is to restrict 9 degrees of freedom, and rotation. Machining fixture layout optimization is often analyzed with FEM and evolutionary techniques. Fixture layout ensures quality and improves the productivity by ensuring ease of loading/unloading of the component and chip removal. In order to completely understand the clamping criteria and part constraints, time and effort need to be spent for imparting of knowledge into the design solution. Fixturing methodology that can be used is vice fixturing, modular fixtures, etc. Depending on the product variety and volume two systems are used: dedicated and modular fixtures. Dedicated fixtures are used for specific components, while modular can be disassembled at the conclusion of a job and reassembled with other components for another job.

2.0 LITERATURE REVIEW:

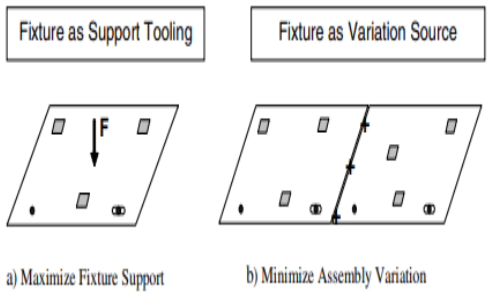
1. **Hakimian & Sulong [2017]** studied the war page for micro gears containing four cavities and consisting of three different types of thermoplastic materials, namely, the amorphous polycarbonate/ acrylonitrile–butadiene– styrene blend (PC/ABS), amorphous polyphenylene–ether/polystyrene (PPE/PS), and crystalline polyoxymethylene (POM) filled with glass fibers were analyzed
2. **Nik Mizamzul Mehata, Shahrul Kamaruddin [2016]** used the Taguchi method for the optimization to improve the mechanical properties of products made from recycled plastic. The results revealed that the product made of Optimization of plastic moulding by reducing warpage with the Application of Taguchi optimization. polypropylene (PP) and 75% virgin PP exhibits a better flexural modulus compared to the virgin form. The same product exhibits a 3.4% decrease in flexural strength. The degradation in mechanical properties of products produced from recycled plastic can be improved by optimizing the influence processing parameters during the manufacturing process
3. **Ming-Chih Huang, Ching-Chih Tai [2014]** studied the effect of various parameters on the warpage & the results showed that the packing pressure had the greatest influence on the warpage, followed by mold temperature, melt temperature, and packing time. However, the warpage was only slightly influenced by the gate dimension and the filling time in thin shell injection molding the packing pressure is the most influential factor, which shows a contribution rate of 15.59%
4. **E. Bociga, T. Jaruga, K. Lubczyñska [2013]** Studied the analysis of „Differences in mould temperature can lead to the problems with manufactured parts like warpage". The reason of this are stresses in the parts, Since polymer with higher temperature exhibits more intensive shrinkage than in lower temperature, the temperature

differences created during part cooling in the mould lead to part distortion, due to difference in shrinkage a bending moment occurs in the part and causes deformation. Part becomes concave from the mould "hot" side and convex from the mould "cold" side. Study was made at two different conditions in which two surfaces were maintained at 20-90deg temperature & vice versa. Similarly concave & convex result was found.

5. **S. Selvaraj, P.Venkataramaiah [2010]** have given the method for the measurement of warpage of injection moulded plastic components using image processing. The images of components are captured by using high resolution digital camera which is fixed in the fixture. The high resolution captured images of FR lever, are processed using MATLAB-Image Processing Tool and warpage is measured by comparing with image of standard component
6. **S. Kamaruddin, Zahid A. Khan and S. H. [2007]** Foong used the product (plastic tray) made from blends plastic (75% polypropylene (PP) and 25% low density polyethylene (LDPE)) for optimizing the injection molding parameters using the Taguchi method. The analysis of the results shows that the optimal combination for low shrinkage are low melting temperature, high injection pressure, low holding pressure, long holding time and long cooling time
7. **Gwebu, L. Nyanga, S.T. Nyadongo, A.F.Van der Merwe, S Mhlanga [2006]** used Taguchi method to determine the optimum values of the injection moulding process parameters for high density polyethylene (HDPE.) plastic parts. A moulding processing window in which the process achieved maximum quality, with major focus being on mould filling is developed.

3.0 METHODOLOGY:

This project implemented on optimization of plastic injection molding process parameters by using Taguchi method. It's an effective method attempted to test a small fraction of all possible combinations by using orthogonal arrays and comes out with the solution. Therefore, it required shorter time to obtain the optimizations parameter setting in injection moulding. One objective of fixture design is to determine the optimal layout of fixture elements such that fixture-work piece deformation during clamping and processing is minimized provided that kinematic and total restraints are satisfied



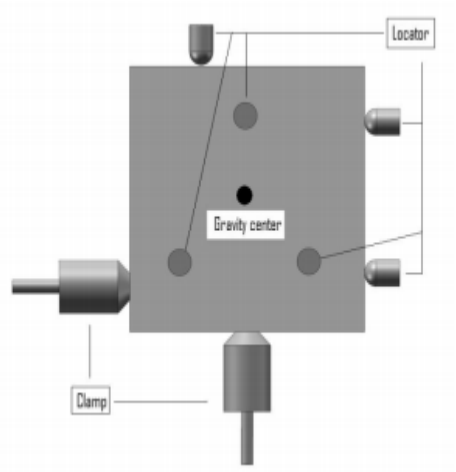
This methodology assumes that: sheet metal deformation is in the linear elastic range; the material is isotropic; the fixture and weld gun are rigid; there is no thermal deformation; and the stiffness matrix remains constant for small part deformations. The joining method considered is resistance spot welding.

It must be noted that the analysis presented is only valid for small deformations. Figure 4 shows amplified deviations in the y-direction. The apparently large part rotations are very small on a normal scale. Using the assembly principle presented

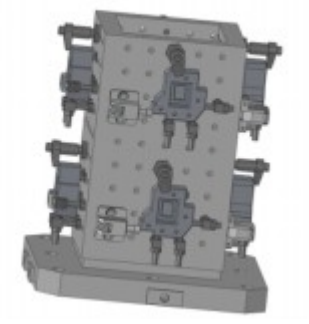
earlier in this paper, the assembly variation.

FIXTURE SOLUTION:

Strategy approach to fixture design: - Analysis of the work piece drawing, problem. - Identification of candidate elements (machined surfaces for locating, possible clamps positions, important regions of work piece, tool path, possible tool interference points etc.). - Support, location, clamping, base, guiding, fasteners and combination elements are taken in consideration. - Methodology (modular, vice, v-block, point surface, angular structure, multi work piece clamping.



Positioned clamping of the locater



Modular fixture, four sided tooling block, with four identical patterns

4.0 RESULTS AND DISCUSSIONS:

Fixtures are parts or assemblies that help orient and hold the stock during a machining operation. Components of a fixture can be created and then saved in part or assembly mode.

Total number of components in complete assembly documents 16, unique parts 16. The number of subassemblies is 6, and unique subassemblies 6 together with 204 mates.

Machining was to be performed under the following conditions:

Fixture: Four-sided grid block, 480 x 300 mm, 8 hook clamp, 8 side clamp, 24 locator pins, 24 adjustable miniature stops

Machine: Horizontal boring and milling machine

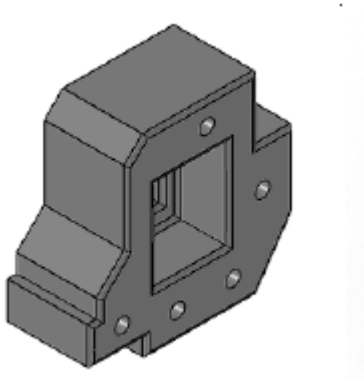
Work piece: rectangle aluminium, Hardness 50-100, 0.25 hp/(in3/min), specific energy

U= 0.7 N-m/mm3, at a chip thickness of 0.01 in)

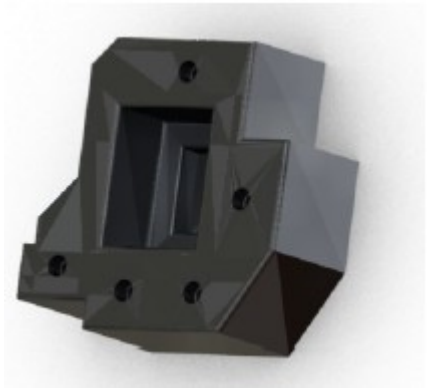
Weight: Mass = 912.23 grams

Dimensions: 105 x 43 x 110

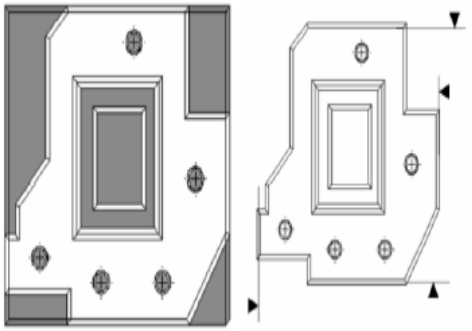
Machining data: Operation number



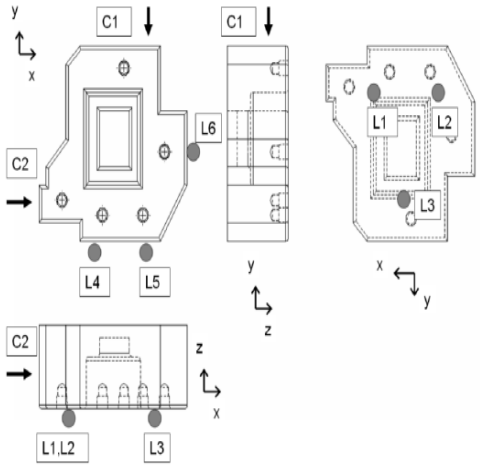
Work piece used in example, contains operations of milling



Work piece used in example, contains operations of drilling

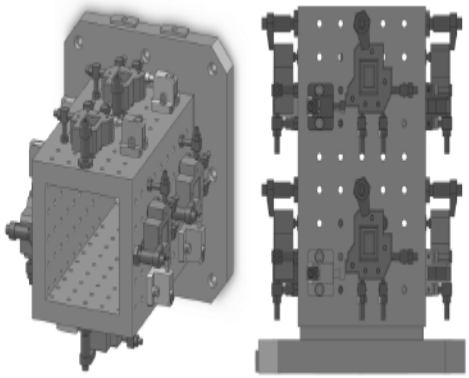


Work piece material to be removed, work piece surfaces that are not machined are selected for positioning



Selection of ideal positions for locating and clamping

The fixture facilitates a machining cycle for work pieces, saving in this way time and production costs.



Final modular fixture design

5.0 CONCLUSION:

High-performance, accurate and long lasting components represent a crucial ingredient of a well-functioning, reliable fixture. Often offers from firms with elements could be found, but there were no data about the process itself. This may prove the importance, complexity and purposefulness secrecy of presented process. Design of fixtures is a complex and intuitive process that usually involves several phases of planning. shown that the combined effect of maintenance, batching, standard times and plant layout proposed have a positive bearing on the minimization of production costs and thus improves productivity By creating a modular fixture costs have been saved and production cycle improved. With proposed procedure a flexible solution has been created and the computer system design 3D and setup plan are exploited to the fullest. The next step is machining simulation and its optimization.

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