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Improvement of Value Procedures in Fixture Design by Lean Assembling Techniques

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ABSTRACT:

This work presents an integral system for machining fixture layout design and optimization. The optimization module of this system allows determination of optimal positions of locating and clamping elements, which provides required accuracy and surface quality, while at the same time guarantees design of collision-free fixtures. The design module performs selection of required fixture elements based on a set of predefined production rules. Adequate criteria for the selection of fixture elements are defined for locating, clamping, tool guiding, and tool adjustment elements, as well as for fixture body elements, connecting elements and add-on elements. The system uses geometry and feature work-piece characteristics, as well as the additional machining, and process planning information. It has been developed to accommodate machining processes of turning, drilling, milling, and grinding of rotational and prismatic work-pieces. A segment of output results is also shown. Finally, conclusions are presented with directions for future investigation.

Keywords: artificial intelligence; fixture; process planning

1.0 INTRODUCTION:

Assembly is an important manufacturing process for cost effective product variety. Significant research has been done in the Design and operations of assembly systems in support of high product variety, but many opportunities exist for future research. Assembly is the capstone process for product realization where component parts and subassemblies are integrated together to form the final products. As product variety increases due to the shift from mass production to mass customization, assembly systems must be designed and operated to handle such high type variety. The concept of manufacturing assembly line (AL) was first introduced by Henry Ford in the early 1900's. It was designed to be an efficient, highly productive way of manufacturing a particular product. Ever changing globalized environment has been posing challenges of competitiveness and survival to all the constituents of the economy. Manufacturers have always faced heightened challenges such as rising customers' expectation, fluctuating demand, and competition in markets. There is no doubt that these manufacturers are always embracing changes and improvements in their key activities or processes to cope with the challenges. One way to stay competitive in this globalized market

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is to become more efficient. This could be achieved by Lean Manufacturing. It helps us to achieve best quality, lowest cost, and shortest lead time through the elimination of waste. Waste is 'anything other than the minimum amount of equipment, materials, parts, space, and worker's time, which are absolutely essential to add value to the product. line is related to over production, inventory, defects, transportation, motion, waiting which increases lead time. Lead time for a process decides cycle time for the product (Cycle time is the time required to complete single unit). Hence by using Lean Manufacturing methods we can optimize cycle time. This paper focuses on optimization of cycle time by line balancing. Lean Manufacturing, also called Lean Production, is a set of tools and methodologies that aims for the continuous elimination of all waste in the production process. The main benefits of this are lower production costs; increased output and shorter production lead times. More specifically, some of the goals include: In today's manufacturing environment, assembly work is routinely characterized by short production cycles and constantly diminishing batch sizes, while the variety of product types and models continues to increase. Constant pressure to shorten lead times adds to these demands and makes the mix truly challenging, even for the most innovative manufacturers. The ability to respond quickly to rapidly changing customer demands requires the use of manufacturing systems that can be re-configured and expanded on the fly, and which can accommodate advances in assembly techniques without making any initial manufacturing investments obsolete. Lean manufacturing, an approach that depends greatly on flexibility and workplace organization, is an excellent starting point for companies wanting to take a fresh look at their current manufacturing methods. Lean techniques are also worthy of investigation because they eliminate large capital outlays for dedicated machinery until automation becomes absolutely necessary. Indeed, the concept of lean manufacturing represents a significant departure from the automated factory so popular in recent years. The "less is better" approach to manufacturing leads to a vastly simplified, remarkably uncluttered environment that is carefully tuned to the manufacturer's demands. Products are manufactured one at a time in response to the customer's requirements rather than batch manufactured for stock. The goal is to produce only the quantity required and no more. And since limited numbers of parts are produced, it may be necessary to change processes during the day--to accommodate different.

DEFINING OF LEAN:

Lean is a philosophy that can be applied throughout the entire business process. Lean is a strategy that affects every aspect of the organization. Although, Lean practices started in manufacturing, the methodology can be applied in every aspect in an organization Lean based methodology focuses on eliminating non value-added activities and streamlining operations by coordinating all of the activities Non-value added activities are all activities that do not directly increase the value of a product or service The primary objective of Lean manufacturing is to improve manufacturing operations, increase productivity, reduce lead time to deliver product to customers, and improve quality of the products A Lean operation is a flexible system that uses considerably less resources, inventory, people, and floor space than a traditional operation. These improvements are accomplished by eliminating non-value added activities, shortening manufacturing lead times, improving product flow, and establishing a process of continuous improvement

Cycle Times: Reduce manufacturing lead times and production cycle times by reducing waiting times between processing stages, as well as process preparation times and product/model conversion times. Inventory levels: Minimize inventory levels at all stages of production, particularly works-in progress between production stages. Lower inventories also mean lower working capital requirement

2.0 LITERATURE REVIEW:

As the customer needs product at higher quality, shorter delivery time, higher customer service level and lower price; companies adopt continuous productivity and quality improvement to survive in the increasingly competitive world market. To cater to this, line balancing and kaizen are effective approaches to improve the productivity and quality.

Aasheet Kumar et al. [1] have made use of these approaches to improve the productivity on a Wire Harness. Assembly line of a company manufacturing wire harnesses for automobiles. They calculated balance rate before and after improvement to show the reduction in manpower requirement and increase in output. They also focused assembly line balancing and sequencing is an active area of optimization research in operations management.

Sandip K. Kumbhar et al. [2] studied the analysis method like Process analysis, Work analysis, Motion analysis and Takt time for calculation the rate at which the product is required and calculated Takt time before and after the Kaizen. The cost of operation is reduced considerably. Optimization of cycle time study is helpful for low cost automation and bench marking activity at industry production improvement level.

Juthamas Choomlucksanaa et al. [3] had improved manufacturing sheet metal stamping process to demonstrate how lean manufacturing can help improve work efficiency. Lean and other improvement tools and techniques such as visual control, Poka-Yoke, and 5s were applied to help companies identify areas of opportunity for waste reduction and improve the efficiency of production processes. Studies of the company processes showed that the deburring and polishing processes tend to create the most non-value added activities and should be addressed as quickly as possible.

Jafri Mohd Rohani et al. [4] implemented lean manufacturing. They had used Value Stream Mapping (VSM) to improve the production line of a color industry for identification and elimination of wastes by using team formation, product selection, conceptual design, and time-frame formulation through takt time calculation.

Zupan H. et al. [5] optimized production line by using the line balancing and discrete event simulation approach. For the real production process, consisting of two production lines and an assembly workplace the simulation model is built and the initial results obtained. After balancing of the production process and improvement of its performance some further steps of the process optimization by using the improved simulation model are performed. The results of the combination of the line balancing and further process optimization raise the production rate of the process enormously, which is obvious from the research results of this paper.

Mr. Silva et al. [6] studied the recent adoption is Lean Manufacturing in Apparel industry in Sri Lanka. The apparel industry faced considerable changes as a result of the removal of Multi Fiber Agreement in 2005. Delivering high quality garments at low cost in shorter lead times are the major challenges faced by the apparel manufacturers. In 2008, global recession badly affected almost all the apparel manufacturing industries in the world. Due to that demand for the low cost garments are increased by the customers. In order to face this global challenge, most of the local apparel manufacturers have adopted lean manufacturing techniques.

3.0 METHODOLOGY:

FIXTURE POSITIONING PRINCIPLES:

In machining process, fixtures are used to keep work pieces in a desirable position for operations. The most important criteria for fixturing are work piece position accuracy and work piece deformation. A good fixture design minimizes work piece geometric and machining accuracy errors. Another fixturing requirement is that the fixture must limit deformation of the work piece. It is important to consider the cutting forces as well as the clamping forces. Without adequate fixture support, machining operations do not conform to designed tolerances. Finite element analysis is a powerful tool in the resolution of some of these problems Common locating method for prismatic parts This method provides the maximum rigidity with the minimum number of fixture elements. A work piece in 3D may be positively located by means of six points positioned so that they restrict nine degrees of freedom of the work piece. The other three degrees of freedom are removed by clamp elements. An example layout for 2D work piece based 3-2-1 locating principle is The number of locating faces must not exceed two so as to avoid a redundant location. Based on the 3-2-1 fixturing principle there are two locating planes for accurate location containing two and one locators. Therefore, there are maximum of two side clamping's against each locating plane. Clamping forces are always directed towards the locators in order to force the work piece to contact all locators.

GENETIC ALGORITHM BASED FIXTURE LAYOUT:

Optimization approach In real design problems, the number of design parameters can be very large and their influence on the objective function can be very complicated. The objective function must be smooth and a procedure is needed to compute gradients. Genetic algorithms strongly differ in conception from other search methods, including traditional optimization methods and other stochastic methods By applying GAs to fixture layout optimization, an optimal or group of sub-optimal solutions can be obtained. In this study, optimum locator and clamp positions are determined using genetic algorithms. They are ideally suited for the fixture layout optimization problem since no direct analytical relationship exist between the machining error and the fixture

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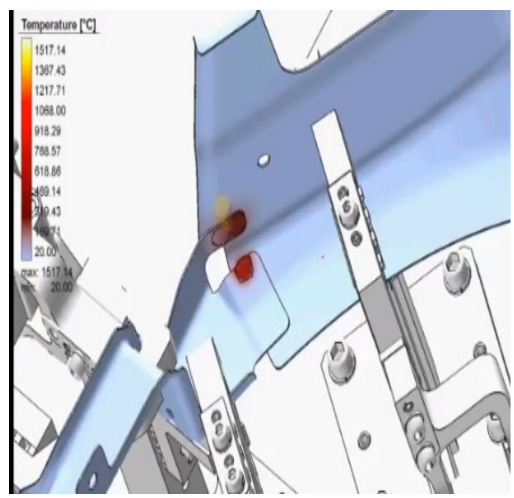
layout. Since the GA deals with only the design variables and objective function value for a particular fixture layout, no gradient or auxiliary information is needed The flowchart of the proposed approach is given Fixture layout optimization is implemented using developed software written in Delphi language named GenFix.

INTRODUCTION TO DESIGN OF FIXTURES:

- Clamping need to be strong and rigid enough to hold the blank firmly during machining
- Clamping should be easy, quick and consistently adequate
- Clamping should be such that it is not affected by vibration, chatter or heavy pressure
- The way of clamping and unclamping should not hinder loading and unloading the blank in the jig or fixture
- the clamp and clamping force must not damage or deform the work piece
- clamping operation should be very simple and quick acting when the jig or fixture is to be used more frequently and for large volume of work
- clamps, which move by slide or slip or tend to do so during applying clamping forces, should be avoided
- clamping system should comprise of less number of parts for ease of design, operation and maintenance
- .the wearing parts should be hard or hardened and also be easily replaceable
- clamping force should act on heavy part(s) and against supporting and locating surfaces
- clamping force should be away from the machining thrust forces
- clamping method should be fool proof and safe

4.0 results



Temperature variance at fixture 1

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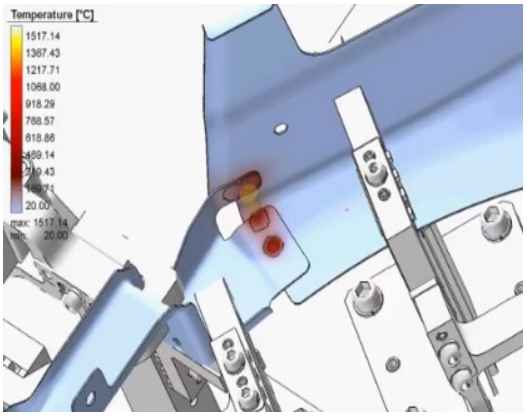
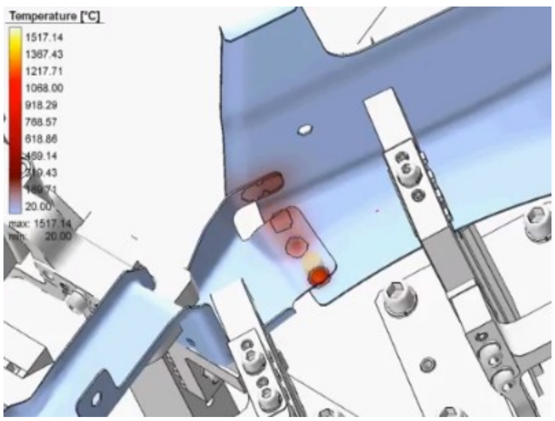
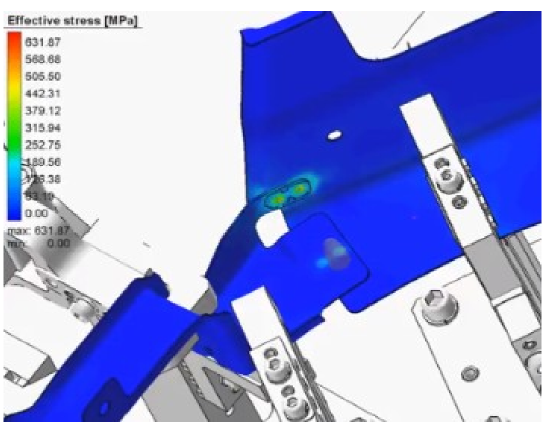


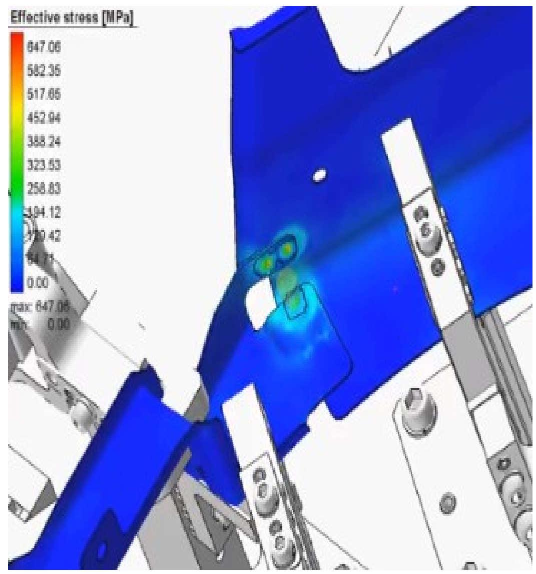
Temperature variance at fixture 2



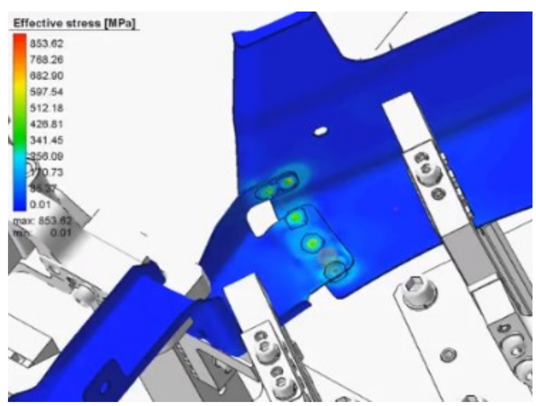
Temperature variance 3 at fixture



Effective stress of the fixture 1



Effective stress of the fixture 2



Effective stress of the fixture 3

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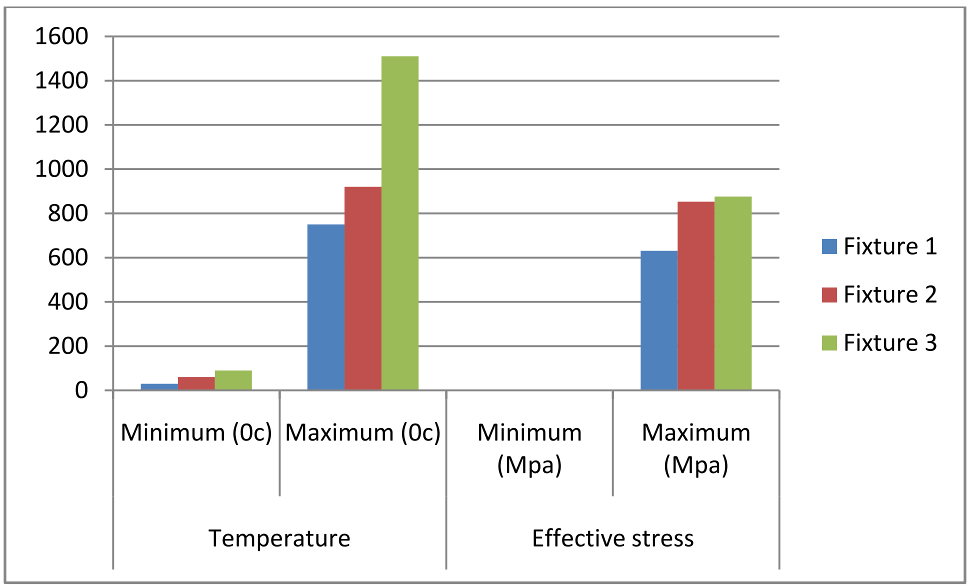
Table fixture maximum and minimum values

Types	Temperature		Effective stress	
	Minimum (^{0}c)	Maximum (^{0}c)	Minimum (Mpa)	Maximum (Mpa)
Fixture 1	30	750	0	631
Fixture 2	60	920	0.01	853
Fixture 3	90	1510	0.01	876



Conclusions:

The investigation, presented in this paper, allowed formulation of basic prerequisites for the development of knowledge base which encompasses more functional groups of fixture elements, and reliable rules for the selection of fixture elements. Beside the selection of elements for locating and clamping, also featured by the existing CAFD systems, the proposed system additionally allows selection of: fixture body elements, tool guiding elements, tool aligning elements, connecting elements, and a substantial number of add-on elements. In order to widely use the developed system for automated fixture design, it is necessary to complete the building of its knowledge base. Special attention should be focused on the development of additional production rule for the selection of securing elements (add-on elements), and elements for bridging height and length distances (add-on elements). The kinetic model of fixture considers work piece as a rigid, not elastic, body. In other words, the kinetic model does not allow for work piece deformations. Instead of examining all possible requirements, this investigation is focused on defining a general framework. Once the framework is established, it will be possible to identify, study, and integrate all other requirements into the proposed system.

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