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PRODUCTIVITY ENHANCEMENT OF KNUCKLE JOINT USING - FLEXIBLE MANUFACTURING SYSTEM (A CASE STUDY)

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ABSTRACT

The knuckle joint developed at M/s. Shri Ram College of Engineering & Management, Banmore, is manufactured in a small scale industry in a batch production of fifty pieces. The machines deployed for the production are efficient & good for producing the parts of joint and assembling them, even though the productivity was low. The reason behind it was the idle time of machine, movement of under production part (work in process inventory) is high due to lack of proper layout and unbalancing line conditions and finally the involvement of direct labour on the floor. As a result of which the production was okay, but the productivity was low.

These all factors were calling for an effective system to increase the productivity, thereby raising the profitability and reduce the lead time to minimum. Flexible Manufacturing System is introduced then to gain the win on uncontrolled parameters. We employed a closed sequential loop type FMS to control the productivity in an optimum way.

KEYWORDS: Inventory, Productivity, Flexible Manufacturing System

INTRODUCTION

In mechanical & automobile domain the joints play very crucial role, depending upon the application the joints are used may be temporary or permanent. For power transmission or motion transfer application we generally uses temporary joints like screwed joint, cotter joint, sleeve- cotter joint, universal joint or knuckle joint. The Knuckle joint is a type of joint which is used in steering system in between the steering rod and pinion of the steering gear [1], as the line of the action/axis of both the mechanical parts are intersecting and lies in different planes, so it is the only joint that we can employ here.

In order to gain the maximum productivity for the plant, the manufacturing technology must not be stiff, it must have an option of customizability of manufacturing system to gain the agility. For this a term FMS, i.e., Flexible Manufacturing System is used in order to gain the advantage over simple manufacturing system. FMS consists of a group of a processing work stations interconnected by means of an automated material handling and storage system and controlled by integrated computer controlled system [2]. FMS is an arrangement of machines interconnected by a transport system which is accurate, rapid and automatic.

The manufacturing plant is located in Gwalior which is a new and developing industry, having a small set up of six milling centres, two turning centres, one drill and a hacksaw machine, with a total employee staff of twenty-five. A small scale industry is manufacturing knuckle joint for automotive applications for his clients in batch production of fifty pieces.

LITERATURE REVIEW

The framework of flexible manufacturing systems (FMSs) combines high productivity, quality and flexibility needed for the fast response to changing market demands (Womack, Jones & Roos, 1990) [3]. The term flexible manufacturing system (FMS) is generally used to represent a wide variety of automated manufacturing systems. Flexible Manufacturing System (FMS) can be defined as an integrated system composed of automated workstations such as computer numerically controlled (CNC) machines with tool changing capability, a hardware handling and storage system and a computer control system which controls the operations of the whole system (Mac Carthy, 1993) [4].

FMS is describe as a growing technology mainly suitable for mid-volume, mid-variety production, they also defined FMS as an integrated production facility consisting of multifunctional numerically controlled machining centres connected with an automated material handling system, all controlled by a centralized computer system. An FMS is designed to have capability of concurrently handling a range of product types in batches (small to medium sized) and at a high efficiency as compared to that of traditional production systems which are designed to deal with low-variety parts in high volume. This system is able to process any part that belongs to specific families within the prescribed capacity according to a predetermined schedule. Generally, the system is designed in such a way that manual interference and change over time are minimized (Chan & Chan, 2004) [5].

One of the objectives of an FMS is to achieve the flexibility of small volume production while maintaining the effectiveness of large-volume mass production. The flexibility of a flexible manufacturing system (FMS) has enabled it to become one of the most suitable manufacturing systems in the current manufacturing scenario of customized and varied products with shorter life cycles. Ramasesh and Jaykumar (1991) [6]stated that manufacturing flexibility can be of several different forms e.g. machine, operation, material handling, routing, program, expansion, process, product, volume, labour and material flexibilities.

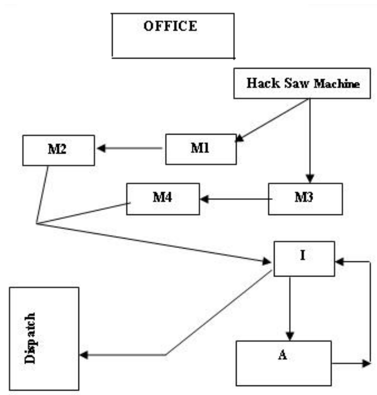
Browne et.al. (1984) [7] gave the concept of eleven flexibility types, illustrated only eight types, which are known as; machine flexibility, process flexibility, routing flexibility, operation flexibility, product flexibility, volume flexibility, part mix flexibility and production flexibility. An FMS can provide one or more of the above flexibilities. The consideration of a particular type of flexibility to be considered in the design of an FMS depends upon the system objectives.

The increase in flexibility provides the alternative resources/machines to do the same processing (Shnits et al., 2004) [8]. However, the flexibility and effectiveness of an FMS is restricted by the availability of equipment. The effectiveness of any FMS is generally described as being its ability to deal with the changes in the nature, mix, volume or timing of its activity. This ability is usually compressed into the term 'flexibility' or more comprehensively an ability to cope with the uncertainty of changes (Correa &Slack, 1996; Barad & Sipper, 1988)[9]. An appropriate pre-planning is essential for FMS success to enhance the efficiency, flexibility, and utilization of resources and to decrease setup costs.

The prominent literature has several descriptions of FMS and its inherent feature of flexibility has been addressed by many researchers (Browneet al., 1984; Upton, 1994; Wadhwa and Browne, 1989) [10]. The flexibility of an FMS issued to enhance versatility of the system and therefore the right type of flexibility is required to be implemented in the system. The case considered for the study is designed for some of the most basic flexibility types such as routing flexibility and volume flexibility. These flexibility types are very much required to make the system more responsive towards the machine failure (routing flexibility) and unexpected increase in demand (volume flexibility).

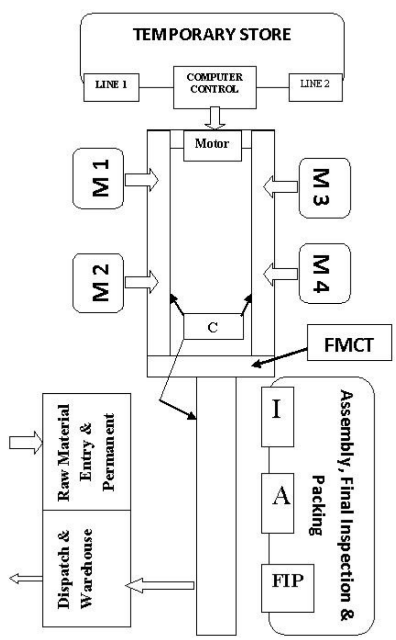
Present Layout of Workspace

The arena of the workspace was irregular as everything placed in the shop-floor was zigzag and meshy. It was too difficult to move the job in a simple way.



PROPOSED SYSTEM OF MANUFACTURING

The present system of manufacturing and the position of work-centres are altered so as to attain the maximum productivity, to reduce idle time of machines, labour and inventory travel can be minimal. The block diagram of the plant layout is shown below.



Job 1 (Double Eye)			Job 2 (Single Eye)		
M/C No	**Operation**	**Cycle Time**	**M/C No**	**Operation**	**Cycle Time**
M1	F, D, T	424 s	M3	F, D, T, BT	435 s
M2	M, D, M	910 s	M4	M, D	590 s

M1- Milling Center 1
M2- Turning Center 1
M3- Milling Center 2
M4- Turning Center 2
C- Conveyor

FMCT- Finish Machined Component Tray

I- Inspection

A- Assembly

FIP- Final Inspection & Packing

The following observations were recorded during the machining and travel of the product on the shop floor.

Job 1 (Double Eye)			Job 2 (Single Eye)		
M/C No	Operation	Cycle Time	M/C No	Operation	Cycle Time
M1	F, D, T	216 s	M3	F, D, T, BT	213 s
M2	M, D, M	437 s	M4	M, D	292 s

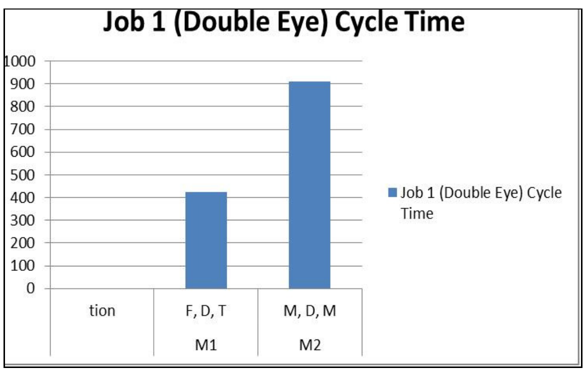
F-Facing D-Drilling
M-Milling T-Turning
BT- Back Turning

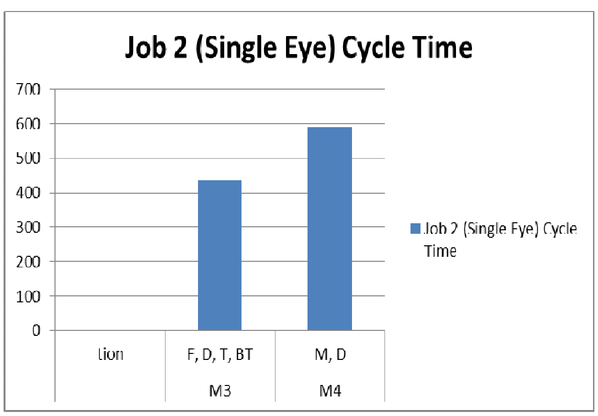
ADVANTAGES

This system of manufacturing has a great adaptability of changing the sequences of manufacturing and utilize the idle time, in spite of that, it produces faster, gives lower- cost/unit, greater labour productivity, greater machine efficiency, improved quality, increased system reliability, reduced parts inventories, adaptability to cad cam operations, shorter lead times.

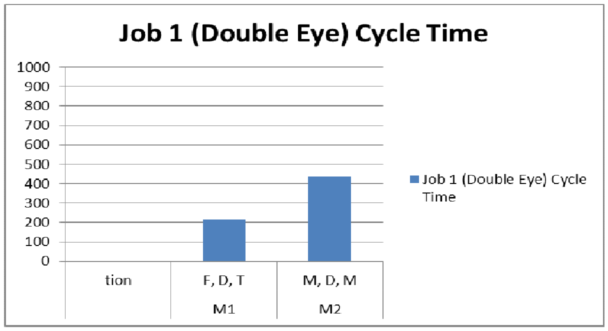
RESULTS

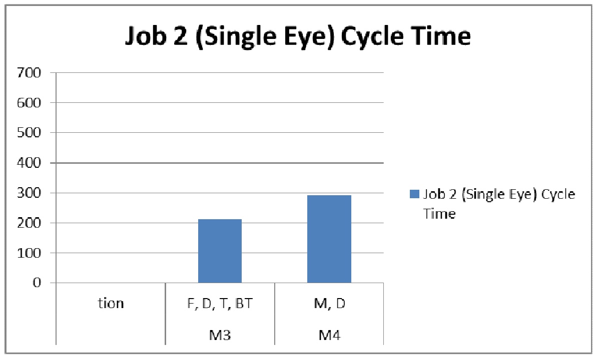
Results for Conventional Present Layout





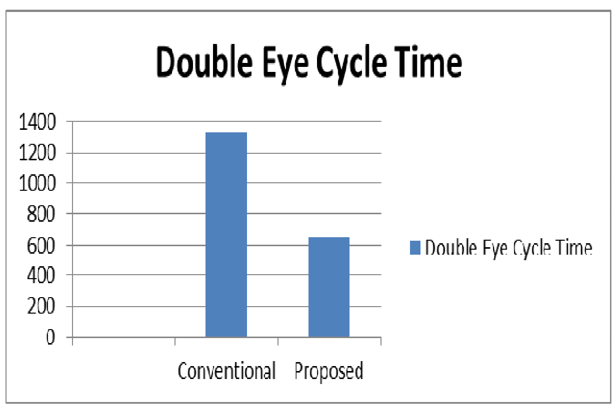
Results for Proposed layout:

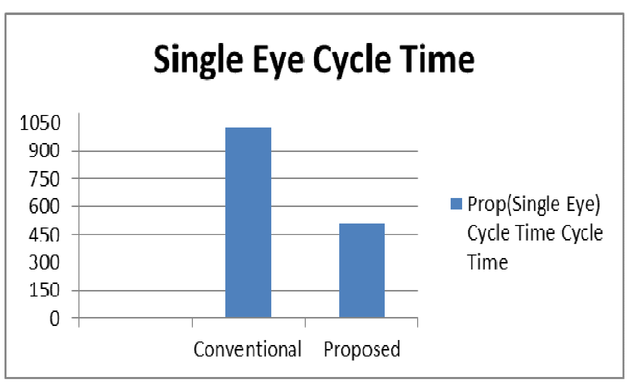




COMPARISON

The comparison between the production time for conventional layout and proposed (FMS) layout is depicted below.





CONCLUSIONS AND RECOMMENDATIONS

By the end of this paper we found that the implementation of FMS in a small scale industry helped it to gain more productivity and to gain profitability by decreasing the dwell time and the utilizing the time, money and material for the healthy production either batch or mass type. To trap the uncontrolled parameters in the limits and to minimize them, FMS is the best tool. We recommend this method to deploy for the fast and flexible manufacturing with minimum time and higher agility to meet the goal of higher productivity.

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