Time and Motion Study of Cutting Tool Production: Recommended Changes & Block Layout (II)

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Abstract—**The purpose of this study was to recommend improvement methodologies for production in a company that designed a cutting tool to be installed on the bottom of a boring machine. To produce the cutting tool, the company has used traditional technology that has resulted in a lengthy processing time and a delay in supplying the finished goods to the vendors. This present study analyzed the production process by means of a worker-machine relationship chart and identified possible causes that may hinder productivity. This case study would be a good example of how methods engineering can be used to improve productivity and to minimize cost.**

Index Terms— **method engineering, lean, layout, worker-machine relationship, idle time**

I. INTRODUCTION

The production delay was primarily caused by an imbalance in worker- to- machine arrangement in workplace. The installation of the manufacturing tools should be restructured to minimize workers' idle time. This would improve productivity along with reductions in customer lead time, cycle time, and manufacturing costs (Flynn et al., 1999; Koufteros et al., 1998; Rachna and Ward, 2003; Sakakibara et al., 1997; White et al., 1999). Efficient productivity could be achieved by optimizing the path travelled by work piece in the machining process since it would reduce material handling cost (Koufteros et al., 1998; Marek and Karwowski, 2000; Phillips, 1997; Rosenblatt and Sinuany-Stern, 1986). This also resulted in appropriate allocation of space within the work place and allowed workers' efforts to be more comfortable and efficient (Freivalds, 2009, Tompkins et al., 2010). Each worker could work with two or three machines if there was idle time (Freivalds, 2009). Although both the operator and the machine could not be occupied during the entire cycle, the company may benefit from minimizing idle time of both

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the operator and the machine. A synchronous servicing technique is useful when dealing with a fixed machine cycle time in which the worker loads/unloads the machine at regular intervals (Freivalds, 2009). In addition, the worker and machine process chart allows analysts to observe the exact time relationship between the working cycle of the operator and the operating cycle of the machine (Freivalds, 2009). This chart illustrates occupied and idle time for both the operator and the machine within the cycle, resulting in a fuller utilization of the cycle time. Adopting these methods would lead to a significant reduction in idle time of worker or machine. The present study was to illustrate and provide possible causes that may hinder productivity.

The rate of production in the company could not be faster than production at the slowest work station (Levinson, 2002). The rate of production at all stages should be uniform to reduce manufacturing problems such as bottleneck issues (Levinson, 2002; Rachna and Ward, 2003; White et al., 1999). In the current manufacturing process, the rates of production at different work stations were noticeably random.

The present study implemented synchronous flow manufacturing for current processes to attain uniform, and thus improved, productivity at each workstation. In order to determine idle times of operators or machines, block layout concepts were implemented to ascertain the general size and configuration of each machining area (Phillips, 1997; Meller and Gau, 1996). Block layout concepts helped to determine the shortest distance to be traveled by the work piece. The remainder of this paper details the current layout and operations, the recommended changes, the new operations and resulting improvements, and concluding remarks.

II. PROCEDURE AND RECOMMENDATIONS

To be competitive in the current market, a company must be superior in the following three areas of manufacturing: manufacturing efficiency (lowest cost), manufacturing quality (high quality), and manufacturing productivity (on-time delivery). Formerly, the company was unable to satisfy two (efficiency and on-time delivery) of the three and, therefore, the vendor was not satisfied with the company's performance. The company had to take action to address the problem.

Because power and water supply were inconsistent in India and road conditions were very poor, meeting the

vendor's deadlines was a challenge even when the orders were completed in time. Basically, the order had to be processed with the provision that delay was possible. The company's administrators and production floor supervisors realized that for a substantial amount of time, the workers remained idle while the machines were processing the work pieces. To complete the orders on-time, the company must transform workers' idle time into unit production time.

The most effective and immediate method to improve productivity would be to change *the process layout*. The essentials of a proposed process layout should optimize the workers' working time on the machines to the maximum extent and, if necessary, additional machines would be brought to the line. After adopting this process layout, (1) the number of operators who worked in this design process was reduced from nine to five, (2) a milling machine, lathe machine, and a drilling machine were additionally introduced, and (3) the inspection was carried out at only one location. As a result, to compare to the old phases (Figure 1,2,3) the path travelled by the work piece between the machines was reduced, and the workers' accessibility to the machines was improved. One phase of operation was completely eliminated in the final process layout.
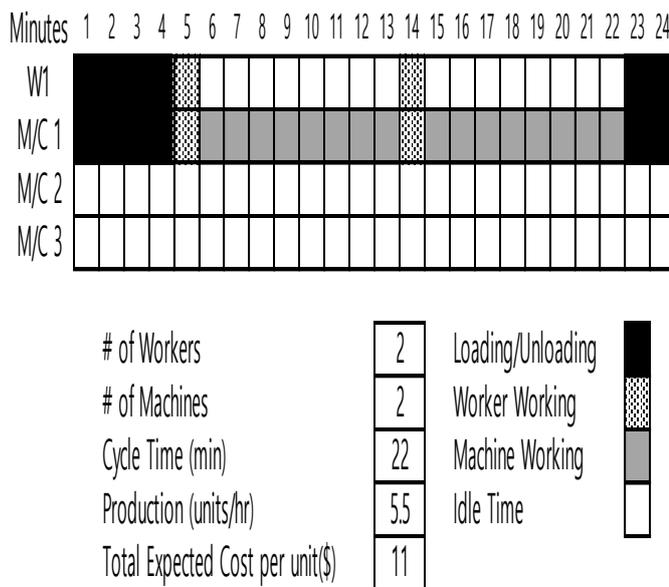

Fig. 1: Prior to changes in phase (2)

Figure 5 showed the block layout of the following phases of the proposed process layout in comparison to the previous layout (Figure 4). A single worker was charged with performing the different operations in phases 1, 6, and 8. Also, a single worker was responsible for performing the two CNC operations in phases 3 and 5.

1. Raw materials were subjected to the cutting operation on two milling machines by a single operator simultaneously.
2. Work pieces were subjected to the turning operation on three lathe machines, all operated by a single operator.
3. Work piece were subjected to the turning operation on the CNC machine.

4. Work pieces were subjected to the drilling operation on the drilling machines.
5. Work pieces were subjected to the drilling operation on the CNC machine.
6. Work pieces were inspected.
7. The drilling operation was carried out by two drilling machines.
8. The final inspection of work pieces was performed.
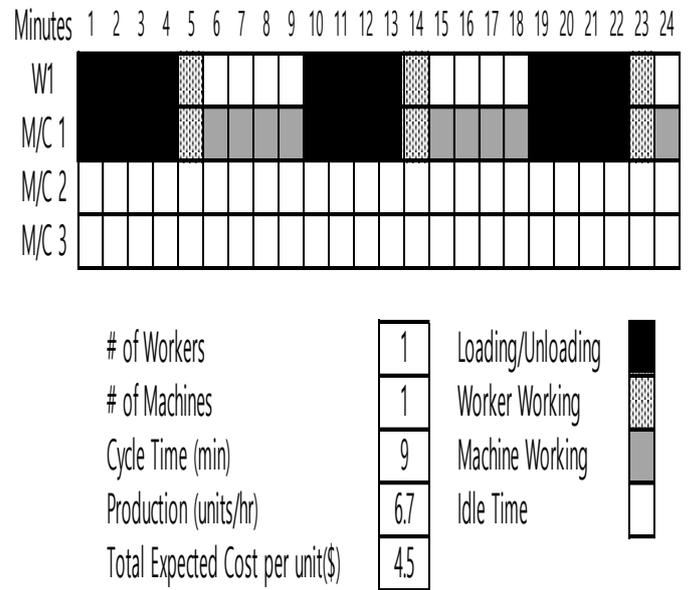9. Finished goods were transported to the storage room.

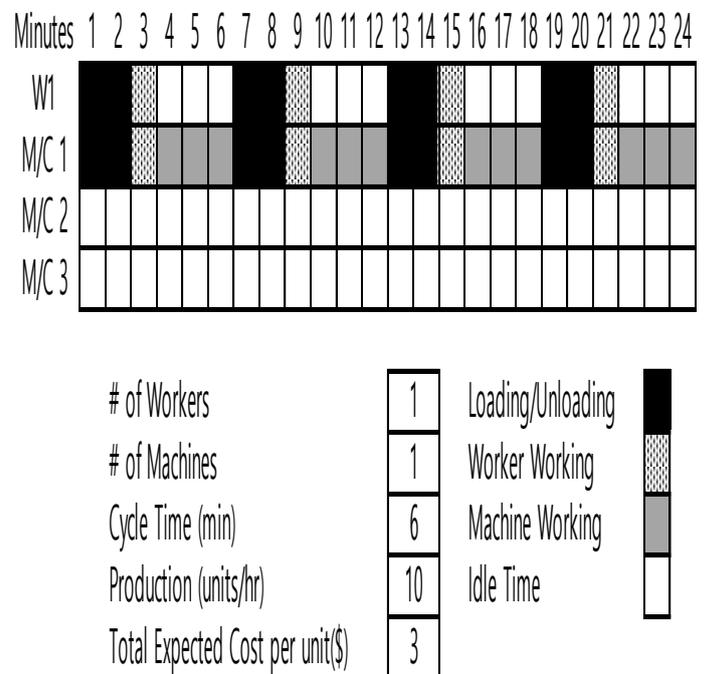Fig. 2: Prior to changes in phase (4) or (8)

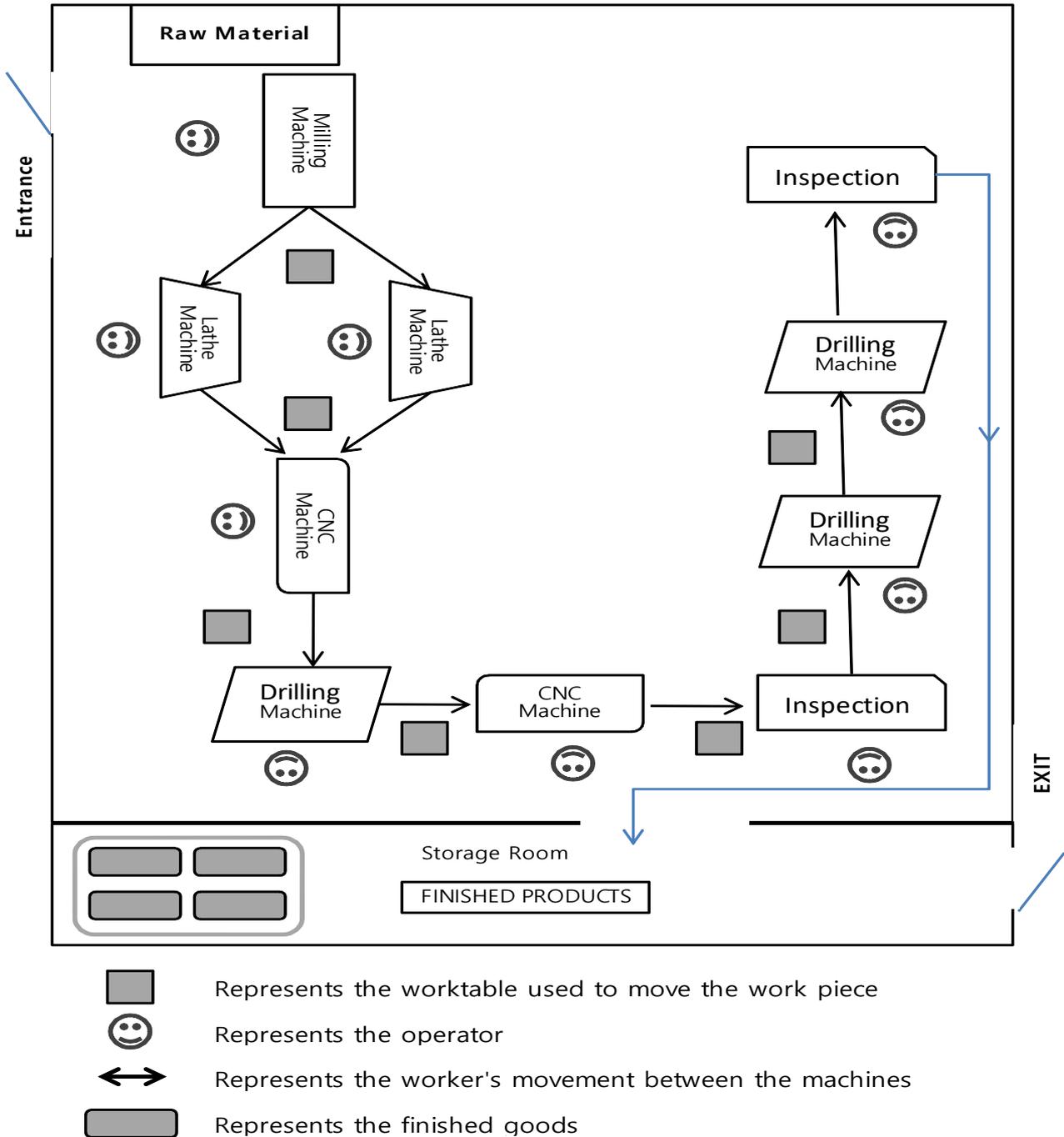Fig. 3: Prior to changes in phase (1),(3),(5), or (7).

Fig. 4: The process layout prior to improvements

In the current manufacturing process, the rates of production at different work stations were noticeably random. According to the theory of constraints (TOC), or synchronous flow manufacturing, the rate of production at each workstation should be as uniform as possible to minimize bottleneck issues in the proposed production cycle (Richey, 1996; Radovilsky, 1998). Standard and Davis (1999, 111-112) described the non-uniform flow of production by using the phrase "pig in a python." This phrase explained the difficulty of inconsistent inventory flow in a small factory. Decreasing randomness in production rates would allow for just-in-time production of

products, improving the rate of production significantly (Davy et al., 1992; McKone et al., 1999; Schroeder and Flynn, 2001; Sakakibara et al., 1997).

III. RESULTS AND CONCLUSIONS

Figure 5 illustrated the process layout of the subsequent phases of the suggested process layout in comparison to the earlier layout (Figure 4). In the new layout, a solitary worker was supposed to charge with completing the diverse operations in the new phases 1, 6, and 8. In addition, a solitary worker was charged with performing the two CNC operations in the new phases 3 and 5.
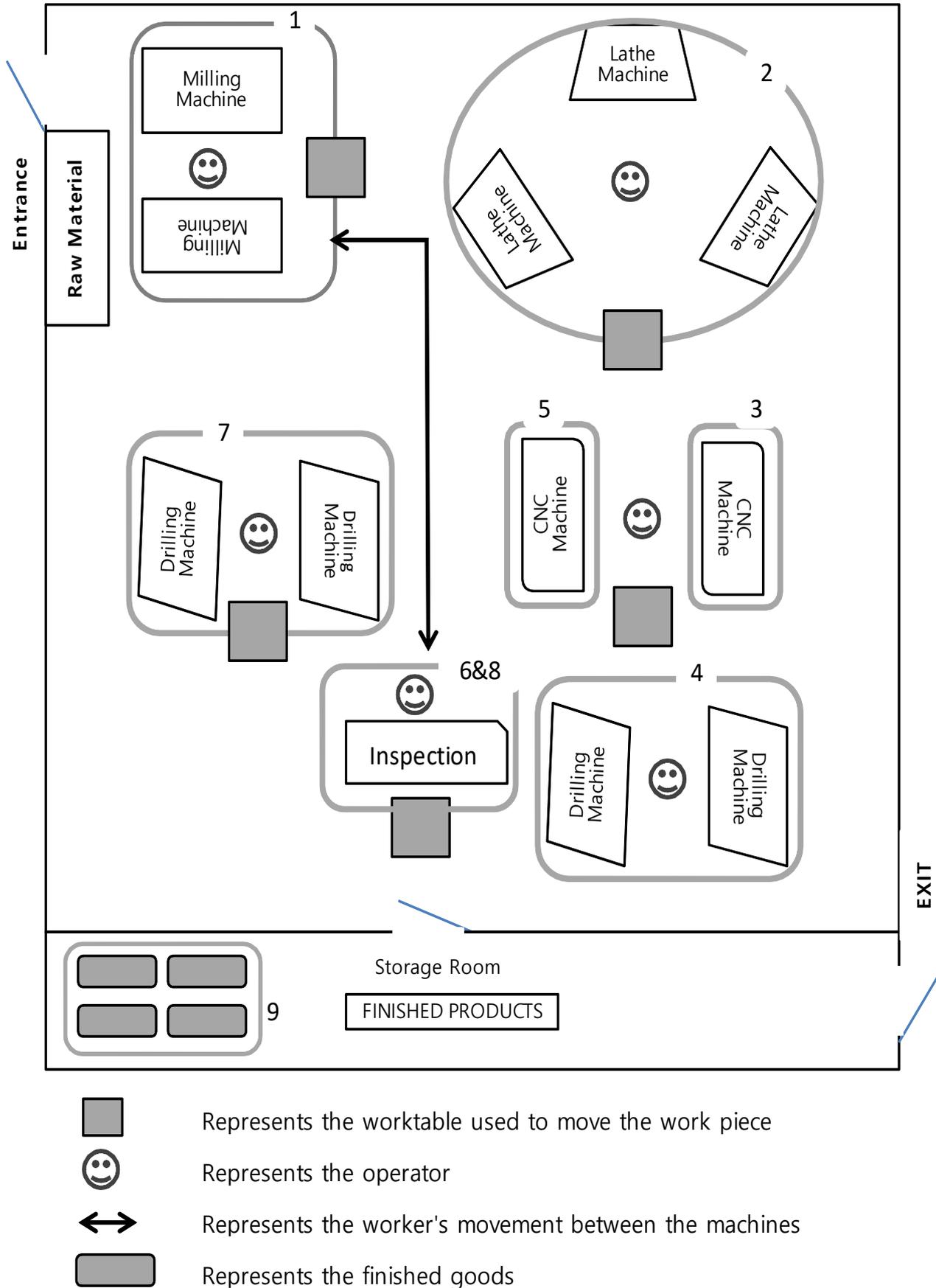
Fig. 5: The proposed block layouts of the company

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