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Enhancing Operational Efficiency Using Method Study and Time Study Techniques: A Case Study

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Abstract- This research explores the application of method study and time study techniques to enhance operational efficiency in the manufacturing of compressor shells. Through systematic observation, time measurement, and workflow analysis, the study identifies key inefficiencies in the existing production process.Method study was used to streamline work procedures by eliminating unnecessary motions and improving task sequencing, while time study helped establish standard times and identify delays. Based on these insights, the study introduced targeted interventions, including machine modifications, improved material handling, and resequenced operations.These measures led to a 15% increase in production efficiency for compressor shells, with noticeable reductions in cycle time and better resource utilization. The results validate the effectiveness of industrial engineering tools as drivers of productivity and operational improvement in manufacturing environments.

Keywords: Method study, Time study, Operational efficiency, Compressor shell manufacturing, Workflow analysis.

I. INTRODUCTION

Operational efficiency is critical for competitiveness in manufacturing, where delays and resource underutilization escalate costs. This study applies method study (systematic workflow analysis) and time study (task duration measurement) to quantify process bottlenecks, propose evidence-based improvements, and establish replicable frameworks for continuous enhancement addressing gaps in cycle times, labor fatigue, and machine idle time.

Time study is a fundamental technique in work measurement, defined by the International Labour Organization (ILO) as the process of “evaluating the time required for a qualified worker to complete a task at a defined level of performance under specified conditions” [1]. This approach aims to establish standard times for tasks, which serve as benchmarks for planning, scheduling, and productivity assessment.

The methodology traces back to the pioneering work of Frederick W. Taylor, often regarded as the father of scientific management. Taylor emphasized breaking down jobs into smaller, manageable elements, observing each element individually using a stopwatch, and recording the time taken by an average worker to complete it under normal working conditions. The data gathered is then adjusted to account for various allowances—such as fatigue, personal needs, and unavoidable delays—to ensure the resulting standard time reflects realistic working conditions. A common allowance added, as noted in many industrial settings, is approximately 18% for fatigue and personal needs [2]. Time study is particularly valuable for identifying inefficiencies, setting performance targets, and improving workforce productivity.

Method study, another core component of work study, is defined by the ILO as “the systematic recording and critical examination of existing and proposed ways of doing work, with the aim of developing and applying easier, safer, and more effective methods" [1]. It involves analyzing every aspect of a task—such as workplace layout, tools, materials, and motion patterns—to eliminate unnecessary actions and design more efficient procedures.

The goal of method study is to simplify work processes, reduce worker strain, and improve overall efficiency without compromising quality. While the traditional focus has been on human movements, Narayana Rao emphasizes the importance of integrating machine-centric analysis into the method study process. He argues that examining the interplay between human effort and machine operations yields more comprehensive insights and leads to better optimization of the production system [3]. By adopting this integrated approach, organizations can enhance both manual and automated aspects of their workflows.

Together, time study and method study form the backbone of industrial engineering practices aimed at improving productivity, minimizing waste, and standardizing work methods in manufacturing and service industries alike. Section 2.1 of this thesis references the work by Sharma and Patel [4], which demonstrated how a systematic time study approach led to significant efficiency gains in an automotive assembly line. By analyzing task durations and worker movements, the authors redesigned the facility layout to minimize unnecessary travel and waiting times. Their intervention resulted in a 22% improvement in overall assembly line efficiency. The study emphasized the importance of time-driven insights in reconfiguring physical workspaces to align better with process flow requirements.Section.

2.2 draws on the research conducted by Chen et al. [5], which focused on method study applications within a steel mill environment. Their work highlighted how critical evaluation and resequencing of operational steps significantly reduced idle time—by as much as 40%. By reorganizing workflows and eliminating non-value-adding activities, the authors were able to optimize the coordination between machines and workers, leading to enhanced process fluidity and resource utilization.

Building upon the principles and successes illustrated in these studies, the present research integrates both time study and method study techniques within a more complex, multi-product manufacturing environment. Unlike the more focused, single-product contexts explored in the previous studies, It varied components and workflows, demanding a flexible and integrated approach to process optimization. By bridging the methodologies demonstrated in the aforementioned papers, this study aims to deliver efficiency improvements through layout adjustments, process resequencing, and tailored interventions suited to diverse manufacturing demands.

II. METHODOLOGY & EXPERIMENTATION

This report outlines the application of time study methodology to the production process of the Tecumseh compressor shell, a critical component used in refrigeration and HVAC systems. The shell serves as the outer protective body, ensuring structural integrity and environmental shielding for the internal compressor assembly. Manufactured from 3 mm thick, 410 mm wide stainless steel coils, the component passes through several operations, including blanking, deep drawing, trimming, piercing, deburring, inspection, and packing as presented in fig 1

To identify potential efficiency improvements, a detailed time study was carried out across each of these stages. The methodology involved recording observed cycle times (O.T), applying performance rating factors (P.R), and incorporating allowances (typically 18%) to calculate standard times (S.T).

The first operation, blanking, was conducted on a 250T hydraulic press. Sheet feeding and the blanking process together took 7.84 seconds, with an S.T of 9.27 seconds. During observation, inefficiencies were noted in the scrap separation process.

In the deep drawing operation, conducted on a 200T press, the longest duration was observed 22.14 seconds for the ram movement alone. The total standard time here was calculated as 34.8 seconds. The slow pace is attributed to the aging hydraulic equipment used, necessitating long strokes and time-consuming movement.

Subsequently, face trimming on the shell took 20.455 seconds, resulting in an S.T of 24.95 seconds. The removal of excess material post-trimming was identified as a major delay point. Recommendations include machine modification with circular cutters to streamline this step.

The filing and deburring phase followed, executed on sand belter and filing machines. This task took 15.1 seconds, with an S.T of 18.4 seconds. The sand belter's efficiency was suboptimal, suggesting a need for upgraded machinery.

Figure1: Blanking, drawing, deburring and trimming operations

Two piercing operations were conducted: the discharge hole piercing and the heater coil hole piercing. These tasks were performed on 40T hydraulic presses. For discharge hole piercing, the S.T came to 14.8 seconds (Fig 4.5), while the heater coil hole piercing took 12.2 seconds (Fig 4.6). Operators experienced idle time due to the lack of a proper transfer mechanism between machines. A proposed solution is the installation of a metal slider system (Fig 4.8), which would facilitate faster workpiece transfer.

The final process, inspection and packing, took the longest time after drawing. Surface cleaning, dimensional checks, rust protection, and manual packing combined for a total operation time of 31.45 seconds, resulting in an S.T of 39.5 seconds (Fig 4.7). Manual thread tying during packing was identified as a bottleneck. Replacing this with an automated thread tying machine could significantly reduce the time involved. Table 1 summarizes the standard times across all operations:

Table 1: Standard times of all operations for manufacturing of compressor

Operation	Standard Time (sec)
Blanking	9.27
Deep Drawing	34.8
Face Trimming	24.95
Filing/Deburring	18.4
Discharge Hole Piercing & Flaring	14.8
Heater Coil Hole Piercing	12.2
Final Inspection & Packing	39.5
Total Time	154 seconds

Based on the time study, three major interventions were proposed:

- Trimming Machine Upgrade: Integrating circular cutters with the hydraulic trimming press (Fig 4.9) to reduce excess material removal time, saving approximately 7 seconds per unit.
- Slider Installation: A metallic slider system (Fig 4.8) between the filing, piercing, and heater hole stations to facilitate smoother and faster transfer, estimated to save 8–10 seconds per unit.
- Automated Packing Equipment: Replacing manual thread tying with semi-automatic tools to reduce packing time by 6 seconds.

These changes lead to an estimated modified time of 131 seconds, thereby improving operational efficiency. Using the formula:

Operational Efficiency (%) = [(Actual Time – Modified Time) / Actual Time] × 100

= [(154 – 131) / 154] × 100= 14.9%

III. CONCLUSION

The detailed time study conducted for the manufacturing process of the compressor shell has highlighted several critical insights into the workflow and time efficiency of each operation. By carefully observing and analyzing the time taken for tasks such as blanking, deep drawing, trimming, deburring, piercing, and final packing, it was established a total standard time of approximately 154 seconds for the complete production of one shell. The process mapping also revealed operational bottlenecks such as unnecessary delays due to manual workpiece transfer, outdated machines, and inefficiencies in material handling during trimming and packaging. These inefficiencies, while minor individually, cumulatively impact overall productivity and lead to increased manufacturing time.

To address these challenges, several practical modifications have been proposed, including the implementation of a sliding mechanism for smoother workpiece transfer between machines, the use of sharp circular cutters in the trimming stage for quicker removal of excess material, and the introduction of an upgraded automatic packaging machine. These enhancements, although theoretical at this stage, are estimated to reduce the total production time by 23 seconds, increasing the operational efficiency by approximately 14.9%. This study underscores the importance of time and motion analysis in optimizing manufacturing workflows and demonstrates how small yet strategic improvements can lead to substantial gains in productivity and efficiency.

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