Translating Time Study Implementation from Academia to the Real World

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Abstract

Conducting time studies is often an essential activity for entry-level industrial engineers. In this paper, we will review the philosophy and methods for conducting time studies as taught in several industrial engineering courses in our curriculum. We will compare these methods to the actual implementation of a time study in a local manufacturing facility. The Mercer University faculty who are implementing the time study will describe the progress on their time study project and offer insights on theory versus practice.

Keywords

Industrial Engineers, Manufacturing Facility, Time Study, Time and Motion Studies

Introduction and Background

Time and motion studies are an essential component of process improvement in any manufacturing industry and are frequently conducted by entry-level industrial engineers. As described in the Institute of Industrial and Systems Engineers (IISE) Z94.17, a time study is a "work measurement technique consisting of careful time measurement of the task with a time measuring instrument, adjusted for any observed variance from normal effort or pace and to allow adequate time for such items as foreign elements, unavoidable or machine delays, rest to overcome fatigue, and personal needs. Learning or progress effects may also be considered. If the task is of sufficient length, it is normally broken down into short, relatively homogenous work elements, each of which is treated separately as well as in combination with the rest." [1] Furthermore, Z94.17 describes motion analysis as the study of the basic divisions of work involved in the performance of a given operation in an effort to eliminate useless motions and organize the remaining motions in the best sequence for optimal performance. The time study was developed and refined by Fredrick W. Taylor, the father of scientific management, and his followers. The motion study was developed by Frank B. Gilbreth and his wife Lillian Gilbreth [2]. Historically, the two studies are discussed individually; however today they generally are discussed as one.

In current practice, time and motion studies are sometimes treated as a set of process improvement methods that also include Six Sigma and Lean Manufacturing. Abdulmalek and Rajgopal [3] described a case study where time study and lean principles were adapted for the process sector for application at a large integrated steel mill. Rahani and Al-Ashraf [4] described a case where Lean Production (LP) principles were adapted for the process sector of an automotive part manufacturing plant using Value Stream Mapping (VSM) and time study to determine reduced production lead-time and lower work-in-process inventory. Kyriacou *et al*.[5] conducted a 5-year time study analysis of emergency department patient care efficiency to calculate the main emergency department (ED) patient care time intervals to identify areas of inefficiency, to measure the effect of ED and inpatient bed availability on patient flow, to quantitatively assess the effects of administrative interventions aimed at improving efficiency, and to evaluate the relationship between waiting times to see a physician and the number of patients who leave without being seen by a physician. Diaz *et al*.[6] focused on a cycle time study of aircraft assembly using wing spar as a case study. The authors studied the current Aircraft manufacturing processes and analyzed the obtained results. Here at Mercer University, two industrial engineering faculty members have recently published an article describing a collaborative time study conducted with faculty from the School of Pharmacy.[7] This article describes one of a series of studies directed by Shogbon with the goal of reducing medication errors and improving patient safety in the inpatient setting.

This paper focuses on the difference between the time study as learned in the classroom versus the actual time study conducted in a manufacturing process. This paper uses a Georgia vehicle manufacturing company as the real life learning environment for the time study. This study evaluates the problems encountered by the industrial engineering students of Mercer University, while they tried to apply their classroom knowledge to a real life time study of the chassis assembly line as part of a process improvement project facilitated by the company management and Mercer industrial engineering professors.

Problem Description

The Georgia vehicle manufacturing facility produces, on average, 70 vehicles per day starting from March to August, which is known as the company's busy season. The manufacturing facility has two chassis assembly lines: conventional (CV) and non-conventional (NCV). The conventional chassis line produces 18 different models. Due to the variation in customer requirements the company could not automate the assembly processes; all tasks require manual labor from start to finish. Currently, the conventional chassis line produces 38 chasses in a 10-hour shift. Figure 1 shows a view of the stations and the flow of the conventional chassis assembly line.

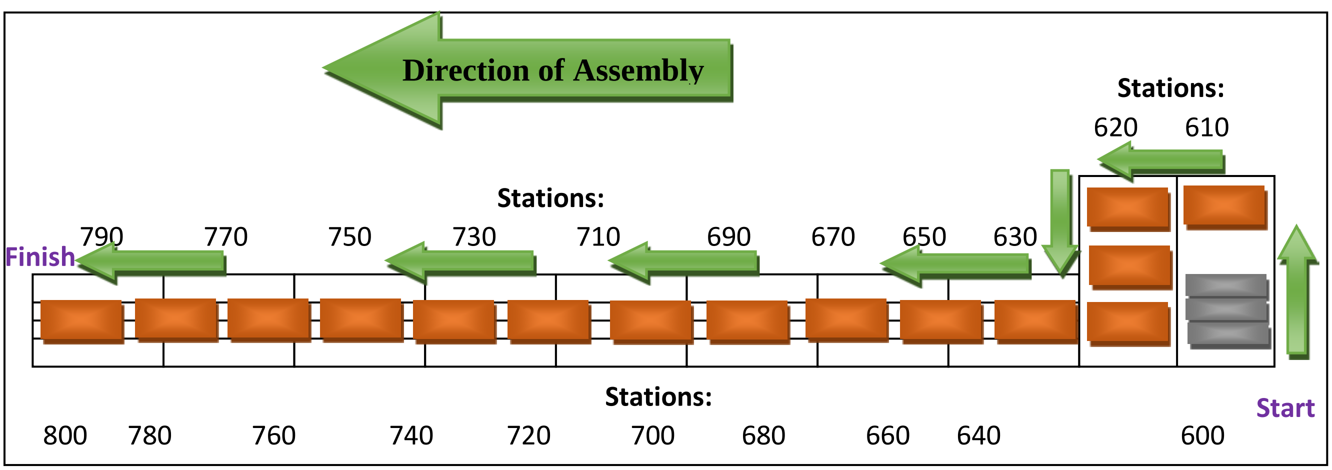

Figure 1: Conventional chassis line stations and direction of flow assembly

The CV chassis line has following properties:

1. This is a serial assembly line with 22 stations (Station # 600-780, and inspection station).
2. A total of 120 people work on the line in different stations throughout the 10-hour shift.
3. It is a manual assembly system.

To improve the production on the conventional chassis line, the plant management did a time study 2 years ago. Based on the study, the company made some adjustments, which led them to improve the production. Now management seeks further improvement. The project that has been assigned by the company to the Mercer University students under faculty supervision is to study the CV chassis line assembly system and recommend modifications that will improve the production of chasses.

Student Team Assignments

Student involvement in this project began at the beginning of summer 2017 when four industrial engineering students were recruited for the Mercer Summer Engineering Experience (MESEE) program. The range of expertise of the students was from sophomore to junior level so that sophomore students could get help in learning from junior students. These students did the preliminary study by observing the assembly lines, talking with the workers and managers who work at the line, and getting the assembly schedule from management. Also, they identified the tasks related to each station. A partial list of tasks in their respective stations is presented in Table 1.

Table 1: Stations and tasks for conventional chassis assembly line (partial)

Station #	Description	Tasks
600	**Frame rail load**	Frame rail load
610	**Frame Rail Assembly**	Cross member install
		Tie down install
		Motor mounts
		Frame rail staging
		Install Barrier
620	**Frame Rail Secure**	Securement of Huck fasteners
		Fuel tank barrier install
		Tie down alignment jigs/tighten bolts
	Hood Latch Install	Hood Latch Install
630	**Axle Install**	Install front axle (air or spring)
		Install rear axle (air or spring)

After the first group completed their studies, the project was forwarded to the next group of students starting in August 2017. The following sections discuss their experiences in classroom learning and real life learning.

Time Study in the Classroom

In the Industrial Engineering Program at Mercer University, students are introduced to the time study in the Introduction to Industrial Engineering and Manufacturing Engineering course (ISE 288). Students perform an actual time study in the Ergonomics and Work Measurement course (ISE 311). As taught in ISE 311, the steps of the time and motion study are:

1. Perform methods analysis.
2. Identify elements.
3. Observe one or more operators to find observed time.
4. Give a rating to adjust observed time and find normal time.
5. Add allowances to normal time to find standard time.
6. Apply additional procedures to reduce inaccuracies of going from the sample to the population and from the present world to the future world.

After students understand the basic steps, they are introduced to the study using a stop watch. To reinforce their understanding, they are assigned small projects in which they identify value added time and non-value added time and perform a time study in the laboratory. As the course advances, they learn more sophisticated methods for measuring and analyzing work. In the Modeling and Simulation course (ISE 403), the students perform simple time studies of systems outside of class, such as Panda Express, the Student Union, etc. Settings such as Panda Express are chosen because the process of serving is simple enough for the students to identify the tasks, which are in series and only one task is performed in each step from taking the order to food delivery and payment process. Therefore, the students who are assigned this project have little difficulty performing the time study and analyzing the system through simulation modeling. In the Healthcare Process Improvement technical elective (ISE 468), students do not have the opportunity to collect data in a live hospital setting; however, they are given real-world data and are taught how to calculate observed times, normal times, allowance factors, and standard times.

Time Study in a Manufacturing Facility

When it comes to performing a time study on a real-world manufacturing assembly line, identifying the tasks per stations is not as simple as the Panda Express food delivery process because, as described earlier, there are several tasks performed simultaneously at each station in the CV assembly line [see Table 1].

According to the management, each station is provided 10 minutes to complete all the installations by the workers assigned to that station. Initially, when the students observed the assembly line and the tasks associated with each station, the time study process became confusing. The students were overwhelmed observing the complexity of the process, which caused the actual time study process to be delayed. Finally, when the students started collecting the data, instead of recording data for a single task they performed the time study for the entire station. Another variation was that the students included the travel time for the workers to get the parts from the side of the station. This was situation for the first team under the MeSEE project. Table 2 represents a portion of the raw data collected for few stations during that summer.

Table 2: Sample time study data collected by students (in minutes)

Station	Time 1	Time 2	Time 3	Time 4	Time 5	Time 6	Time 7	Time 8	Average Time
600	12:55:00	11:51:00	9:54:00	8:07:00	12:23:00	10:52:30	9:00:30	10:15:00	10:39:45
610	10:23:00	14:01:00	11:37:00	15:38:00	12:12:00	12:49:00	1:37:30	1:55:00	10:01:34
620	13:30:00	8:50:00	8:26:00	11:18:00	11:10:00	8:38:00	9:52:00	11:14:00	10:22:15
630	10:29:00	8:16:00	9:16:00	8:46:00	9:22:30	8:46:00	9:01:00	9:04:15	9:07:36

After the end of the MeSEE project (end of summer 2017), a second team consisting of 3 students joined the project as the first team could not finish the time study for all 22 stations. As the new team members didn't have prior knowledge of the assembly line at the vehicle manufacturing company, they also encountered the same issues learning the system. This time they got help from the previous team and were able to learn the process faster than the first team. Still, it took them a while to get used to the manufacturing environment and understand the process by observation. Due to schedule conflicts, when the team was available to collect the data, the assembly line was shut down for maintenance. Therefore, data collection for the time study was delayed. By the end of the term, the students were unable to make data-driven recommendations on modifications that would improve the production of chasses. Although the actual time study is still in progress, the students have learned valuable lessons on how to perform actual time study.

Conclusion

Based on the lessons learned by the students while performing the actual time study, it can be stated that

1. Applying classroom knowledge to the real world is not difficult if students can get proper help.

2. Classroom knowledge provides guidance for the students to survive in the real word.

3. A real-world time study requires lot of patience and proper understanding of the process.

4. Data collection can be a challenge and data must be reviewed and corrected as needed before reporting to management.

5. Finally, conducting a time study in a manufacturing facility provides a great opportunity to apply and analyze the knowledge learned in classroom.

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