World Academy of Science, Engineering and Technology
International Journal of Industrial and Manufacturing Engineering
Vol:11, No:10, 2017

A Classical Method of Optimizing Manufacturing Systems Using a Number of Industrial Engineering Techniques

John M. Ikome, Martha E. Ikome, Therese Van Wyk

Open Science Index, Industrial and Manufacturing Engineering Vol:11, No:10, 2017 publications.waset.org/10008052/pdf

***Abstract*—**Productivity optimization of a company can significantly increase the company's output and productivity which can be in the form of corrective actions of ineffective activities, process simplification, and reduction of variations, responsiveness, and reduction of set-up-time which are all under the classification of waste within the manufacturing environment. Deriving a means to eliminate a number of these issues has a key importance for manufacturing organization. This paper focused on a number of industrial engineering techniques which include a cause and effect diagram, to identify and optimize the method or systems being used. Based on our results, it shows that there are a number of variations within the production processes that can significantly disrupt the expected output.

***Keywords*—**Optimization, fishbone diagram, productivity,

I. Introduction

PRODUCTIVITY has been generally defined as the ratio of an extent of output to the unit of all of the resources used to produce this output. In reality, it can be used to measure or assess the total raw material that needs to be in place in order to get a final output in the form of a product or service [1]. However, operational efficiency is used as an indicator that reveals the level of effectiveness in using production resources which includes, raw materials and supplies, manpower, land, building, machine, equipment and energy. From an industrial engineering point of view, it is notable that the production process is done with inputs which should be considered as part of the manufacturing, Hence, understanding the concept of a number of this input which is a relationship between the work in progress (WIP), and final product within the production process can greatly improve the company's expectations in terms of outputs or final products, under different operating conditions.

In a situation where one or a number of these inputs are changed, it may cause a variation of the total quantity and quality of the product. In addition, in real life situation, this may come from two main sources which include, mass production and productivity increased [2]. According to a research work done by Galarneau and Dumas [3], it states that an increase in productivity or any gross domestic product (GDP), is very vital to the economic growth of a country. This evidently shows that productivity is therefore considered to be a component of growth, and improvement in any part of the productivity process will hold a significant benefit to the industry and the country's GDP. According to Pisuchpen and Chansangar [4], productivity does increase as quality decreases and this has been a challenging issue for manufacturing industries as it usually incurs additional production cost.

As a result of the aforementioned information, one of their main concerns is to choose improvement operation to manufacture quality product at a lower cost. However, it is one of the main core strategies towards manufacturing excellence, and also, it is important to study and always to find a way of improving productivity. It enhances customer's satisfaction and also reduces time and cost to produce and deliver products or services. Productivity has a positive and significant relationship to performance measurement for process utilization, product cost, WIP, process out-put and on timely delivery.

Our main aim is to apply a number of industrial engineering techniques which include a critical examination of how the various activities are performed to get an out-put through all the given inputs and process. This will help to identify and reduce an amount of waste which is within the WIP, time, resource utilization and unnecessary activities that do not add value to the product and customers perspective.

In application, one can say that the correlation between a cause-and-effect diagram and productivity, including system engineering or work-study can play a vital role because if it results in cutting down cost just by merely identifying wasteful process and re-arranging certain activities in an orderly manner and cutting down the lead time use to perform them or produce a product by 15 percent, it will actually heal a productivity by 15 percent, which is value added to the organization and customer.

According to a research work done by Pycraft et al. [5], it was stated that industrial engineering techniques are very important to any manufacturing organization, and to further appreciate its advantages, we should look at how certain activities are being examined and simplified to save time and unnecessary waste. After the selected job to be processed is taken into consideration, an examination of the total time required to perform the job can be done, which includes the following; all information about the selected job needs to be recorded, the selected job needs to be simplified or split into different elements, the simplified elements should be examined in order to determine their size, a stop watch should be used in

John M. Ikome is with the Dept. of Industrial Engineering, VUT, Vanderbijlpark, South Africa (e-mail: ikome20022000@yahoo.com).

Martha E. Ikome is with the Technology Transfers and Innovation, (TTI), VUT Vanderbijlpark South Africa.

Therese Van Wyk is with the Dept. of Industrial Engineering, VUT Vanderbijlpark South Africa.

Open Science Index, Industrial and Manufacturing Engineering Vol:11, No:10, 2017 publications.waset.org/10008052/pdf

recoding the total time that it will take for each sample size to be completed, the speed in which the job is been carried out should be assessed, the time observed should be converted to basic time, the total allowance and standard time should be determined [6].

Work study can be classified in two different criteria, which include method study and work measurement. From the aforementioned information, all human working methods and factors that affect the smooth processing, efficiency and productivity within the organization can systematically be studied.

Work study is the generic name of method study and work measurement. This was developed by Gilberth and Taylor, and it was the most important industrial engineering basic techniques that was used in the industries. This is because of a number of advantage that it has, it is less costly for an organization to use or implement and also aid in strengthening the competitiveness through the improvement of various operational process or parameters, job allocation, resource utilization, etc.

From an industrial engineering point of view, method study can be defined as a technique or process that critically scrutinizes a work system in order to simplify the process and make the job at hand more effective. This is a principal method of improving and achieving productivity, whereas the technique used to define the level of performance of a worker to perform a task or operation is called work measurement. It is concerned with the length of time that it takes to complete a work task assigned to a specific job [7]. Work study is the systematic methodology that helps to improve resource utilization and any human related activities during a manufacturing process in order to achieve an improvement and set standard of performance and quality. It is classified generally into two areas: method study (motion study) and time study (work measurement) [8]. Method study is essentially concerned with finding better ways of doing things. It adds value and increases the efficiency by eliminating unnecessary operations, avoidable delays, and other forms of waste.

In the relationship of work associated with machine, human or a combination of both, time study is the best to use because it contains a wide diversity of procedures to determine the amount of time required, under an excellent working condition, to complete a job. Frederick W. Taylor, in the early centuries, introduced this in 1881, and till date, it is wildly used as time study. This is generally used to measure work and also to analyze the normal time. This is called Time Standard of Operation [9]. Time study includes using stopwatch, “Predetermined Motion Time System or Synthetic Time System”, and “Work or Activity Sampling". Conversely, in this study, we have only used the time study, using a stopwatch to gather our data, and thereafter, we used a cause and effect diagram which is one of the best industrial engineering fault finding tools. The time study was used to deduct all idle time. Talib and Daim [7] talked about statistics that may be proved by the work sampling operation of organizations that operate without an expert time of 60% than the normal organization. If achievement standard is set and the performance improved to an average of 85%, then this is a 42% increase in performance.

II. Application and Production Capacity of the Firm and Problem Statement

An automotive part manufacturing industry in South Africa has two production lines operated with recuperative type furnace having 22 m2 aluminum melting capacity. Both production lines use Blower-Blower T28 machines for shaping the parts according to the required design and after, cutting process takes place automatically only on one line. The factory produces different types of automotive parts which includes: gearbox housing, wiper mechanism, engine oil pan, etc. The general layout plan and different stages of manufacturing are illustrated in Fig. 1.

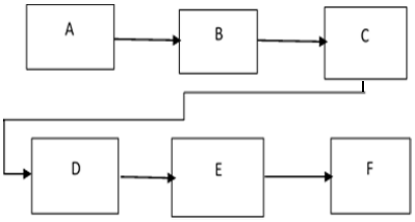


Fig. 1 Layout plan of production line. A. Cleaning and Cutting, B. Furnace, C. Extruder, D. Drilling/Grinding, E. Inspection, F. Packaging

The purpose of this study is to determine whether or not the models used for producing automotive parts (wiper motor mechanism and generator gear box hosing for Nissan, BMW in South Africa) comply with efficiency principles. Hence, our goal is to compare standard time which can be achieved through “time study” with actual process times, and thus, to determine avoidable insufficient periods and to state measures to be taken for preventing these periods.

III. Application of Time Study

The first step of time study to be performed for the case study in SA automotive part manufacturing industry’s production lines, is the preparatory process of the injection molding. Within this section, the work process that needs to be studied is selected. The preparation of the aluminum which includes melting through different funnels for casting the automotive parts is classified as the primary process. Hence, those processes including drilling are chosen to be studied in order to improve the productivity of the industry. After that, the process is divided into different work elements because of the different types of automotive parts that are being produced, 15 repetitive steps or process are basically performed before a final product is obtained at the end of the production lines. Making any change on the first six steps will have a great impact on productivity improved. All steps are considered as Machine/Operator Check Time. In the other words, machines and workers work together at all steps. Progression of these steps is as follows;

1. Cleaning the scrap aluminum using water jet is classified as the initial process, and after that, putting them in a

machine that crushes them into small pieces.
2. The pieces are melted using a furnace and a heat blower, then later transported in a tank to the various work station.
3. Within the work station, the operators carry the liquid aluminum using a metal cup, to feed their various extruded which have the shapes of the part that is to be produced.
4. After a period of time, the part is extruded and the operator puts in in an exit been.
5. When the bean is full, an overhead crane picks it up to another work station which does the filing and grinding, in order to remove all the particles that are not need.
6. After this process, a hand trolley is used to transport this parts to the inspection table and if it passes' the inspection test, they are sent for packaging and if not, the go back for re-work to the work station that is appropriate.

TABLE I
MEASUREMENT RESULTS

Process Description	Time/Productivity	1	2	3	Average	Ordinary Time
Washing the aluminum	T	4.12	3.41	3.64	3.68	2.70
Crushing them	p	74%	75%	76%	75%	
Putting them in the furnace	T	5.35	5.91	5.01	5.42	3.84
Melting them	p	70%	73%	69%	71%	
Transporting it to work stations	T	5.56	7.40	6.77	6.58	4.50
Dropping them	p	70%	83%	78%	77%	
Operator feeding extruder	T	3.55	4.23	2.02	3.27	3.78
Extruding part	P	70%	75%	75%	73%	
Filling the bean with extruded part	T	5,57	7.56	6.88	6.67	3.66
Transporting part for grinding	p	70%	84%	79%	78%	
Setting parts for grinding	T	7,04	6,58	5,07	6,23	4,26
Grinding/filing the part	P	70%	%70	69%	70%	

It should be noted that the observations are based on 10 for each work station.

IV. RESULTS

A. Observation I

From the observation and data analysis, it shows that the operators are not working according to the standard time. Transportation of raw materials from different work stations including the drilling and inspection, waste a lot of time. In addition, according to the findings of the cause and effect diagram in Fig. 2, shows that there is a problem with the various control process which includes (Defects, long distance delays, idling and human errors)

We proposed that management should install conveyer belts that will reduce the delay in transporting material and WIP from on work station to another by so doing, productivity will increase to approximately 25%.

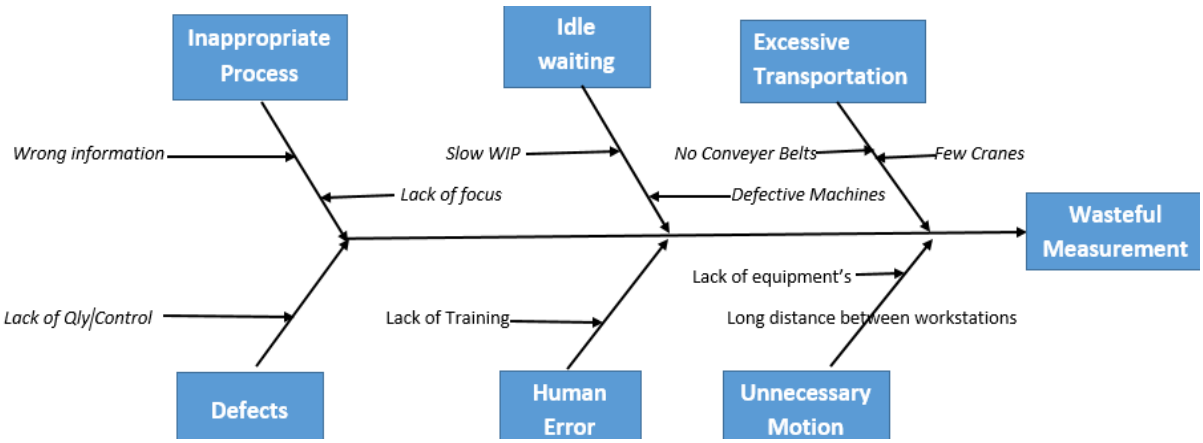


Fig. 2 Cause and effect diagram

B. Observation II

Every time the parts are not being processed or moved, the delay of waiting occurs and the main reason of this lead time is caused by waiting for the next operation from a workstation causing a bottleneck or longer idle time. Table II shows calculation and results of data obtained for delays and defects.

Over production is a manufacture of parts before it is required. This is highly negative to the companies output and financial well-being because it causes uneven flow of materials and increase the opportunity of producing defective products which has to be re-work, causing the company to spend more on energy and cost related to production.

Open Science Index, Industrial and Manufacturing Engineering Vol:11, No:10, 2017 publications.waset.org/10008052/pdf

Open Science Index, Industrial and Manufacturing Engineering Vol:11, No:10, 2017 publications.waset.org/10008052/pdf

TABLE II
RESULTS OF DELAYS AND DEFECT

Good piece	=Total piece- Reject piece
	=19,271-423
	=18,848 pieces
Availability	=Operation Time/Planned Production Time
	=373 Minutes/420Minutes
	=0.8881 or 88.81%
Performance	=(Total Piece/Operating Time)/ideal run Rate
	=(19,271 piece/373 minutes)?60piece per minutes
	= 0.8611 or 86.11%
Quality	Good piece/Total Piece
	= 18,848/19,271 piece
	0.9780 or 97.80%
OEE	Availability * Performance * Quality
	=0.8881 * 0.8611 * 0.9780
	=0.7479 or 74.79

C Observation III

Fig. 3 represents the result of the previous and recommendation made to the management. It shows the initial productivity without the conveyer belt system and also the productivity with the conveyer belt system install.

In order to evaluate the integration of the new system, we had to do a comparison in the form of a pilot test to be certain that the process will give positive results in the form of saving time and will improve the productivity in terms of out-put and quality.

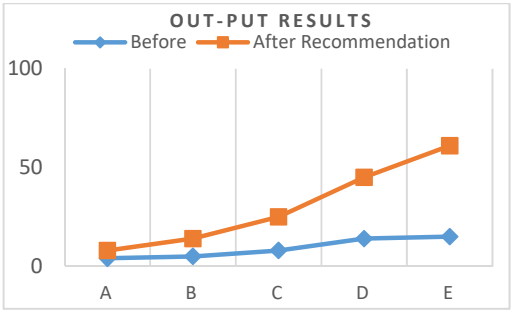


Fig. 3 Comparison result

V. CONCLUSION AND SUGGESTIONS

The distance to the various work station causes the operators to work a long distance, including the WIP which causes a delay in the production, thus dropping the productivity output. The operators also get tired, a routine training is not given to operators, which makes productivity to go to a standstill if operators in particular work station are absent from work. A solution to this problem, is to eliminate the old transportation methods of WIP and to introduce conveyer belts. Management should do a frequent routine cross training so that employees can be able to operate a number of machines within the company in order to eliminate a zero productivity if an employee is absent.

ACKNOWLEDGMENT

The authors will like to thank the SA part manufacturing Industry for granting us the access to their facility in order to gather data to do this research and also every other person or organization that assisted us.

REFERENCES

[1] Qiang, Z., Ling, S., Yu, Y., & Yongzhi, W. (2012). Simulation optimization for multi-type and batch production system based on Witness. Computer Engineering and Applications, 48(21), 209-216.
[2] Lijun Song, Shanying Jin, Pengfei Tang. (2016). Simulation and Optimization of Logistics Distribution for an Engine Production Line. Journal of Industrial Engineering and Management JIEM, 2016 – 9(1): 59-72
[3] Perspectives on Labour and Income, Spring 1993, Vol. 5, No. 1 (Statistics Canada, Catalogue 75-001E)
[4] Pisuchpen, R. and Chansangar, W. (2014). Modifying Production Line for Productivity Improvement: A Case Study of Vision Lens Factory. *Songklanakarin Journal of Science and Technology*, 36(3), 345-357.
[5] Pycraft, M., Singh, H., Philela, K., Slack, N., Chambers, S. and Johnston, R. 2012. Operations management: Global and South African perspectives, 2nd edition. Cape Town: Pearson Education.
[6] Lan S., Wang, X. and Ma, L. (2009). Optimization of Assembly Line Based on Work Study. Industrial Engineering and Engineering Management. 2009. IE&EM '09. 16th International Conference, 4, 813-816.
[7] L Bon, A. T. and Daim, D. (2010). Time Motion Study in Determination of Time Standard in Manpower Process. 3rd Engineering Conference on Advancement in Mechanical and Manufacturing for Sustainable Environment, April 14-16, 2010, Kuching, Sarawak, Malaysia.
[8] L. Shuang, W. Xue, M. Lixin, 2009. Optimization of Assembly Line Based on Work Study, IEEE
[9] Stevenson, W.J. 2012. Operations management: Theory and practice. 11th edition, Global edition. New York: McGraw-Hill.