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Resource Balancing to Enhance Productivity At Earthmoving Equipment Manufacturing Company

KEYWORDS: Resource balancing, Time study, Takt time, Cycle time

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ABSTRACT *This paper focuses on production enhancement of a particular model, to meet the customer demand in the fabrication department of welding process using the lean approach of resource balancing. The optimum allocation of resources in terms of man power deployment at each workstation is considered and the actual time required to process at each workstation is determined using time study. Also, the number of manpower required to meet the lean rate of production enhancement at each workstation and the standard time of each process is determined. Hence, implementation of this method will result in production enhancement and process improvement.*

1. INTRODUCTION
Organizations look for ways to provide qualitative products and satisfy its customers by providing defect free goods, customized machines. They look for ways to improve their production and management processes in order to remain competitive in the market, this leads to reduction of production lead time and their cost involved, higher productivity and increased product quality. All the available resources must be utilized efficiently and effectively in order to satisfy the customer needs with high quality products at a low price (Nabeel Mandahawia, Rami H. Fouad, & Suleiman Obeidata, 2012).

The current line output per day of a particular model is 5 per day which is not meeting the customer demand. In order to meet demand of the customer, the production enhancement has to take place about 7 per day in the fabrication department of the welding process.

(P.Arunagiri, & Dr A.Gnanavel Babu, 2013), have reported that, delays occur in the day to day process during manufacturing. Thus results in ineffectiveness, inefficiencies, and poor performance. The various process methodologies are identified to reduce the delay in the manufacturing process in order to improve the productivity of the manufacturing systems. (Ngoc Hien Do, Ki-Chan NAM, Quynh- Lam Ngoc LE, & Hoon- Do CHOI,2010),presents a systematic way to achieve the balance of resources. In order to determine resource requirement, the Takt, weighted standard processing time and quantity of resources required for each process are computed. A case study was conducted at hybrid job shop of the furniture company. The research shows the results of the new lean system in resources balancing.

The major gap was found in balancing the resources that includes manpower deployment in lean manufacturing methodologies to improve the production. The present work is aimed to study the enhancement of production using the lean approach of resource balancing. The constraints of resource balancing considered are in terms of man power deployment. The balancing of process times at each workstation with respect to the Takt time of the production enhancement is considered.

2. METHODOLOGY
Balance is the key to the success of a Lean manufacturing line (Hobbs, 2004). When the line operates, all processes complete work at the same rate and no one single process has more capacity than another. Balance is at the heart of every Lean manufacturing line (Ngoc Hien Do et al., 2010).

Based on the study and works of other experts and authors, it has been observed that for the resource balancing, different steps and procedures have been planned, which have been shown in the Figure 1 (Naveen Kumar & Dalgobind Mahto, 2013).

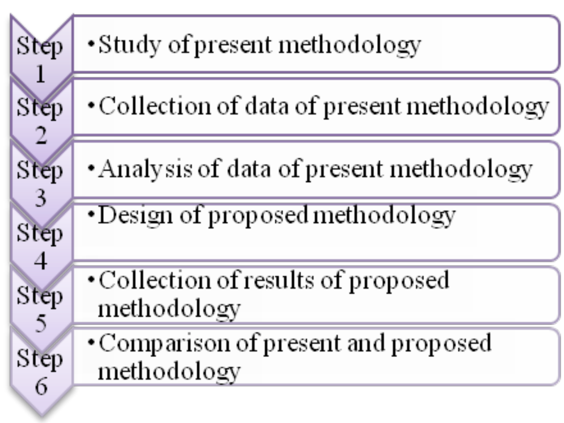

Figure 1. Steps involved in resource balancing

The products which will be produced in the lean line and their stages of operation, demand are determined. The most important data required to design lean line is the Process flow diagram (Ngoc Hien Do et al., 2010).

2.1 Present Methodology
The present methodology includes the study of actual processing time of each workstation by the single operator. The

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time study is conducted for all the workstation. The existing system includes determining the actual time required for processing 5 output per day at each workstation and the number of manpower deployed. The existing system has been shown in Table 1.

Table 1: Existing system

	Single Manpower deployed	5 output/day	
Stages	Observed time (minutes)	Actual time (minutes)	Man power Deployment
1	44	22	2
2	80	80	
3	90	60	1.5
4	180	90	2
5	180	90	2
6	30	30	1
7	30	30	1
8	20	20	1
9	74	37	2
10	60	30	2
11	35	35	1
Total	823	524	15.5

The major constraint of balancing is the optimization of allocation of the resources in terms of labour or manpower deployment is been considered in the study to meet the customer demand of 7 output per day. The balancing of resources is done considering only the manual welding operations, where the resources in terms of manpower can be added at particular workstation in order to meet the production enhancement. The automated welding workstation is not considered for resource balancing as the resources assigned is based on shift basis in order to match the capacity and demand of the product. Also different components are considered for performing operations at automated welding workstation and thus the requirement of manpower is based on the line operating conditions. The takt time to meet the customer demand of 7 output per day is determined and is as follows (1):

Takt time = Available time/Demand (minutes per unit) = 7.33×60/7=62.85 minutes/unit. (1)

Balancing to Takt and physically linking manufacturing processes enable the complete output of one process to be directly consumed by other, this dramatically reduces inventories and cycle times. In the lean line only the resources required to produce the demand are located. The number of resource in terms of manpower deployment required to achieve the throughput volume of each process is calculated using equation (2) (Ngoc Hien Do et al., 2010).

Number of Resource (i) = SOE (i)/ Takt time (2)

Where, Number of Resource (i) = the number of resources required of process i.

SOE (i) = Standard processing time of process i (Ngoc Hien Do et al., 2010).
Takt is a key factor to design lean lines. The required resources and the lean balance among processes are determined at Takt (Ngoc Hien Do et al., 2010). The bottleneck process in the operation with the longest cycle time is workstation 4 and 5 which takes 180 minutes each to complete particular operation from the Table1. The standard time of each workstation is determined and is calculated using equation (3).

Standard time= Normal time × (1+allowance) (3)

2.2 Design of Proposed methodology
The proposed methodology includes determining the number of manpower deployment at each workstation to meet the lean rate of 7 output per day for the manual welding operations. This results in the following improvements:

Determining the Number of Manpower deployment at each workstation: The number of manpower deployment at each workstation is determined to meet the lean rate of 7 output per day is calculated based on the balancing of the cycle time of each workstation with the takt time by using the equation (2).

Reduction in the cycle time: Determining the number of manpower deployment at each workstation to meet the takt time of 7 output per day, the cycle time of each process gets reduced.

Determining the standard time: The standard time to meet the demand of 7 output per day of each workstation is determined.

Combining the two workstations to one and therefore reduction of manpower deployment from 3 to 2 for that workstation:
The workstation of Stage 8 requires cycle time of 20 minutes and it requires single operator. The workstation of Stage 9 requires cycle time of 74 minutes and requires two operators to perform the task. The workstation combining results in the processing time of 94 minutes. Both the sets of operations can be performed in the single workstation. Therefore, the proposed system includes combining workstations to one, thus results in:

- Decrease of the workstation from 11 to 10.
- The manpower deployment from 3 to 2 operators when combining the workstations.
- The reduction in the cycle time from 94 to 47 minutes.

The proposed technique for the production enhancement of 7 output per day includes determining the Number of manpower deployment at each workstation using equation (2) and determining the standard time of the process using equation (3) are shown in the following Table 2.

Table 2: Proposed Technique

	Proposed system 7 output per day			
Stages	Required man power (Number)	Assigned Man power (Number)	Actual time (minutes)	Standard processing time (minutes)
1	1.96	2	22	25.3
2			80	80
3	1.42	1.5	60	58.5
4	2.85	3	60	78
5	2.85	3	60	78
6	0.47	1	30	34.5
7	0.47	1	30	34.5
8	1.49	2	47	54.1
9	0.95	2	30	34.5
10	0.55	1	35	40.3
Total		16.5	454	537.2

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In the proposed system of 7 output per day, the number of manpower assigned is rounded up to the next whole number. As the Stage 9 requires 1 operator but the assigned resources are 2 operators in order to meet the workload of that particular workstation. The resources assigned to the Stage 3 is 1.5 instead of 2, here the workload by the operator is shared to another workstation of different standard configuration depending upon the line requirement. Hence the resources assigned are 1.5 instead of 2 for Stage 3.

3. RESULTS AND DISCUSSION

Some improvements were observed upon implementation of this proposed technique. The comparison of the present system with the proposed technique and their improvements are shown in the following Table 3.

Table 3: Improvements by applying proposed technique

	Present	Proposed	Improvements (%)
Output/day	5	7	40%
Total task time (minutes)	524	454	13%
Number of workstation	11	10	9%

- The production rate increased by 40%
- The total task time decreased by 13%
- The number of workstation decreased by 9%

4. CONCLUSIONS

Implementation of this proposed technique results in production enhancement from 5 to 7 output per day. The total production lead time gets reduced. The number of workstation gets reduced from 11 to 10. The standard time of each process is determined.

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