ASSEMBLY LINE PRODUCTION IMPROVEMENT BY OPTIMIZATION OF CYCLE TIME

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Abstract- Automobile manufacturing organizations are currently encountering a necessity to respond to rapidly changing customer needs, desires and fluctuating market demand. Markets are affected by diverse customer needs, which demand higher quality, shorter delivery time, higher customer service level and lower prices. Many automobile organizations have realized the need to improve the quality of products & services to compete successfully. To compete in dynamic environment, these organizations must have to develop new methodologies allowing them to remain competitive and flexible simultaneously so that they can respond to the new demands. Production Process improvement becomes obligatory to gauge as well as improvise the current manufacturing scenario (outline) and hence advent of kaizen automation plays a chief role. This requirement is focusing on optimization of cycle time, reduction non value added work (3M-Muda, Muri, Mura), Kaizen: Continuous Improvement. In Japanese Kaizen is for continuous automated improvement designed to eliminate waste on resources of manufacturing system i.e. machinery, material, worker and production methods.

Keywords- Analysis methods, Cycle time, Production improvement, Takt time, Wastage of 3M.

I. INTRODUCTION

Production improvement in the any sectors depends upon 5M like man machine material, methods and management. To balance all 5M in the way of customer satisfaction is very important. Basic terms to reduce wastage of cycle time study with various parameters and standard work formats is used by Toyota production system (TPS), TPS is the world's one of the best production improvement method. The production system developed by Toyota Motor Corporation to provide best quality, lowest cost, and shortest lead time through the elimination of waste. Waste ("muda" in Japanese) is 'anything other than the minimum amount of equipment, materials, parts, space, and worker's time, which are absolutely essential to add value to the product.' by shoichiro toyoda founder of toyota.

A. Cycle Time

Cycle time is one of the important data for the line balancing at any production line. Cycle time is the time it takes to finish one product or the total of time takes before the product leaves the workstation and move to the next workstation. The cycle time required to process a customer order might start with the customer order and end with the order being delivered.

The overall process is made up of many sub-processes such as order entry, assembly, inspection, packaging, and delivery. Cycle time is inversely related to throughput, decrease cycle time leads to increased throughput, show in the following equation

Cycle Time, C = Total production time / Quantity of production produced
 = 1/ throughput
Production Rate, p = 1/ cycle time.

B. Optimization of Cycle Time

Cycle Time Reduction is identifying and implementing more efficient ways to do things. Reducing cycle time requires eliminating or reducing non-value-added activity, which is defined as any activity that does not add value to the product. Examples of non-value- added activity in which cycle time can be reduced or eliminated include repair due to defects, machine set-up, inspection, test and schedule delays. Reducing cycle time will have a significant impact on a company's bottom line when implemented.

Cycle time reduction is provides tremendous benefit to a company. From the cycle time reduction the non-value added activity will be reduced or eliminated. The benefit from this reduction is following below:
i. Reduced cost
ii. Increase throughput
iii. Streamlined processes
iv. Improved communications
v. Reduced process variability
vi. Schedule integrity
vii. Improve on-time delivery

C. Takt time

Takt is a German word for rhythm and refers to how often the part or product is required or the rate at which the product is required (typically by the customer). Takt time (time/piece), takt, is computed as

Takt =Available Operating time (sec/day)/Daily Demand (pieces/day)

Cycle time is a measure of how much time it takes for a particular operation, which is also expressed in similar units (time/piece). Takt and cycle times are illustrated in Figure

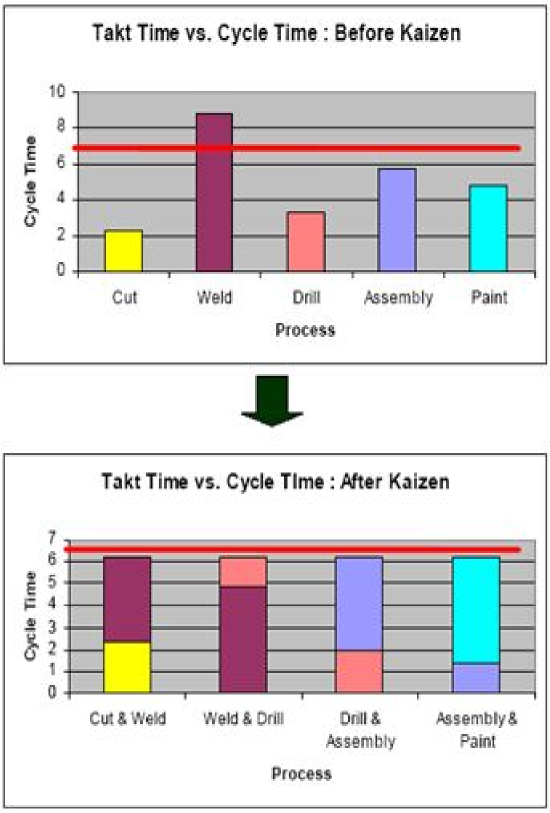

Fig.1. takt time vs. cycle time before and after kaizen

II. METODS FOR ANALYSIS

A. Process analysis
B. Work analysis
C. Motion analysis

A. Process analysis

Process analysis is useful to prepare systematic work, in the stage of various operation are shown in the below figure before and after condition.

There is no standard sequence of process so the cycle time for any work is imbalance, the process analysis useful to arrange systematic manner of work and reduce the wastage of muda, muri, mura at the level of gemba (Production Floor).

Process analysis is useful to 4S (seiri, seiton, seisou, seiketsu) 4S is arrangement, clean, store and maintain the condition. Standard work and optimize cycle time is possible at best level.

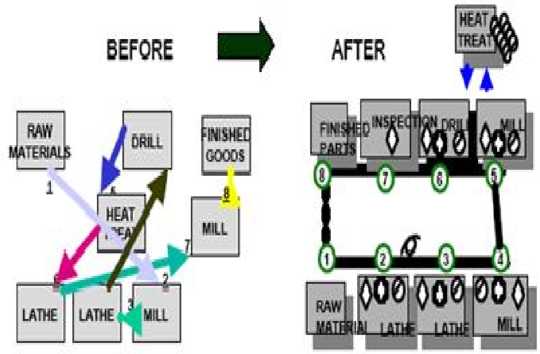

Fig.2 Process analysis

B. Work analysis

Work analysis is one of the important part of toyota production system (TPS), work analysis is useful to study relevant work process and cycle time process optimization. The strength of work analysis is its inherent simplicity. It is the easiest and fastest method to get started. This analysis follows study of general level to minute details for compilation of task and overall work burden on the worker and cycle time study optimization for production improvement is carried.

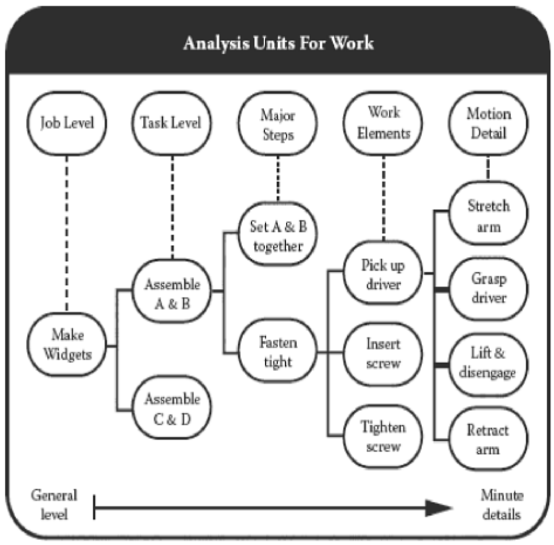

Figure 3 work analysis system

C. Motion analysis

A third basic technique utilized in kaizen by toyota motion analysis. Motion analysis introduced by toyota. In this motion analysis is key ingredient for properly understanding other topics for improvement such as standardized work. Basic motion analysis taught in toyota kaizen course is easily understood through introduction of Therblig symbol. These symbols relevant human body and ergonomic actions. These symbols useful to study of motion analysis on the gemba and this conclusion of study is useful for optimization of cycle time.

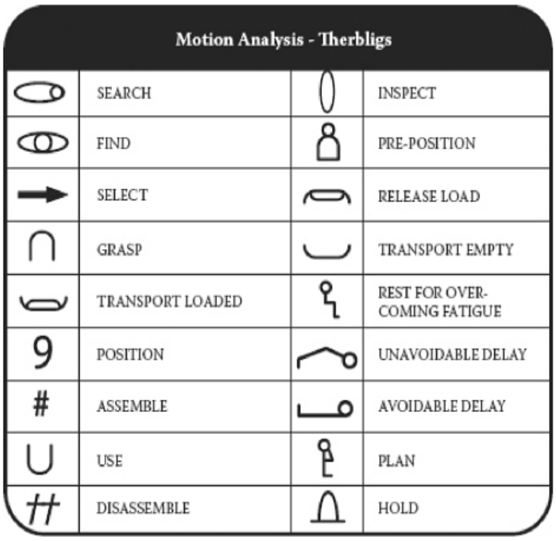

Fig.4 motion analysis

III. CASE STUDY

Problem Statement:
In order to achieve highly productive assembly line, the optimum amount of resources in terms of workstations and labor will need to be determined. One way to do this is by performing a line balancing study. Line balancing tool can help to characterize the line capacity and take into account the dynamic behavior of the system. Line balancing tool also can assist in implementing changes in a quick and effective manner. It also is able to evaluate and optimize the line throughput, machine utilization and cycle time. The line balancing problem is often express in one possible term which is to determine the minimum number of work stations needed and task allocation to produce maximum output rate.

TKAP- R transmission planned to increase the production capacity from 708/day to 775/day. The main basic theme is to improve the productivity through 3M's (Muda, Muri, and Mura) elimination at R transmission line to meet customer demand and main challenges to minimum addition of manpower.

Background and current condition:

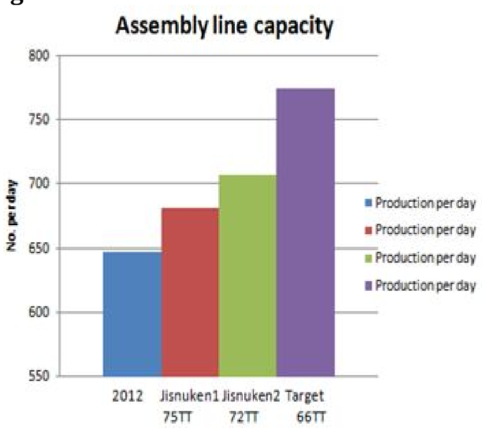

Fig.5 Assembly line capacities

Solution for optimization of cycle time: Both side weight balances with safety side cylinders for up and down movement of chute.

Methodology: Assembly production improvement done by analysis study of process, work, motion. As per analysis study of assembly line conclude wastage of 3M (muda, muri, mura) and optimize cycle time. Actual model developed in the case study at the stage of safety comfort work so think of changes can adopt with low cost automation creative think in chute modification. So the design data is prepare and modification think process about if the both side weight lifting can be easily handle load and suitable work constants so from this idea team execute at floor level and fabricate parts newly. There are also some things required to think like match dolly and chute easily. This karakuri mechanism fully depends upon weight rope mechanism, after the finalize design changes its take for fabricate & trails for feedback.

As per case study , simulated model has developed at actual level and try to conclude as per requirement of safety, productivity, man power reduction etc. this model useful to reduce muda as per requirement and safety improvement achieved by the conclusion after adding side cylinders. Cycle time variation 10 cycles study graphs prepare as following

Element Name	Match the dolly	
Cycles	Shift 1	Shift 2
c1	25.78	16.9
c2	20.18	11.48
c3	26.72	14.36
c4	9.8	10.76
c5	20.81	24.73
c6	28.17	14.5
c7	24.99	43.15
c8	29.79	29.23
c9	13.55	20.08
c10	17.19	26.01
Avg	21.70	21.12

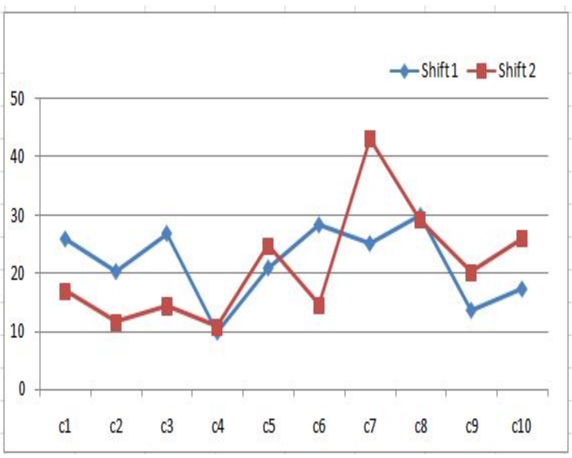

Fig.6. time observations table and graphs

Time Variation Reason- Time variations between both shifts are less, so best one average selected.

Line balancing by yamazumi chart:

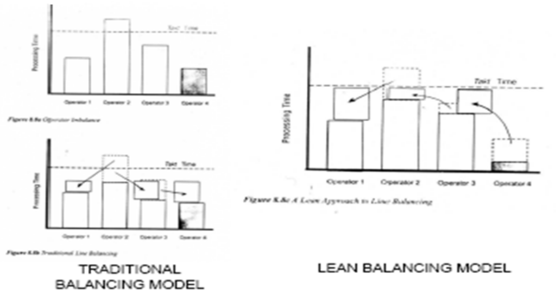

Fig. 7 line balance model

Yamazumi chart:

Toyota's reliance on basic charting can also be seen by the use of their yamazumi charts and their material and information (M&I) charting techniques. Yamazumi is Toyota's technique for line balancing which is performed by their team leader role. The team leader is responsible for completing yamazumi analysis for work balancing every month. Team leaders use this simple charting technique to analyze cycle times to reduce idle and overburden of work stations. The M&I charting technique is used by management to examine systems (i.e. several processes combined) to reduce lead time. Toyota's yamazumi and M&I charting techniques are simplified approaches in analyzing work at the appropriate level. This data demonstrates that Toyota is deploying techniques similar to those used during the era of scientific management which are more easily transferred throughout the organization.

Line before condition:

Fig.8 Assembly line before implementation of LCA at TKAP.

At the stage of before implementation of low cost automation analysis of cycle time study and tact time of one process required 70sec. there found wastage of time, non value added work, muda, muri, and mura. Production quantity in numbers at 95% line efficiency at the stage of before implementation is produce 708 units per day.

After LCA implemented:

At the stage of after implementation of low cost automation analysis of cycle time study and tact time of one process required 66sec.

Production quantity in numbers at 95% line efficiency at the stage of after implementation is produce 775 units per day. This implementation is reduce the wastage of non value added work, line balancing in standard way and reduces the cost of product with improvement of production.

Fig.9 LCA implementation for optimization of cycle time

CONCLUSION

In this paper focus given on the optimization of cycle time and reduction of non-value added activity. Improvement in the productivity achieved and elimination of non value added activities has been done. The cost of operation is reduced considerably. Optimization of cycle time study is helpful for low cost automation and bench marking activity at industry production improvement level.

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REFERANCES

[1] ACMA [2010], “Principles of Low Cost Automation”, ACMA Center of Technology India.

[2] Artun Torenli [2009], “Assembly line design and optimization”, Master of science thesis in the International Masters

programme automotive engineering, Chalmers university Of Technology Goteborg, Sweden.

[3] Dr. Jay Baron, Brett C. Smith [2006], “Low-Volume Vehicle Production by Manufacturing, Engineering and Technology”, Center for Automotive Research, USA.

[4] G Reinhart, J Werner [2009], “Flexible Automation for the Assembly in Motion”, Institute for Machine Tools and Industrial Management, Faculty of Mechanical Engineering, CIRP Vol. 56.

[5] Imai, M. [1988], “Kaizen: The Key to Japan’s Competitive Success”, McGraw-Hill, New Delhi, ISBN 1-25-900619-2.

[6] Liker J.K.[2012], “Book of The Toyota Way- 14 Management Principles”, TMH Publication, New Delhi, ISBN 81-219-2822-7.

[7] Mathias Jonsson, Carin Anderson, Jan-Eric Stahl [2011],“Relations between volume flexibility and part cost in assembly line”, Robotics and Computer-Integrated Manufacturing, Vol. 27 pp 669–673.

[8] Nils Boysen, Malte Fliedner, Armin Scholl [2008], “Assembly line balancing”, International Journals of Production Economics pp 509–528.

[9] Sarvesh Kumar Srivastava, R. M. Belokar, Mudit Jaithalia, Akash Verma, Kuldip Singh [2013], “Kaizen for low cost automation in automobile assembly line”, Manufacturing, Engineering and Technology Group Center for Automotive Research, Chandigarh.

[10] Timothy J. Sturgeon, Olga Memedovic, Johannes Van Biesebroeck and Gary Gereffi [2009], “Globalization of the automotive industry: main features and trends”, International Journals Technological Learning, Innovation and Development, Vol. **2**, Nos. 12.

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