

Production Planning Control of Bottlenecks by Operation Shifting in Workplace

Jitendra G. Shinde¹, Shamuvel V Pandit², Raju B Lokapure³, Sunil J. Kadam⁴

Assistant Professor, Department of Mechanical Engineering, BVC Engineering, Kolhapur, Maharashtra, India¹

Assistant Professor, Department of Mechanical Engineering, BVC Engineering, Kolhapur, Maharashtra, India²

Assistant Professor, Department of Mechanical Engineering, BVC Engineering, Kolhapur, Maharashtra, India³

Associate Professor, Department of Mechanical Engineering, BVC Engineering, Kolhapur, Maharashtra, India³

ABSTRACT: Manufacturing firms primarily aim at maximizing profit by way of meeting the customer demands with respect to quantity, quality, cost and time through optimum utilization of available resources such as; manpower, inventories, plant and facilities etc. Sometimes, due to various bottlenecks the demand is not fulfilled. This paper concerns the production planning and control of bottlenecks by operations shifting in medium scale industry.. It is possible to improve performance of manufacturing system by improving throughputs, reduction in WIP inventories; improve on time delivers and better utilization of constraint resources. Operation shifting on bottlenecks is applicable to any kind of industry for improving scheduling planning.

KEYWORDS: Bottlenecks, Production line, Production process, production line layout, workplace.

I. INTRODUCTION

Competing situations in today's manufacturing environment force organizations to adopt a new Production Management System (PMS). In the last three decades, different PMS systems have been developed: MRP II, JIT, and TOC. The traditional approach, MRP, is "passive" in that it plans and controls a production system that it assumes rates and times are fixed. These include, but are not limited to, setup times, processing times, move and queue times, breakdown rates, repair times, and scrap rates. Within the constraints of this fixed environment, it tries to maximize the production output. JIT, on the other hand, is 'active'. It reduces inventory levels, making production plans difficult to execute unless improvements are made in the production system. Typical improvements include reducing setup times, move and queue times, breakdown rates, repair times and scrap rates. JIT tries to achieve two equally important goals maximize production and make improvements [Miltenburg, 1997] [8]. Both MRP II and JIT have their own weaknesses to deal with in different conditions [Fogarty et. al., 1991] [2]. MRP ignores improvement of the production system. To be successfully implemented, JIT needs very rigid and restricted conditions.

Operation shifting on bottlenecks can be summarized as a solution for continuous improvement including operations strategy tools, performance measurement systems, and thinking process tools [Cox and Spencer 1998] [1]. The operations strategy tools include the five focusing steps, VAT analysis, and specific applications such as production management (drum-buffer rope, buffer management, batching, and product mix analysis), distribution management, and project management.

II. IDENTIFICATION OF BOTTLENECKS

The comparison between available capacity and the required capacity (demand) is very useful to identification of constraint resource (CR). The resource having capacity less than demand is identified constraint resource (CR). The resource having available capacity more than required capacity (demand) is identified as non constraint resource (NCR). When the available capacity matches with demand those resources are identified as capacity constraint resource (CCR). If the capacity constraint resources are not scheduled properly, they will become constraint resources. Hence equal amount of attention is given towards the capacity constraint resources.[4]

Table no.1 shows the comparison between total available capacity of each resource and total required capacity of each resource in the housing production line. Identification of constraint resource by comparing available capacity and demand placed on each resource is shown in table no. 1



Table no.1 Comparison of Total Available Capacity of the Resources and Total Demand Placed on the Resources

Sr no.	Machine resource	Available Capacity (min.)	Demand per Day (Required Capacity) (min.)	Remark
1	VTL 2	1230 min	1380 min	Constraint Resource
2	HMC 2	1230 min	1500 min	Constraint Resource

Time Study sheet

For constraint resource Time Study is carried out using stopwatch is shown in table no.2

Table no.2 Time StudySheet

III. EXPLOITATION OF THE CONSTRAINT RESOURCES

Once the constraint resource is identified, it should be exploited so as to utilize them up to the maximum extend. The exploitation of the constraint includes preparation of the master production schedule for the constraint. This schedule is called as drum. Once the drum schedule is decided, the schedules for other non-constraint resources are adjusted to support the drum schedule. The next step during the exploitation is decision regarding the location and sizes of buffer stock. The buffer stock should be maintained in front of the constraint resource so as to avoid any disruption in the flow.

1. Preparation of ‘Bottlenecks

The manufacturing production line needs some control points for control of the product flow through entire production line. The Theory of Constraints argues that, the best place for control point is at the bottleneck. This

VTL 2	6/7/18	8.50 min	3.01 min	11.51 min	19 sec
		8.50 min	3.02 min	11.52 min	22 sec
		8.50 min	3.04 min	11.54 min	20 sec
		8.50 min	3.00 min	11.50 min	21 sec
HMC 2	7/7/18	12.50 min	----	12.50 min	20sec
		12.50 min	----	12.50 min	19 sec
		12.50 min	----	12.50 min	22 sec
		12.50 min	----	12.50 min	20 sec

control point is called the drum, as it strikes the performance of manufacturing function.Drum mainly includes single machine scheduling of the constraint resource (CR). Once the monthly demand of housing received from the production planning department, this demand converted into the number of days for production on the constraint resource (CR). As the company manufactures different types of housings, the loading of the constraint resources i.e. VTL 2 machine and HMC 2 machine has done on basis of the due dates for different types of housings. At sametime, as the company has to carry out at least five housing products settings per month. This has done for the housing production line; there is considerable impact of setting time on the availability of the constraint resource. Hence, the schedule is prepared such that non-productive time of the constraint resources due to setting should be as less as possible.

2. Planning regarding time buffer

According to Operation shifting methodology the buffer stock should be maintained in front of constraint resources so as to compensate any disturbance in the product flow. This buffer stock will ensure that the constraint resource running continuously with ‘no-load’ condition. Although, these time buffers add extra amount of WIP inventory, they make



sure that no time will be lost at these constraint resources. The location as well as size of this buffer plays a very important role in DBR methodology. Initially, utilization of the constraint resources HMC 2 machine and VTL 2 machine has been carried out in idle period by providing a time buffer in front of them. During the idle period, 35 minutes were available. We utilized these constraint resources for 35 minutes in two shifts and observed that some amount of improvement in production volume. But production volume of selected housing product has not increased up to the required demand. The suggestion of utilizing constraint resources in the idle period was found unsuitable on practical grounds because of unavailability of skilled workers on these resources and also reluctance from workers. Hence, utilization of constraint resources in idle period is not possible to achieve required demand. [6]

3. Decision regarding buffer stock (capacity buffer)

According to Operation shifting methodology, buffer stock should be maintained in front of constraint resources. The fig 1 shows layout of housing production line. In this production line two constraint resources are identified i.e. HMC 2 machine and VTL 2 machine, because of limited capacity with respect to demand placed on these resources.

4. Planning for HMC 2 constraint resource

According to Operation shifting process, the resource whose capacity is less than demand is identified as a constraint resource and also the resource in front of maximum WIP inventory is identified as a constraint resource. Available capacity of each resource in the housing production line is 1230 minutes per day (3 shifts). The demand placed on HMC 2 machine was 1500 minutes per day before TOC. This means that capacity of HMC 2 machine was less than demand placed on it and maximum number of WIP inventory accumulated in front of HMC 2 machine. Hence HMC 2 machine has been identified as a constraint resource. For achieving the production target, 40 parts are required from each resource in housing production line per shift, but because of limited capacity HMC 2 machine it produces about 32 parts per shift. Hence there was a shortage of about 8 parts per shift.

HMC 2 machine is utilized for side milling, side drilling, tapping and counterboring operations on selected housing product. For these operations, cycle time required on HMC 2 machine was 12.5 minutes. To overcome this problem, we introduced Tap Fast 1 (TM L1) machine. The tapping and chamfering operations of HMC 2 machine were shifted to Tap Fast 1 machine. Therefore HMC 2 machine now utilizes only for side milling and side drilling operations.

Table 2 Time Study of the HMC 2 and Tap Fast 1 Machine Resources

Resource	Date	Remark		Total Cycle Time
		Cycle Time	Loading/Unloading	
HMC 2	04/11/2018	10.00 min	----	10.00 min
		10.00 min	----	10.00 min
		10.00 min	----	10.00 min
		10.00 min	----	10.00 min
		10.00 min	----	10.00 min
Tap Fast 1	05/11/2018	2.48 min	2.53 min	5.01 min
		2.51 min	2.50 min	5.01 min
		2.49 min	2.51 min	5.00 min
		2.5 min	2.49 min	4.99 min
		2.5 min	2.50 min	5.00 min

After involving Tap Fast 1 machine (TM L1), the HMC 2 machine utilizes only for side milling and side drilling operations. For these side milling and side drilling operations, 10-minute cycle time is required for machining on the HMC 2 machine. The Tap Fast 1 machine utilizes only for tapping and chamfering operations. Cycle time on (TM L1) is 5 minutes per job for tapping and chamfering operations. Time study of HMC 2 machine and Tap Fast 1 machine is shown in table 2. Therefore, HMC 2 machine has converted from a constraint resource (CR) into a capacity constraint resource (CCR), if it is not properly scheduled it will again convert into a constraint resource.



5. Planning for Solved VTL 2 constraint resource

After HMC 2 machine has converted constraint resource (CR) into capacity constraint resource (CCR), the performance of production line has measured. After performance of housing production line measured by introducing Tap Fast 1 machine, it is found that, VTL 2 machine has constraint resource because its capacity less than demand. Also in front of VTL 2 machine huge WIP inventory accumulated. The capacity of the each resource in housing production line is 1230 minutes per day. The demand of VTL 2 machine is 1380 minutes per day. This means that, capacity of VTL 2 machine less than demand placed on it. In front of VTL 2 machine we observed 5 parts WIP inventory accumulated per shift; hence VTL 2 machine identified as constraint resource. Because of limited capacity of VTL 2 machine there was disruption of the product flow in the housing production line. The buffer stock should be maintained in front of the constraint resource to avoid any disruption in the flow. For achieving the production target, 40 parts are required from each resource in housing production line per shift. But, because of limited capacity VTL 2 machine it produces 34 to 35 parts. Hence there was shortage of 5 parts per shift. To overcome this problem, by introducing Turret Lathe 3 (TL 3) machine. Turret lathe 3 machine has maintained 5 housing parts (capacity buffer stock) in front of the VTL 2 machine and balance the production line. Total cycle time of (TL 3) machine has 16 minutes per job. After involving (TL 3) machine, it provided 5 parts per shift and line has balanced. Each shift TL3 utilize up to 80 to 90 minutes. Remaining 320 minutes TL3 utilized for machining of other housing products and development work. Time study data of Turret Lathe 3 machine is shown in table 3.

Table 3. Time Study of Turret Lathe 3 Machine

Resource	Date	Remark		Total Cycle Time
		Cycle Time	Loading/Unloading	
Turret Lathe 3	11/12/2018	13.01 min	3.03 min	16.04 min
		13.02 min	3.00 min	16.02 min
		13.02 min	3.03min	16.05 min
		13.04 min	3.00 min	16.04 min
		13.00 min	3.02 min	16.02 min

Now, the VTL 2 machine resource has converted constraint resource (CR) into capacity constraint resource (CCR).

IV. RESULTS AND DISCUSSION

After Operation shifting on bottlenecks, the analysis gives following results.

Table. 4 Result and Discussion

Performance Parameter	Before Operation shifting	After Operation shifting	Percentage of Improvement
On Time Deliveries	82%	97%	15%
Production Volume	992%	1162%	17%
Profit	Rs.3,53,010/-	Rs.4,14,313/-	17%
Labour Productivity	17.71	18.17	2.59%
Machine Productivity	2.4195	2.8356	17.19%
Material Productivity	0.3787	0.4388	15.87%
Work in process inventory	207	35	83%
Raw material inventory	239	62	74%

V. CONCLUSION

Operation shifting brings an important dimension to management philosophy and provides an interesting challenge to the traditional ways of looking at an organization's profitability. Adopted within a wide variety of organizations and settings, it appears that organizations using Operation shifting have determined that it can help them achieve a number of management objectives, including continuous improvement.

Inventories are used to give the impression of good control and maximum equipment utilization. But much were inventories same times accumulates more investment of the organization and this concept keeping inventory was traditionally used in proven new industry. Operation shifting proves the above traditional logic wrong. The Operation shifting provides reduction of WIP inventory, improvement in percentage of on time delivers, improvement in production rate and reduction of the raw material inventory.

REFERENCES

- [1] Cox, J.F. and Spencer, M.S., The Constraints Management Handbook, CRC Press LLC: Boca Raton, FL, 1998.
- [2] Fawcett, S.E. and Pearson, J.N., Understanding and Applying Constraint Management in Today's Manufacturing Environment. *Production and Inventory Management Journal*, 1991, 32(3), 46-55.
- [3] Fogarty, D.W., Jahn H. Blacstone, Thomas R. Hoffman, *Production and Inventory Management*. Southwestern Publishing CO., 1991, 2nd Edition.
- [4] Fox, R.E. and Goldratt, E.M., *The Race*. New York: North River Press, 1986.
- [5] Fredendall, L.D. and Lea, B.R., Improving the Product Mix Heuristic in the Theory of Constraints. *International Journal of Production Research*, 1997, 35(6), 1535-1544.
- [6] Gupta, M.C., Constraints management—recent advances and practices, *International Journal of Production Research*, 2003, 41(4), 647-659.
- [7] Mabin, V.J., The performance of the theory of constraints methodology Analysis and Discussion of successful TOC applications, *International Journal of Operations & Production Management*, 2003, 23(6), 568-595.
- [8] Miltenburg, J., Comparing JIT, MRP and TOC, and Embedding TOC into MRP. *International Journal of Production Research*, 1997, 35(4), 1147-1169.
- [9] Schragenheim, E. and Ronen, B., Drum-Buffer-Rope Shop Floor Control. *Production and Inventory Management Journal*, 1990, 31(3), 18-22.
- [10] Spencer, M.S., Using "The goal" in an MRP System Production Control. *Production and Inventory Management Journal*, 1991, Q4, 22-77.
- [11] Spencer, M. and Cox, J.F., Optimum Production Technology, *International Journal of Production Research*, 1995, 33(6), 1495-1504.
- [12] M., Umble and Murakami, S., Implementing theory of constraints in a traditional Japanese manufacturing environment, *International Journal of Production Research*, 2006, 44(10), 1863-1880.
- [13] ThomsCobett, J.M. Csillag, "Analysis of the effect of DBR implementations", *Production and Inventory Management journal*, (2001), vol.4, pp.17-23.
- [14] Tsai-Chi Kuo, Sheng-Huang Chang, Shang-Nan Huang, "Due-date performance improvement using TOC's aggregated time buffer method at a wafer fabrication factory", *Expert Systems with Applications* 36, (2009), pp.1783-1792.
- [15] Christopher Olson, "TOC: Application to a Service Firm", *Production and Inventory Management journal*, (1998), vol.2, pp.55-59.