AN ASSESSMENT OF MODULAR MANUFACTURING APPROACH IN GARMENT INDUSTRY BY USING SIMULATION

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ABSTRACT

Currently, the readymade garment industry plays a vital role in the National economy of every country around the globe. In this case study, the concept of the modular approach is in the Garment industry with the help of Plant simulation software. If modular approach the sectional framework was intended for a base product taking a shot at three changed movement principles which change in some way from the ones accessible in literature. Then show of the framework was settled as far as machine efficiency, workers and productivity, throughput time and work in progress WIP.

KEYWORDS: *Modular Manufacturing, Plant Simulation & Expert-Model*

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I. INTRODUCTION

Because of better expectations of living and quickly changing design patterns, piece of garment producers have experienced startling requests and decent variety. So as to react as quickly as conceivable to demonstrate and volume changes and to deliver high-quality, low-cost products, the makers are supporting new generation frameworks which depend on JIT. In view of its adaptability and effortlessness, measured assembling has started to be actualized in certain associations. AAMA has defined modular manufacturing as “a contained attainable work unit of 5 to 17 human beings appearing a measurable task. The workers are interchangeable amongst responsibilities in the institution to the quantity sensible and incentive repayment is based totally at the group’s output of first high-quality output” [1]. In a modular approach, techniques are grouped right into a module as opposed to being divided into their smallest components. Normally, less quantities of multi-functional workers work at the machines which can be organized in a U-line. All of the workers in the institution are answerable for the best of each item which are produced within the line. The approach works while a hassle of pleasant is reached; the workers in the institution ought to coordinate their fine work, which ends up in a rise in exceptional. The modular framework works at the precept of pull-kind production approaches’ frameworks, in which the task order request originates from the end venture to past advances. Because of this, the work in progress is low, even working when no inventory is feasible.

II. THE LITERATURE REVIEW

The modular approach changed into first put into effected at Toyota in 1978 as a part of JIT, and become recognized in the 1980s within the West because the Toyota stitching machine. Monden gave this machine a U-

turn layout and claimed that the main benefit of that approach become that the volume produced can easily be organized with the aid of changing the quantity of workers working inside the approach [2]. Gilbert confirmed that the principle advantage of the machine was the low quantity of the work in approach [3]. In 1990, Kuler & Dewitt reached encouraging results, and claimed that it was viable to produce pleasant products at a whole lot decrease prices. They also decided that the throughput time of the products in the gadget changed into an awful lot shorter than in conventional approaches'. Furthermore, the approach became pretty resistant to worker turnover [4].

When the operating ideas of the structures in literature are analyzed, it's far seen that numerous researchers worked on one-of-a-kind approaches' with special motion standards. The commonplace point of the unlike research is that the researchers have preferred to examine the approach by using simulation. In 1991, Wang & Ziemke simulated an approach which became working at the motion concepts primarily based at the Toyota stitching approach. On this machine, the following precept is stated: the items always circulate ahead in the approach, even as the workers circulate ahead with the item and then circulate backward for additional paintings. In the Toyota approach, the workers shifting backward for locating a work piece can interrupt the workers if he cannot find any work piece waiting to be sewn. Wang & Ziemke discovered that the gadget showed excessive execution, despite the fact that the operation times of each station numerous considerably among each unlike. In addition they decided that when a while the workers formed their very own paintings styles [1]. Schroer et al. built a simulation package deal that is appropriate for use in garb manufacturing agencies. This array can simulate the approach according to 3 ideas of motion, which can be the rabbit chase, the Toyota seam approach and the combined production module. Within the rabbit chase, the workers working on all machines in sequence. For the blended manufacturing module, the researchers defined the bundle and time limits that are the premise for the choice taken by way of the workers [5]. According to Schroer & black the modular approach as manned modules and given to use decouplers which separate and hyperlink the mobile, and characteristic as a balancing element for exclusive operation instances [6]. Black & Chen built linked modules in the gadget in step with the variety of employees in the approach, and brought decouplers thru that approach. They studied the effects of changing the potential of decouplers at the machine [4].

III. METHODOLOGY

3.1 Description of Model

The modular approach will promptly be applied in firms that primarily produce standard products. During this study, the approach is meant for a garment company manufacturing men's, women's, and children's casual and sportswear. The shirt for man was chosen as the base product due to the high and constant demand for this product. Once establishing the base product, the operational flow for that product decided. The operations that are conducted on a similar kind of machine area unit combined together. The quality times for every operation are determined, and also the combined operations times' area unit added to any or all of them. Normal deviations for each operation were taken as 100% of the operation time.

The expert model Simulation Package was employed in the modelling, that was conducted in three steps; define, detail and display. Within the program, information about the execution parameters was collected as statistics.

Three specific principles of motion concepts had been designed for the modular manufacturing model. The variation in approach execution was analyzed by means of changing the range of workers and the allowed inventory reachable. Furthermore, the bottleneck station with a high operation time became analyzed, a parallel line changed into shaped and the growth within the device execution was determined.

3.2 The Principles of Motion

3.2.1 Expanded Rabbit Chase

This name was given to this method as it contrasts from the bunny rabbit hunt method which has been generally experienced in the symbols. All the workers in the approach are multi-functional. The workers takes the work piece from the primary station and plays out all the tasks in succession to the last station. In any case, if the workers meets another workers at the following station which he will work, he leaves the piece on that next station, and goes to take the work piece which is holding up at the station nearest to the finish of the U-line. Inside this method, approach execution with various number of workers was dissected. Additionally, the station which causes a bottleneck in the working condition with 5 workers, since it has the longest activity time, was paralleled and the adjustment in the approach's exhibition was watched.

3.2.2 Connected Module Method (Table 1)

The quantity of modules is controlled by isolating the all-out activity time by the quantity of workers. The tasks are assembled by this profit discovered. The stations close to one another were placed in a similar module; the U-turn format made this guideline substantially more relevant. The modules were connected together with the decouplers, which allowed various stock. In this method, the workers in any module takes the piece from the primary station of the module, directs all the activities in grouping and takes it to the last station of the module. Inside this method, the adjustments in the approach's exhibition with various quantities of workers and diverse decoupler limits were broke down.

3.2.3 Communal Modules Method (Table 2)

In this method, the approach is again partitioned into modules. This method was shaped to dispose of the bottlenecks that happens in the connected module method. In the connected module method, the workers work in particular modules, and as the all-out activity times of every module are not actually equivalent to one another, bottlenecks sometimes happen and the workers can wind up inert while sitting tight for a work piece. To avoid these bottlenecks, workers in the module are allowed to work in the last and first stations of the modules when his very own module is between them. The workers takes the work piece from the first station in quite a while possess working module and takes it to the last station of that module by making tasks in succession. In the event that the workers who works on the following module isn't occupied and is sitting tight for him to hand over the work piece, the workers gives the work piece to the workers who isn't occupied, and turns back. On the off chance that the workers on the following module is occupied, at that point the workers of the past module keeps on working on the common station with the work piece which he has brought. Inside this method, the impact of various measures of workers and allowed stock on the approach's exhibition was broke down. In this approach, the bottleneck station which makes the activity time longer (despite isolating the approach into shared modules) was likewise paralleled, and the impact of this on the approach was watched.

- The accompanying suppositions and limitations were utilized in like manner for all 3 movement standards in the development of the master model reenactment model:
- All workers perform at a similar productivity at each station.
- The handling time at each station pursues the ordinary circulation, with a standard deviation of 10 percent of the interim.

- The machines are accepted to have no downtime.
- Decouplers can hold more than one section.
- The time for the workers to move between stations is thought to be zero.
- There are constantly cut materials holding up at Station 1. Subsequently, the approach never looks out for approaching parts.
- Within all approaches', the work piece which is nearest to the finish of this U-line has need.

IV. RESULTS OF SIMULATION

4.1 Productivity

The maximum productivity and the productivity per work as per not at all like quantities of workers and not at all like movement standards is displayed in table 3.

The measure of productivity is most noteworthy with the RCB methods, where the specialist has the opportunity to take a shot at all of the stations. The productivity in shared modules is also higher than the connected module technique, in which the activity times of each module don't actually relate to each other. In the extended hare pursue and shared modules methods, the third station which caused the bottleneck in working condition with 5 workers was paralleled and reproduced for that condition. From the consequences of the reenactment, it is effectively observed that including a parallel station also rises the productivity, yet not as much true to form.

Table 1: The Total Operation Time and Stations of each Module in the Connected Module Method

Worker	Station No.	Total Operation tme(Sec)
3-Module Case		
1 st worker	1,2,3,5	202
2 nd worker	4,7,8	193
3 rd worker	6,9,10	190
4-Module Case		
1 st worker	1,6,9	138
2 nd worker	2,4,7	136
3 rd worker	3,5	145
4 th worker	8,10	157
5-Module Case		
1 st worker	1,2,10	114
2 nd worker	3	133
3 rd worker	4,7	103
4 th worker	5,8	103
5 th worker	6,9	124

Table 2: The Number of Stations that each Worker can Work on of each Module in Shared Module Method

Worker	Station No.
Shared Module with 3-Workers Case	
1 st worker	1,2,3,4,5
2 nd worker	5,6,7,8
3 rd worker	8,9,10
Shared Module with 4-Workers Case	
1 st worker	1,2,3
2 nd worker	3,4,5,6,7
3 rd worker	7,8,9
4 th worker	9,10
Shared Module with 5-Workers Case	
1 st worker	1,2,3
2 nd worker	3,4,5,6
3 rd worker	6,7,8
4 th worker	8,9
5 th worker	9,10

4.2 Decoupler Capacity

The result of the permissible decoupler's capacity in operational conditions with 3 and 4 workers is introduced in Figure 1. As the decouplers' capacity rises, the absolute productivity rises. In any case, that rise happens at a shrinking rate, and gets consistent subsequent to arriving at the utmost worth. The rise in decoupler capacity rises the framework's productivity by shrinking the measure of inert time of the workers who are sitting tight for the following work piece.

Table 3: Total Productivity and Productivity per Labor with Respect to Change in Number of Workers and Various Motion Principles

Type of Method	Total Productivity with 3 Workers	Individual Productivity with 3 Workers	Total Productivity with 4 Workers	Individual Productivity with 4 Workers	Total Productivity with 3 Workers	Individual Productivity with 5 Workers
Shared module method (SM)	148	49.33	180	45.00	197	39.40
Shared module method with parallel station (SMP)	0	0.00	0	0.00	217	43.40
Linked module method with interval stock capacity of 1 (LM-1)	122	40.67	149	37.25	235	47.00
Linked module method with interval stock capacity of 2 (LM-2)	129	43.00	157	39.25	240	48.00
Linked module method with interval stock capacity of 3 (LM-3)	137	45.67	173	43.25	240	48.00
Expanded rabbit chase method (ERC)	160	53.33	191	47.75	263	48.00

Expanded rabbit chase method with parallel station (ERCP)	0	0.00	0	0.00	277	55.40
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Figure 1: The Effect Allowed Decouplers Capacity in Working Conditions with a) 3 Workers b) 4 Workers.

Figure 2: Expected and Real Cycle Time According to Different Principles of Motion.

Figure 3: Case-1: With 3- Workers, Case-2: With 4- Workers Case-3: With 5-Workers
(The First Number in the Abbreviations Stands for the no. of Workers,
the Second Stands for Stock Capacity.

Figure 4: The Throughput time According to Different Principles of Motion.

Figure 5: Average Work in Process in the System for Different Methods.

4.3 Labor Efficiency

The worker's efficiency as per the methods utilized is given in Figure 2. The work load is progressively adjusted in the extended hare pursue method, depending on the opportunity given to the workers. The work load in both the connected module and shared module methods relies upon the absolute activity time of every module. In the common module method, the work load doesn't actually show the complete operational time contrasts of various modules, as the workers are permitted to work at two additional stations which don't have a place with their very own working module.

4.4 Machine Handling Ratio

The machine handling proportion as indicated by the various movement standards is given in Table 4. Machine handling proportion relies upon the measure of the generation of the approach. The machine handling is low as the workers are movable and there are less workers than machines. So there is no unfaltering worker who works on each machine during all the recreation time. In the efficiency investigation, it was seen that parallel stations expanded the profitability; in any case, in the table above it is seen that the handling of both these parallel machines become very low. This proportion can be expanded if the quantity of workers in the approach increments.

4.5 Progress Duration (Cycle Time)

The normal and genuine progress duration (Cycle time) as per various movement standards is given in Figure 3. The determined progress duration, which is assessed by partitioning the all-out activity time for one item by the quantity of workers in the approach, is just come to with the bunny pursue method, which additionally has the most extreme efficiency.

4.6 Throughput Time

The throughput time as indicated by various movement standards given at Figure 4. The throughput time is most noteworthy in the connected module method, where it is permitted to work with interim stock. It is likewise observed that throughput time increments as the decouplers' ability builds, regardless of the measure of workers in the approach. Dissecting the consequences of Table 3 and Figure 4 together, it tends to be said that the increase in the decouplers' ability

influences the throughput time substantially more than the efficiency of the approach.

4.7 Work- In- Progress

The normal work in progress in the approach for various methods is given in Figure 5. The extended bunny pursue and shared module approaches' don't utilize any close by stock, so the work in progress for both of these approaches is low. Then again, it was discovered in the connected module method that the decoupler's ability expands the normal work in progress, yet again the measure of work in progress scarcely arrives at 7, which is exceptionally low.

V. CONCLUSIONS

In this case study, a modular manufacturing approach working based on three movement standards, the expanded rabbit pursue, connected modules and shared module methods, was created utilizing the Expert-model reproduction bundle program. The approach execution as far as efficiency, machine and work use, throughput and process duration and the volume of normal stock close by was investigated. The quantity of workers and the volume of interest were taken as control parameters. The impacts of the volume of stock permitted and multiplying the bottleneck station were watched.

Table 4: Machine Utilization Ratio with Effect Different Motion Principles

Machine No	SM-5	SMP-5	LM-5-1	LM-5-2	LM-5-3	ERC-5-1	ERMP-5
M-1	8.81	9.69	10.71	10.75	10.82	11.58	12.25
M-2	20.33	22.72	25.08	25.19	25.33	27.48	28.67
M-3	81.76	60.80	98.78	99.62	99.62	99.32	74.31
M-3-2		15.16					14.66
M-4	3.73	4.08	4.54	4.54	4.48	4.93	5.24
M-5	7.45	8.05	9.01	8.92	8.92	9.87	10.40
M-6	20.00	21.97	24.70	24.88	24.59	27.07	28.20
M-7	59.67	65.23	71.19	71.97	70.48	77.79	82.63
M-8	55.05	61.00	67.40	67.56	65.88	72.88	77.37
M-9	54.63	59.96	67.03	66.36	65.79	73.14	76.36
M-10	40.12	44.10	48.87	48.87	48.49	53.75	56.34

It was found that the expanded rabbit pursue approach, which gives more opportunity to the workers as far as movement, indicated the most noteworthy execution. In the expanded rabbit pursue method, the worker who is obstructed by another worker leaves the work piece he was working on in the blocked station, and goes to take up another work piece in another station. In the other two approaches examined, it was seen that the shared module approach demonstrated higher execution than the connected modules method. The purpose behind the connected module approach's lower execution is the modules' lopsided activity times. So the shared modules method, which was offered as having adaptable module locales and enabling the workers to utilize the stations which lie on different sides of the module districts, demonstrated higher execution.

Then again, expanding the decouplers' ability and multiplying the bottleneck station expanded the execution of the approach where these circumstances were analyzed. It was seen that the increase in decouplers' ability changes the execution somewhat, however in the wake of arriving at a cutoff esteem, it has no further impact. When multiplying the bottleneck station, it was seen that this facilitates the work stream in a specific way. However, disposing of the principal bottleneck of the approach can make another bottleneck happen, as is found in the expanded rabbit pursue method.

All in all, it was found that the expanded rabbit chase method in which the workers are given the opportunity to decide their very own work designs was substantially more effective. The issues that happen during activity can be illuminated by multiplying the bottleneck stations. Then again, the module type creation execution of the approach can be improved by expanding the volume of the decouplers' ability or by permitting some adaptability as far as the module areas, as on account of shared modules.

VI. REFERENCES

1. Wang, J., Schroer, B.J. & Ziemke, M.C., 'Understanding Modular Manufacturing in the Apparel Industry Using Simulation', *Proceedings of the 23rd Winter Simulation Congress, Baltimore, Arizona, 1991, 8-11 December*, pp. 441-447.
2. Bischak, D.P., 'Performance of a Manufacturing Module with Moving Workers', *IIE Transactions*, 1996, 28, pp. 723-734.
3. Gilbert, C.S., 'Tracking Modular Production', *Apparel Industry Magazine*, 1988, April, pp. 72-74.
4. Black, J.T., Chen, J.C., 'The Role of Decouplers in JIT Pull Apparel Cells', *Int. J. of Clothing Science and Technology*, 1995, 7, pp. 17-36.
5. Farrington, P.A., Schroer, B.J. and Swain, J.J., 'Simulators as A Tool for Rapid Manufacturing Simulation', *Proceedings of the 26th Winter Simulation Conference, Orlando, Florida, 1994, December 11-14*, pp. 994-1000.
6. Black, J.T. and Schroer, B.J., 'Simulation of an Apparel Assembly Cell with Walking Workers and Decouplers', *Journal of Manufacturing Systems*, 1993, 12, pp. 170-180.