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SIMULATION BASED APPROACH TO EVALUATE MODULAR MANUFACTURING SYSTEM IN THE APPAREL INDUSTRY

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ABSTRACT

The Sri Lankan garment industry needs to become competitive to face the quota-free global challenges and industry is now facing new challenges to compete with a global market. In the path to achieve the new challenges to compete with quota-free global, many Sri Lankan apparel manufacturing companies are moving towards lean concept, especially into modular manufacturing from traditional line production. Recent interactions with local apparel manufacturing companies revealed that most factories could not achieve desired results through modular systems due to various causes such as resources and capacity issues, operational issues and production strategies. Furthermore, it appears that many apparel manufactures are uncertain about the outcomes of the modular system with respect to their own situations before implementing in a real system. Therefore, it is very important to compare performance and operational characteristics of the modular system over the line production system before adoption of such changes. These changes are costly and time consuming in the real situation, and many manufactures are resistant to these changes, especially while production are running for existing orders. This paper discusses how computer simulation is used as a test bed for compare production performance in two production systems, line and modular, before they are implemented in real systems.

Key words: Modular Manufacturing, Simulation, Apparel

1. INTRODUCTION

With the removal of US quota, Sri Lankan garment industry had to diverted to methods in unit cost reduction, pursue timely delivery and develop quick response to foreign orders. Therefore, apparel industries need to review their business functions constantly; search new ways of streamlining their businesses, implement new changes make them more effective to meet an increasingly competitive market place. These “changes” enable local industries to provide better services, minimize their administrative and labor cost, and reduce cycle time and increase quality and productivity. As a result, many Sri Lankan apparel manufacturing companies are moving towards the lean concept, especially into modular production system.

Most of the Sri Lankan factories employ line production set up which has long throughput time, high work in progress, unmanageable queues lengthy lines, quality and absenteeism issues. Therefore, manufacturers focus on a modular system, one of most popular layout system in lean manufacturing concept [1]. Recent interactions with local apparel manufacturing companies revealed that most factories could not achieve desired results through modular systems due to various causes such as resources and capacity issues, operational issues and production strategies and commitment. Furthermore, it appears that many apparel manufactures are uncertain about the outcomes of the modular system with respect to their own situations before implementing in a real system, and the manufacturers wanted a pre assurance from consultants before moving to modular system/lean manufacturing.

This paper summaries how computer simulation is used to assess performance of two production systems, line and modular, allowing investors to assess their own performances prior to implement in a real system. Two simulation models were developed using Arena simulation software, and these models enable to identify production bottlenecks and measure performance indicators more accurately.

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2. APPAREL PRODUCTION SYSTEMS

One of the major features within the plant or production environment is the production system. An apparel production system is an integration of materials handling, production processes, personnel, and equipment that directs work flow and generates finished products.

2.1 Bundle System and Progressive Bundle System

There are two types of conventional production systems are commonly used to produce mass apparel. They are bundle system and progressive bundle system. The progressive bundle system is a variation of bundle system [2]. Each system requires an appropriate management philosophy, materials handling methods, floor layout, and employee training. The progressive bundle system gets its name from the bundles of garment parts that are moved sequentially from operation to operation. This system, often referred to as the traditional production system, has been widely used by apparel manufacturers for several decades and still is today [2]. Bundles consist of garment parts needed to complete a specific operation or garment component. For example, an operation bundle for pocket setting might include shirt fronts and pockets that are to be attached. Bundle sizes may range from two to a hundred parts. Some firms operate with a standard bundle size, while other firms vary bundle sizes according to cutting orders, fabric shading, size of the pieces in the bundle, and the operation that is to be completed. Some firms use a dozen or multiples of a dozen because their sales are in dozens. Bundles are assembled in the cutting room where cut parts are matched up with corresponding parts and bundle tickets. Bundles of cut parts are transported to the sewing room and given to the operator scheduled to complete the operation. One operator is expected to perform the same operation on all the pieces in the bundle, tie up the bundle, process coupon, and set it aside until it is picked up and moved to the next operation.

A progressive bundle system may require a high volume of work in process cause of the number of units in the bundles and the large buffer of backup that is needed to ensure a continuous work flow for all operators.

The progressive bundle system may be used with a skill center or line layout depending on the order that bundles are advanced through production. Each style may have different processing requirements and thus different routing. Routing identifies the basic operations, sequence of production, and the skill centers where those operations are to be performed. Some operations are common to many styles, and at those operations, work may build up waiting to be processed.

Advantages:

1. Operators perform the same operation on a continuing basis, which allows them to increase their speed and productivity
2. The success of a bundle system may depend on how the system is set up and used in a plant.
3. This system may allow better utilization of specialized machines, as output from one special purpose automated machine may be able to supply several operators for the next operation.
4. Small bundles allow faster throughput unless there are bottlenecks and extensive waiting between operations.

Disadvantages:

1. The progressive bundle system is driven by cost efficiency for individual operations.
2. Operators who are compensated by piece rates become extremely efficient at one operation and may not be willing to learn a new operation because it reduces their efficiency and earnings. Individual operators that work in a progressive bundle system are independent of other operators and the final product.
3. Slow processing, absenteeism, and equipment failure may also cause major bottlenecks within the system.
4. Large quantities of work in process are often characteristic of this type of production system. This may lead to longer throughput time, poor quality concealed by bundles, large inventory, extra handling, and difficulty in controlling inventory.

2.2 Modular Production System (MPS)

The modular system was first implemented at Toyota as part of Just in Time (JIT) production [3]. A Modular Production System (MPS) is a teamwork sewing system, which contains manageable work unit of 5 to 17 people performing a measurable task. The unit of work is a garment. Components for one garment are fed into the workflow in single ply so that bundles of components are not moved. Dissimilar machines are

clustered into a skill center or team area, for a self contained workflow. Components are passed by hand or Kanban as needed for the next operation. Cross-trained sewing teams perform short production runs and are involved in line decision making. Operators are interchangeable among tasks within the team to the extent practical, and incentive compensation is based upon the team's output of first quality products ([1] and [2]). Common layouts for modular are U, L and parallel. U become more popular as input and output can be controlled by the leader who was loaded only 80%. U shape also provides privacy and quality audits to operate from outside cell.

Advantages of a Modular Production System:

1. High flexibility
2. Shorter throughput times
3. Low wastages
4. Reduced Absenteeism
5. Reduced Repetitive Motion Ailments
6. Increased employee ownership of the production process
7. Empowered employees
8. Improved Quality

Disadvantages of Modular Production System:

1. A high capital investment in equipment.
2. High investment in initial training.
3. High cost incurred in continued training

3. COMPUTER SIMULATION MODELLING

Computer simulation is now seen as an integral tool in the design, planning, operation and restructuring of manufacturing systems. The typical manufacturing simulation model is usually used either to predict system performance or to compare two or more system designs or scenarios ([4], [5] and [6]). Layout design applications may involve modelling many different aspects of the production facility, including equipment selection, control strategies (push/pull logic), martial handling design, buffer sizing, dispatching/scheduling strategies, martial management, etc ([4] and [7]).

The availability of affordable and user-friendly software has improved the usability of computer simulation, and visual interactive simulation allows model to be viewed with real time animation.

4. DESIGN OF THE SIMULATION EXPERIMENTAL

Two simulation models for two production systems, modular and the traditional line production system i.e. progressive bundle system were developed using Arena software. A ladies chemise was chosen as the base product for the both production systems. After selecting the base product, the sequence of operations, standard times for each operation, setup times and many operational data were collected from one factory using same team of operators to maintain same operational characteristics in each set up. The alternative layouts corresponding to the study are shown figure 1 and 2.

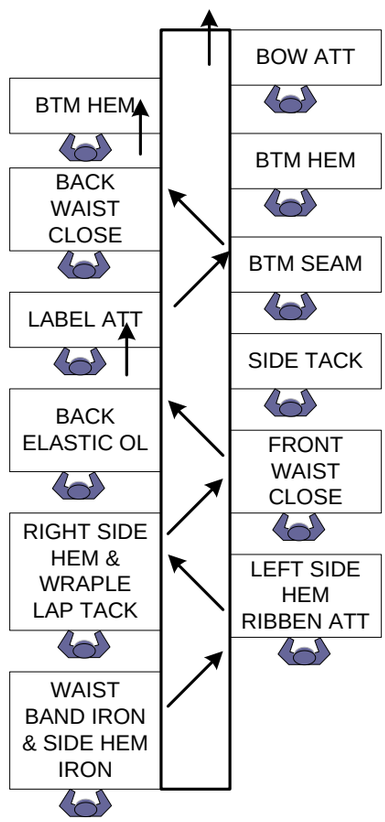

Figure 1. Layout for the line production system

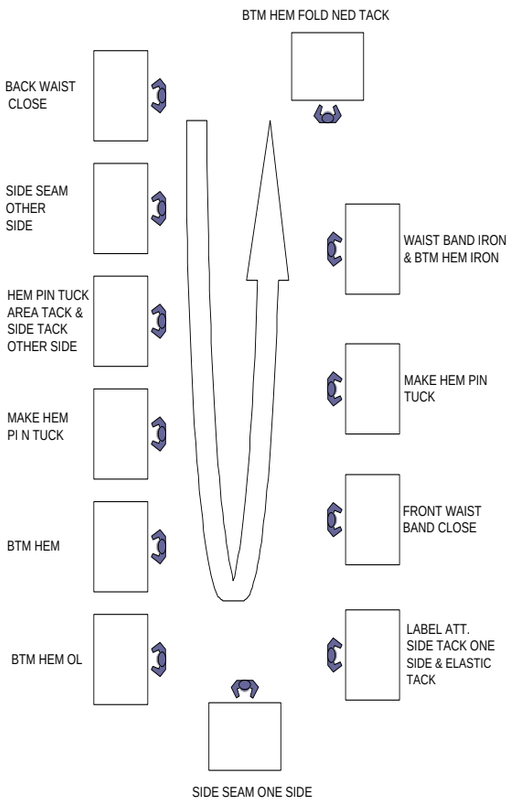

Figure 2. Layout for the modular production system

4.1 Results of the Simulation Experiment

	Line set up	**Modular set up**
Efficiency	42%	88%
Waiting time per item (min)	114	30
Resource utilization	35%	39%
Throughput time (min)	119	49

Table 1. Comparison of simulation results

Comparison of simulation results for line and modular systems are summarised in the table 1. In accordance with the results obtained, the advantage of the modular manufacturing system is demonstrated. Simulation will provide more ideal which can be the bench mark for the factory to achieve. In actual situation throughput time may take longer than the simulation due to delayed in decisions making by supervisors, personal delays and machine breakdowns etc. which are not considered in simulation models. However, these parameters can also be included into the simulation which makes model more realistic and accurate.

Furthermore, these simulation models can also be used to address following specific issues which are more important for apparel manufactures.

- Timeliness of deliveries
- Inventory policies to determine the appropriate inventory levels
- Optimum production scheduling
- System operating strategies
- Requirements of number of machines/equipments to meet specific objectives
- Material handling mechanisms
- Evaluation of a change in product volumes or mix
- Labor requirements planning
- Number of shifts required to meet customer orders

5. CONCLUSION

It can be seen that there is a strong need to introduce modern operations management techniques to textile and apparel industries in Sri Lanka. The benefits from modern operations management tools are immense. Quick response system, advanced scheduling and manufacturing, logistics and transportations, computer simulation and enterprise modelling are some of the important tools under operation management which solve the problems of manufacturing and operational problems, etc.

Among these techniques computer simulation is one of the most important and required area for the present garment industry. Computer simulation allows managers to create computer models of real systems and enable to identify production bottlenecks and measure performance indicators more accurately. Simulation models can also be used as test bed for testing new solutions before they are implemented in real systems.

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