Simulation based approach to evaluate modular manufacturing system in the apparel industry

by Gamin Hanthiringe and Kapila Liyanage

Abstract

The Sri Lankan garment industry needs to become competitive to face the quota-free global challenges, and it is imperative for the garment industry to acquire most appropriate and advanced technology, as well as modern operations management techniques. Many Sri Lankan apparel manufacturing companies are moving towards lean concept, especially into modular manufacturing from traditional line production systems. 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. Therefore, it is very important to compare performance and operational characteristics of the modular system, over the line production systems 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 model as a testing ground to show comparison of the production performance in two systems; line and modular, before they are implemented as real systems.

Key words: Modular manufacturing, Simulation, Apparel.

1. Introduction

With the removal of US quota, Sri Lankan garment industry had to get diverted to methods in unit cost reduction, pursue timely delivery and develop quick response to foreign orders. Therefore, 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 organizations 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 having 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. 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.

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 (Lin et al., 2002). 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. (Lin et al., 1995)

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

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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 (Kalaoglu and Saricam, 2007). 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 (Lin et al, 2002 and Castro et al, 2004).

Common layouts for modular are U, L and parallel. U become more popular as input and out put 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 wastage.
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 Modeling

Computer simulation is now seen as an integral tool in the design, planning, operation and restructuring of manufacturing systems. The availability of affordable and user-friendly software has improved the usability of computer simulation and it is frequently used to address a wide variety of operational problems. In computer simulation, Visual interactive simulation (VIS) allows model to be viewed as it progressed and also to interact with user. Also user can interrupt Visual display of elements moving between location and small steps in each stage, at a bottleneck. It can then be interacted by adding extra resources and continued running to obtain result to this action. Therefore simulation becomes a handy tool to run projects with changing parameters until desired results are obtained. There are tremendous opportunities to improve performance of production operations though the computer simulation. It appears that many apparel manufactures are not aware of the existence of this technique and its business benefits.

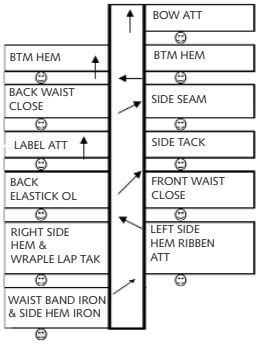

Figure 1. Plant layout for the line production system.

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.

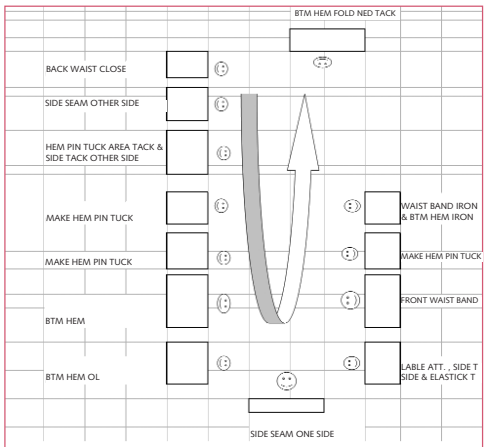

Figure 2. Plant layout for the modular production system.

	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

Results of the simulation experiment

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 decisions making by supervisors, time spent in looking for mechanics, personal delays and machine break downs 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.

- Bottlenecks analysis.
- Timeliness of deliveries.
- Inventory policies to determine the appropriate inventory levels.
- Optimum production scheduling.
- System operating strategies.
- Requirements of number of machines/equipment 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.

Limitations

1. Lead time of a production set up is disturbed by off standard times. Some of them are machine breakdowns, quality issues, material delays, no work due to unbalanced flow, fabric damages, cut damages, planning issues and personal issues.
2. Simplification was made wherever possible to avoid complicated logic that may convert the project objectives to a software application development.
3. The simulation model is to compare two systems and hence both systems suffer from above of standard times quantitatively in similar fashion. The first two are the major problems and a study was carried out for two factories and found that the distributions of these values are discrete. Though it is possible to include failures in the window "resource states and failure", these are omitted.
4. At present all factories employ a "zero feeding" or minimum set up time in both line set ups and PBS. Hence, starting at "0" time with "no production in the line or team" concept cannot be rejected at simulation when efficiency is calculated. Single Minute Exchange Die (SMED) employed in modular and conventional line set up times still applies to both systems.

Conclusion

The textile and apparel industry plays a vital role as a key driver of Sri Lanka's national economy. The apparel manufacturing industry has grown to be the most significant contributor over its twenty-five years of existence and the apparel industry is the strongest manufacturing sub-sector in terms of its contribution to industrial production, foreign exchange earnings and employment generation.

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 transportation, computer simulation and enterprise modeling 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 assess the impact of alternative solutions before implementing a chosen solution. These models not only provide vital information that mangers require. They also produce animated displays of the real system and this has become an essential element of modern business.

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