Stock Options

During Motorola’s first five years of Six Sigma deployment, there was no formal design, measure, analyze, improve and control (DMAIC) training, let alone any formal lean training. In the mid to late 1990s, Six Sigma and lean systems tended to be viewed as separate and distinct improvement methods.

Today, many organizations are integrating Six Sigma and lean, along with project management and business process reengineering. Integrating lean concepts into Six Sigma means Six Sigma implementation can borrow improvement methods from lean concepts.

All organizations have some type of inventory and control planning. A lean Six Sigma (LSS) approach to inventory management can provide competitive advantages, such as improving customer satisfaction by working with customers to develop a solution to increase on-time packaging.

A supplier of gardening, outdoor and building materials discovered those advantages when it successfully implemented an LSS framework to inventory management at its operations in Taiwan.

LSS background

LSS is a system that combines two philosophies: Lean creates the standard, and Six Sigma investigates and resolves any variation from the standard. Alternatively, LSS has been defined as an approach that synthesizes the use of established tools and methods.

The tools and methods of an LSS practitioner encompass lean production and Six Sigma toolsets. The function of LSS is to reduce production costs, increase productivity, improve safety, shorten time to market and enhance product quality and yields.

Implementing LSS principles includes lean prioritization, training, securing stakeholder involvement, quantifying the impact of just-in-time production and creating a culture for success. LSS effectively combines Six Sigma principles with lean manufacturing to spur a relentless pursuit of sustained improvement. Lean helps products weave through processes faster, and Six Sigma improves quality. Integrating the two complementary methods can yield even greater benefits than implementing them separately.

Inventory management

Inventory processes are important to any trading or manufacturing company. An inventory system is a set of policies and controls that monitor levels of inventory and determine levels to maintain, timing to replenish stock and sizes of orders. The purposes of inventory control are to maintain an...
independence of operations, to meet variation in product demand and to take advantage of economic purchase-order size.

The organization must work and communicate effectively to address inventory problems. For instance, if you do not know what or how much stock is in the warehouse or whether it is usable, you will have a difficult time meeting production schedules and performing to customer expectations.

There are three basic systems of multiperiod inventory models that implement control: the basic fixed order-quantity model, economic order quantity (EOQ) model, and the two-bin system.  

1. Fixed order-quantity model: This model determines the specific inventory point at which an order will be placed and the size of that order. The fixed order-quantity model provides a good starting point for coverage of the inventory model.

2. EOQ model: The calculations to obtain the EOQ model can be divided into the off-season and busy season. For instance, the quantity of orders in the busy season will be double those in the off-season.

The EOQ model assumes demand for the product is constant and uniform throughout the period and the price per unit of product is constant.

3. Two-bin system: The purpose of classifying items into two bins is to establish the appreciation of each item. The order period of the two-bin system is bimonthly. The two-bin system assumes inventory holding cost is based on average inventory ordering, setup costs are constant, and all demands for the product will be satisfied—that is, no back orders are allowed.

Building an LSS framework

An LSS framework can be constructed to include the implementation principle, waste elimination and the inventory models methods. The framework is shown in Figure 1.

Process one—implementation principle: The first step is to confirm the rules of the implementation principle. Organizations must then look at the available process change methods and process improvement tools to meet customer requirements. Finally, organizations need to take a look at the different inventory models available. LSS implementation must also be accompanied by commitment and support from the organization's top management.

Process two—waste elimination: There are some non-value-added activities that create wastes, which increase inventory costs. Waste can include defects, processing, unnecessary motion, transportation, delay and waiting, and overproduction (the six wastes from the Toyota Production System). By exploring the root causes of wastes and finding ways to eliminate them through the lean approach, you will eliminate non-value-added activities in the process flow.

Process three—LSS method: LSS aims to integrate the DMAIC method with inventory models. In this way, the definitions of DMAIC include seven steps:
1. **Subject evaluation**: Confirm the main problem and define the priorities that must be improved (define phase)

2. **Setting goals**: Establish the baseline on control and check points during the project improvement process. Goals are set as management criteria and objectives of LSS (define phase)

3. **Situational survey**: Understand the environment's situations, as well as the root causes of cost problems. Situation surveys not only help you understand LSS performance and cost requirements, but also obtain key points for improvement (measure phase)

4. **Finding cause**: Use cause and effect analysis and five whys activities to find cost problems and discover opportunities to improve while looking for inconsistencies between actual and anticipated results (analyze phase)

5. **Implementing strategy**: Use LSS approaches and methods to achieve greater quality performance (improve phase)

6. **Confirming results**: Measure corrective actions and see if they lead to the anticipated performance goals (control phase)

7. **Maintaining standardization**: Validate improvement actions to become the standard operating procedure and apply them to the lean concept of continuous improvement (control phase)

**Theory to action**

Fountline (FL) sells leisure furniture, gardening materials and equipment; imports sandstone material from Bali, Indonesia; builds thatched huts and pavilions; and harvests southern yellow pine lumber from the United States and sells it to construction companies in Taiwan.

If FL could not control its inventory costs, management costs will be higher, and profits will suffer. So the company used LSS to manage its inventory, following the three steps outlined earlier.

**Process one**: Implementation principle: FL's product requirements are in high-mix and low-volume orders. The first process to implement LSS was to balance organizational capacity and customer requirements via a marketing survey. If the matching between customer requirements and the organization's capacity isn't balanced, FL can't control the business requirement. A Six Sigma team at FL was chartered to:

- **Figure 2: Total cost percentage of cost items**

- Increase the value-added activities in the process by eliminating the overstock cost or shortage stock.
- **Process two**: Waste elimination. Because LSS activities are based on waste elimination, this action to exclude non-value-added activities must be clear, quantifiable, and concrete. Eliminating waste enabled FL to use its essential resources to achieve the best quality products with the highest profitability.

There were six prime waste areas in FL's business processes:

1. **Defect wastes**: The lumber is imported from abroad. Although the supplier passed the preliminary quality audit, the material did not meet a 100% acceptable quality level.

2. **Processing waste**: The climate affects quality of the lumber during the long term, so lumber requires increased processing and, therefore, adds more to the costs.

3. **Unnecessary motion wastes**: Additional processing of the lumber increases the use and wear of the equipment, and raises the demand for spare parts to fix the equipment, which raises the cost of those parts.

4. **Transportation wastes**: The lumber may be damaged while in route.

5. **Delay and waiting wastes**: Sometimes, the lead time of orders from abroad is too long, so domestic orders are cancelled.

6. **Overproduction wastes**: Some semifinished goods need to be stocked to meet last-minute, emergency needs of customers. This semifinished...
stock is sometimes unnecessary, so there were overproduction problems.

Process three—LSS method:
1. Subject evaluation: The LSS team conducted a survey and listed all cost items to evaluate. The receiving and stock costs were 40% and 30% of the total cost, respectively. The receiving and stock costs have the greatest influence in increasing management cost (see Figure 2 on p. 29).

2. Setting goals: The costs that affect product quality performance the most are stock and receiving costs. H1 assumed the baseline period of stock quantity (QIV) was 8,300 units (a one-year baseline of historical experience). The improvement goal was set at 1,000 units. Improvement performance would be achieved at 87.5% [8,000 (QIV baseline) - 1,000 (goal-setting QIV) / 8,000 (QIV baseline)].

3. Situational survey: Past sales data showed the stock cost increased because the quantity of monthly purchasing was fixed and the monthly sales were variable. The profit curve was smaller than the total cost, which caused the revenue income to become negative (see Figure 5).

4. Finding cause: The LSS team used the five whys to act on possible solutions:
   - Stored warehouse material needed to be reduced.

Figure 4. Trend curve of basic fixed-order quantity model

- Sales revenues
- Total cost
- Accumulated profit
- Variable trend of sales revenues
- Variable trend of total cost
Figure 5. **Trend curve of EOQ model**

- The equipment needed regular maintenance
- Products characteristics needed to meet customer requirements
- The lead time of orders from abroad needed to be reduced
- The process defects needed to be reduced

The fixed order-quantity model determines the specific inventory point, \( R = 2,500 \) units (at which an order will be placed), and the size of that order, \( Q \), is 3,000 units. Also in the model:

- The minimum stock (\( S \)) is 2,500 (when inventory drops below 2,500 units)
- Annual amount to be ordered (\( Q \)) is 3,000 units.
- The holding cost per unit, \( (H) \) is \$0.30
- Holding cost (\( HC \)) is accumulated stock \( x \) \( H \)
- Total cost (\( TC \)) is order cost + \( HC \)
- On-hand stock (\( I \) is order, (\( Q = 3,000 \) units) - \( Qi \))

Figure 6. **Trend curve of the two-bin system**