Conclusion

The MOST® System is indeed the work measurement tool for today's high-mix and low volume production strategies. It does away with the over dependency on motion analysis to focus on activity sequences that manage the motions in the sequence itself.

In this respect, MOST® System analysis has a high system reliability and cycle time development consistency. This is mainly due to system simplicity and reduced applicators' errors which are quite prevalent with other measurement systems.

Besides the General Move Sequence, ABG ABP A, the MOST® System includes the Controlled Move Sequence, ABG MXI A, for the analysis of machine operations and the Tool Use Sequence ABG ABP U ABP A, for analysis of work with all types of tools. Additionally, for heavy machine work, the Manual Crane Sequence, the Power Crane Sequence and the Truck Sequence are available in the Maxi- MOST® System.

Within the MOST® System of work measurement – Mini-MOST®, Basic-MOST®, and the Maxi-MOST® and the Admin-MOST® almost all conceivable service, administration, engineering, warehousing, and manufacturing operations are measurable for analysis and improvement.

Inventory Control and Lean Manufacturing

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Introduction

The ultimate solution to the issues of matching orders with production and converting this to cash, at the same time as reducing overproduction, waste, errors and high working capital has been demonstrated by the Japanese car makers like Honda and Japanese electronics manufacturers such as Panasonic and Canon. These lean thinking principles were first developed by Leonardo Da Vinci, Dr Walter Shewhart, Dr W.E. Deming, Mr Soichiro Honda, and later by Dr Taiichi Ohno. Honda and others added Kaizen to this and later still, Canon have added new training systems, and environmental friendly processes. (see www.blakemore.com.au).

The first part of the solution is to define and implement a strategy where the rules can be demonstrated internally so that maximum support of the staff can be obtained. Later this can be extended to the whole of the supply chain. At all times the "Voice of the Customer" must be paramount. This strategy can be introduced without inconveniencing customers during the change process and initially would fit in and improve the culture of the organisation. These techniques can then be further extended to all functions of the business.

This is not a step function change. It means however that the focus of the whole of the company will need to gradually change. Herein is the major challenge.

There has to be a continuous focus on making each batch to order or making with a batch size of one, with integrated non wasteful processes. This means that excess inventory, preparation time, set-up time, clean-up time must be considered to be a waste and therefore continually reduced. The value added time as a percentage of the total time must be continuously increased. To do this the workforce must understand the principles and work at the correct skill level and be innovative in all ways.

Waste takes several forms and includes potential waste in planning, the finance department, supply, and in fact all operations.

Inventory Control

Success in manufacturing operationally relies on three basic performance metrics:

Quality (Q)
Cost (C)
Delivery (D)

The quality level should aim for zero defects, in process and product.

The cost should be as low as possible consistent with market expectations.

Delivery should be to the customers promised date 100% of the time.

It is a very simple matter to reduce inventory at the expense of on-time deliveries. This can be fatal for a business. Also, cost should not be driven down to the extent that quality is compromised. The quality level should express the desire to continuously innovate processes which reduce the cost of production and improve quality at the same time.

All products should be delivered seamlessly from the bottleneck in production and the bottleneck removed as soon as possible. Since the total production lead time tends be much greater than the desired delivery lead time expected by the customer, unless stock is held at the point of sale (POS), either the customer waits or we supply from stock. Since freight delivery times can vary from 1 day to 5 days within Australia then a more clever option is to have all subcomponents in stock and assemble to order. This model is similar to the Dell production system. The issue now is how much buffer stock we need. We can estimate this from the following relationship:

$$B = \sqrt{(Rbar*Rbar(\sigma S*\sigma S) + Sbar*Sbar(\sigma R*\sigma R)} \quad (1)$$

Where:

B = Buffer stock

Rbar = average replenishment cycle

Sbar = average sales in the period

σS = standard deviation of the sales in the period

σR = standard deviation in the lead time for replenishment

For a lean manufacturing overlay on ERP, this translates to:

Replenishment level =

$$\text{If } (Sbar \le 0,0(Sbar*L)+normsinV(Fill\%)*\sqrt{L}*\sigma*\sigma+((Sbar*Sbar*(\sigma R*\sigma R)) \quad (2)$$

Where:

Normsinv(Fill%) = the normal distribution for the expected fill% for the order

L = lead time from supplier

Equation 2 has a high degree of flexibility in determining the correct level of inventory to deliver 100% fill rate (customer on time delivery).

Lean Manufacturing Algorithms for ERP

Late in 1999, Shaw Carpets USA engaged Blakemore Consulting to introduce Lean into their two plants. They specified that $40M needed to be reduced from the working capital. They believed that the way forward was to apply Lean manufacturing methods to the shop floor processes. A business audit by Blakemore Consulting revealed that while that approach would eventually lead to the desired objective, the complexity of the manufacturing processes and the large range of products made the task relatively slow. There was a faster way. This involved the application of the 25 Lean guidelines to the planning system as a first step. The results were spectacular as shown in Figure 1. Immediately the correct lean parameters were fed into the ERP system, the on-time deliveries improved as the inventory was reduced.

The guidelines that were applied were chosen from the following list of ***25 Guidelines for Easy Lean*** (The United States Air Force is using these for training with permission). Not all of these can be applied immediately but as far as

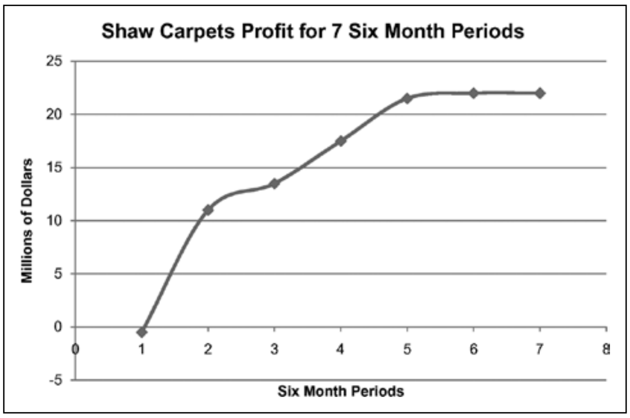

Figure 1

the ERP system is concerned we can start with sending the planned order to production when the calculated buffer stock (B) (where B = Buffer = Replenishment Level) in inventory is reached.

To achieve this end the 5500 products were separated into 3 groups depending on demand, A, B, C. The A group were high demand and low risk and were to be made to stock (MTS), since the production lead time far exceeded the acceptable lead time to customers. These were to be made at the Economic Production Run or greater if the demand was high. The C group were high risk and would only be made to order (MTO). The intermediate group, B, were to be made at the Economic Production Run and the divisions between the groups were to be continuously assessed and readjusted.

When these rules were applied there was an immediate improvement in on-time deliveries, a reduction in manufacturing cost and a reduction in inventory. Finished goods inventory fell from $20M to $9M and the company withstood a 6 week strike by the TCF trade union. On-time deliveries improved from 34.7% to 99% for the top 20 customers, and 95% overall in the same period. The Infors Visual system operates similarly through a ROBS (Resource Operating Buffer Status).

25 Guidelines for Easy Lean

People	1	Customer	Optimise Customer Response. Listen to his voice
	2	Teams	Form Teams at Interface and Free up Communication
	3	Culture	Continuously Improve the Culture
Integration	4	Demand	Demand = Supply
	5	Pull	Pull not Push
	6	Supply Chain	Apply to whole of Supply Chain
	7	Variation	Minimise Variation
	8	Cycle	Shorten Financial and Total Cycle

	9	6S	Apply 6S to all activities and work stations
	10	Constraint	Send demand to Bottleneck
	11	Mix	Aim for Even Mix at Bottleneck
	12	FIFO	First in First Out
	13	Supply	Optimise Supply
	14	Load	Level the Load as much as possible
	15	EB at EPR	Equal Batches at Economic Production Run
	16	Sequencing	Optimise Sequencing for Max Value added
Operations	17	Waste	Minimise
	18	Continuous Flow	Minimise Interruptions
	19	Value Added	Maximise
	20	Link	Link Processes
	21	Hold Points	Minimise
	23	Prevention	Prevention not Rework
	24	SPC	Apply Statistical process Control
	25	SMED	Apply Principles of SMED

The Major Variables influencing Inventory Levels

When we start with a rapid supply inventory model (such as that used by Dell), where the total lead time will be the assembly time from the sub component buffer stock, and we allow say 2 to 3 days for assembly, then it is clear that the following principles must be obeyed:

- There must be sufficient stock of components for assembly and finished goods.
- To satisfy the above requirement, stock levels must be high enough to allow for variations in supplier lead times, and variations in demand and any variations in available labour for assembly.
- For outside suppliers on short lead times say local suppliers, the requirement no 2 above should not be a problem. For overseas suppliers this could be an issue.

Sensitivity of Inventory to Usage Variation and Lead Time Variation

For the work done at Shaw carpets, a limited study of these two major variables and their influence on inventory stock turns has been done. For this study the inventory turns is defined using the more popular definition as given:

Inventory Turns = (Yearly Sales at COGS)/(Average Inventory at COGS) (3)

Using this equation, the number of inventory turns can be calculated and is plotted in Figure 2.

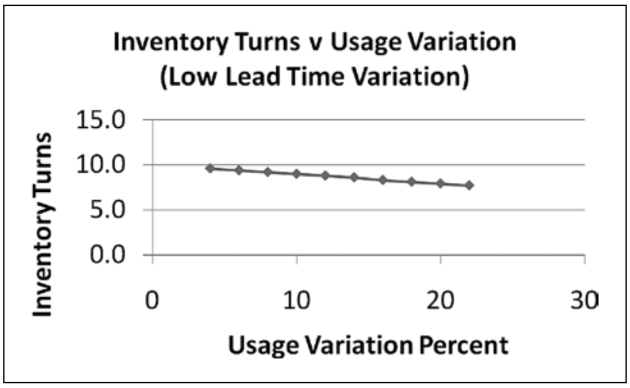

Figure 2

As can be seen from the above graph, the relationship between inventory turns and usage variability (for a minimal variation in lead time of 10% and for a fill rate of 99%) shows inventory turns of the order of 9.6 to 7.7. Provided that lead time for supplies are predicable and reliable then reasonably high usage variations can be absorbed and inventory turns can be good.

If we now turn to the sensitivity of the inventory turns to lead time variation at low usage variance, we end up with a relationship as shown in Figure 3 below.

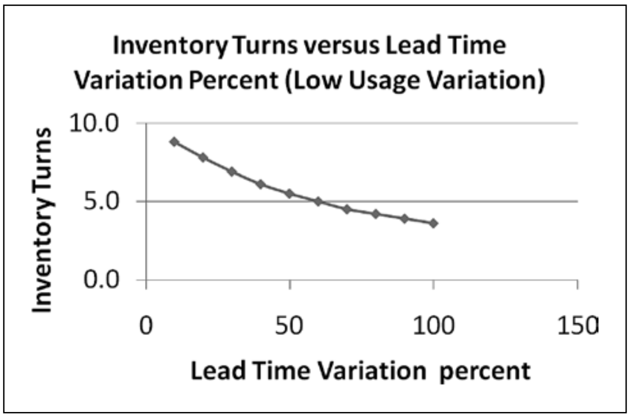

Figure 3

The above graph illustrates that even with a plot of lead time variation, provided that the usage variance is not great, then stock turns can vary from 8.8 to 3.5. Supplier lead time variation is a major determinant of inventory turns, but no more so than a 20% variation in useage. The values of the variances are critical to good control. Models have been developed to assist in setting the parameters. For the case of a high usage variation combined with a high lead time variation we see the relationship as plotted in Figure 4.

The above table summarises the results published in the three figures. In all cases the variations in lead time and usage are believed to be reasonable based on past experience. The fill rate is set at 99% for each set.

From Figure 2, it is clear that if the lead time is not greatly variable, then inventory turns of up to 9.6 are possible and even 7.7 when the usage variation increases to

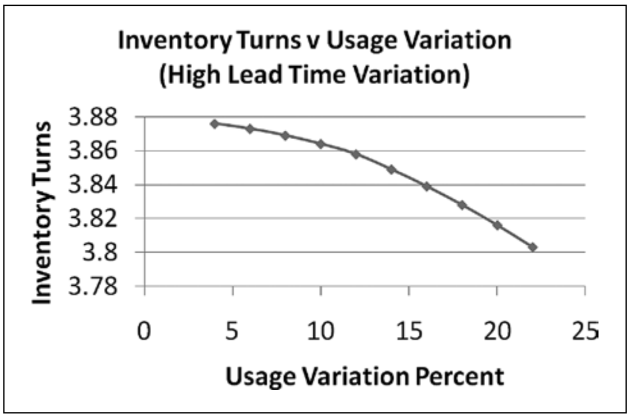

Figure 4

22%. Remember these models are allowing for delivery in say 2 days plus freight time to the POS, and for a complex system with hundreds or thousands of product variations where stocking of the finished product is not a viable option. For the case of low product complexity and a small number of suppliers, T can approach infinity since JIT can be implemented. In real complex systems in Australia with many components from overseas suppliers and the uncertainties of freight deliveries by sea in particular, JIT is not an option.

For Figure 3, a large increase in inventory is seen if the supplier is not offering a reliable and predictable lead time, then the inventory turns will decrease to approx 4 turns. In real terms this is taken as a benchmark in Australia because of our isolation and dependence on overseas suppliers. Inventory turns of 4 correspond to 3 months stock at the cost of sales and this erodes profitability by as much as 2% of profit on sales depending upon finance and gross margin. For businesses operating at a gross margin of 50% or more this is not so bad but if the gross margin is less than 25% this could be the difference in the company remaining viable or not.

Figure 4 illustrates that the value of T will collapse to approx 3.8 which as mentioned is the benchmark value for many Australian companies. Hence improvement is needed, and reliability of supply is paramount.

Conclusions

1. Simple mathematical algorithms can be added to ERP systems to enable Lean thinking to be applied into normal ERP systems.
2. Numerous models have been developed to aid in achieving improvements in Quality, Cost and Delivery using the Honda based supplier system.
3. The results in Australia where these methods have been developed have been spectacular and can be applied almost universally.
4. The models developed provide valuable guidance on the resetting of the major parameters controlling production and the inventory level needed to deliver on time and maintain a competitive advantage of fast delivery.
5. The model uses all the basic algorithms used to set the replenishment level (trigger point), ie usage, lead time, lead time variance, and demand variance.

Table 1. Summary of Figures 2, 3 and 4

Figure	Graph	Fill %	L	U	T	Notes
2	T v U	99	10%	4 to 22%	9.6 to 7.7	10% achievable
3	T v L	99	4% to 100%	4%	8.8 to 3.6	Large increase in inventory
4	T v U	99	4 to 22%	4 to 22%	3.8 const	If L is high, usage variation less significant

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16-17 June 2010
Melbourne Cricket Ground, Melbourne
www.aipack.com.au

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