

# COST ANALYSIS FOR WORLD CLASS CHANGE

## Part 1: Inventory Reductions for Profitability

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This article discusses the financial model by Womack and Jones [5] and highlights further analysis that should be undertaken by companies considering or planning the implementation. The authors identify a further two layers of analysis that should be considered.

### INTRODUCTION

The renowned tome “*The Machine that Changed the World*” [4] focused on the competitive advantage achieved by automotive assemblers. The lean paradigm emerged from this work that focused on the ability to reduce raw material, work in progress and finished goods stock.

In the February 2001 issue of *Control*, Günther Kruse [2] graphically identifies the significant effect reducing material costs could have on gross profit. The models sum the cost of sales and includes both assets and overhead costs. To achieve the overhead reductions referred to by Kruse, Martin Christopher [1] proposes a square root rule-of-thumb. He suggests, for example, that if previously there were 25 stock locations and now there are only 4, the overall reduction in inventory would be in the ratio from  $\pm 25$  to  $\pm 4$  - from 5 : 2, ie. a 60% reduction. It is unclear from Christopher's work if overhead costs would reduce linearly or via the square root mode.

Womack and Jones [5] by comparison propose a profit and loss statement model showing figures for mass and lean manufacturing. Table 1 is based on Womack and Jones' analysis of the relative merits derived from changing over to lean manufacturing. Two columns have been added to show the percentage change and whether this was favourable or unfavourable to the business. In this example, while inventory reduced to near half the value of mass production, apparent profit shrank to negative territory. This is a result of management accounting practice that classifies stock as an asset. By reducing stocks, the assets reduced, which impacts on the apparent value of the business. Pre-tax cash flow virtually doubled.

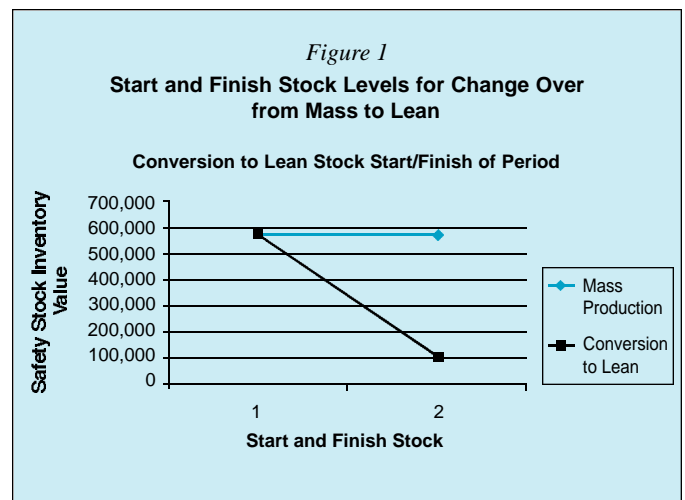
	Mass Production	Lean Production		
Beginning in-process inventory	576,000	576,000	0.00%	U
Direct materials purchased	924,000	637,000	45.05%	F
Direct labour	958,000	958,000	0.00%	U
Indirect manufacturing costs	465,000	465,000	0.00%	U
Sub total	2,923,000	2,636,000	10.89%	F
Minus ending in-process inventory	576,000	100,000	476.00%	F
Total costs of production	2,347,000	2,536,000	-7.45%	U
Total revenue from sales	2,500,000	2,500,000	0.00%	U
Profit (loss) - pretax	153,000	-36,000	-525.00%	U
Cash flow - pretax	153,000	440,000	187.58%	F

Source: Adapted from Womack and Jones (1996:138)

Note: The profit shown above in blue is in fact from the manufacturing account rather than from the business as a

whole. The temporal profit for this example stemming from the consumption of safety stock is £476,000. This is reduced to £440,000 by covering the £36,000 shortfall in the manufacturing account. Having said that, we will continue this discussion focusing on the profit from the manufacturing account.

Figure 1 graphically shows the start and finish stock levels for both mass and lean production systems from the data in Table 1. This would seem to be a very encouraging graph - that lean manufacturing can reduce safety stock down to about 18% of the mass production system.



### LIMITATIONS OF THE WOMACK AND JONES COSTING MODEL

Limitations identified in the costing model shown in Table 1 include:

- The method used only considers the transition period and does not look at the 'return on investment' over an extended period
- Goodwill in the supply chain is not taken into account
- The model isolates safety stock as the key variable that changes. The model seems to ignore any anticipated change in direct labour or indirect manufacturing costs due to the quality initiative that would be required to ensure the flow of goods through the plant
- The model assumes total sales volumes can be reached - most likely as a result of improved flow and eliminated expediting. The model seems to tacitly imply that the volume is stable. This may be true for auto plants, where the flexibility is component variants. For non-automotive companies, a volume plan surely would be required
- Inventory is treated as an asset rather than a liability
- No mention is made of the costs of lost production due to downtime for the *Kaikaku* (rapid change, as opposed to *Kaizen*). The cost of any downtime to change over system would cause a delta in the turnover. The model is only applied, one suspects, to final assemblers. A more extensive model would need to be considered to assess the impact on first and second tier suppliers

- There is an absence of consideration for payback periods, net present value and the average rate of return
- The model does not take into account obsolescence costs. A probability or confidence level would be useful to determine profitability resulting risk reduction is absent
- This model did not state the unit material cost or how many units were produced in the year
- There is no mention of the costs of consultants, training, equipment, software to control the manufacturing system and literature, etc.

Gross temporal profit = £763k - £287k = £476k = improvement budget

Temporal Improvement = £476k/£924k = 51%.

The temporal profit is 51% of direct materials purchased for the change and first subsequent trading period. The profit is 'temporal' since it provides a budget to cover the deficit in the manufacturing account, implement the various improvements, pay for training, consultancy etc. The US National Research Council [3] suggests this budget can be used to acquire under-performing companies. By converting suppliers to lean, a further budget is formed to fund the acquisition of more businesses.

If the remainder from the temporal profit is declared as taxable profit, management will have reduced the impact of a significant investment opportunity. The next section examines this frequently overlooked element.

## IMPROVING THE MODEL

Womack and Jones' model makes sense if an extra period is added on. Table 2 draws on the same set of data, without adding the cost of inflation or other cost variances that may occur year-on-year. It seems that the following year, the company would need to buy stock! This may come as a shock. What happened is that the lean argument is based on using up safety stock in production for the changeover period. In reality, the company will buy new stock in the following period. Okay, the company should be in Just-in-Time mode using Kanbans and scheduling micro-batches. If the safety stock is 100k at the beginning and the end of the next trading period, then the trading profit returns to that of the mass production system. So what's the benefit of lean over mass production if the profits are the same? It seems reduced obsolescence risk, purchase exposure, stock holding cost and a one time profit (or loss depending on the accounting convention used).

Table 2 shows an extra trading period extrapolated from the model by Womack and Jones. An average rate of return for this example is nearly 31%, clearly more than putting pennies in a Post Office savings account. Since the company did not have to spend as much money on stock during the transition, it will have to start again in the first period of lean manufacturing. This constitutes a negative impact on the results obtained in the transition period. A 'temporal profit' is created that is the net benefit after the end of the first subsequent trading period. This temporal profit turns out to be the total value of the reduction in safety stock.

## IMPACT OF CAPITAL GAINS TAXATION WHEN CONVERTING TO LEAN

A significant impact on the business is the effect capital gains taxation could have on gross profit. Despite the company making an apparent net loss, the company could face paying more tax due to the fact that the effects of inflation are not normally accurately reflected in the taxation system as a result of the replacement cost of inventory. The cost of goods sold is charged in the profit and loss account at prices that reflect their cost at the time of purchase or manufacture. The sales are recorded at the prices at the time of sale. If there is inflation between the time when the goods are purchased or manufactured and the time when they are sold, then the company can find itself paying tax on illusory gains.

In the example by Womack and Jones, the temporal profit is reduced from £763k to £476k, since the difference - £287k - would be needed to re-purchase working stock the following year. The £287k would therefore have exemption from capital gains tax. Management should make sure there is clear agreement with the taxation authorities concerning the £476k remainder. If the company puts this toward profit, capital gains tax will be charged against it. If the remainder is put toward internal investment, ie. for the purchase of other capital goods,

Table 2

### Mass to Lean Improvement Payback Appraisal

	Lean Year				
Beginning in-process inventory	100,000				
Direct materials purchased	924,000	287,000	Delta purchase cost	-287,000	Delta purchase cost
Direct labour	958,000				
Indirect manufacturing costs	465,000				
Subtotal	2,447,000				
Minus ending in-process inventory	100,000	476,000	Delta end of year stock	0	Delta end of year stock
		763,000	Temporal profit	-287,000	Temporal loss
Total costs of production	2,347,000	476,000	Gross Temporal Profit		
Total revenue from sales	2,500,000	49.69%	Temporal profit/labour	0.00%	
Profit (loss) - pretax	153,000	94,500	Average return (two years)		
Cash flow - pretax	153,000	30.88%	ARO I P.A.		
Conventional Profit over Direct Labour	15.97%				

ie. new machinery, then capital gains can be deferred to a later date. This has the added advantage that the company increases capacity and can write off the value of the machine against depreciation allowances permitted by the government.

The effect of different accounting systems on stock profit can perhaps best be illustrated by an example. Let us consider a company that purchases goods for £1000 on 1 January and sells them on 30 June for £1500. A general price index stood at 100 on 1 January and had risen to 110 by 30 June. Profit and loss accounts prepared on the basis of unadjusted historical cost (HC), historical cost adjusted for inflation, ie. the current purchasing power method (CPP), are given below:

End price index	110	
Start price index	100	
Percentage increase	10.00%	
	HC	CPP
Sales	1500	1500
Cost of sales	1000	1100
Profit	500	400

With historic cost accounting, using a first-in first out (FIFO) approach the profit is £500, whereas with CPP accounting £100 of the £500 could be described as 'stock profit' and would be exempt from tax if this method of accounting were adopted.

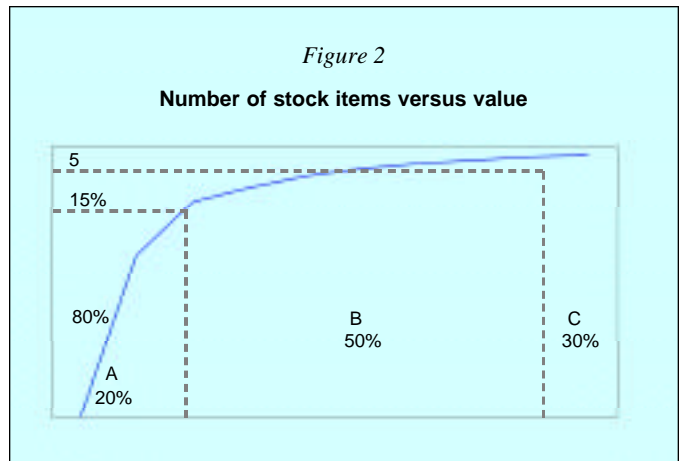
It can be argued that the £100 is an illusory or temporal profit resulting from the fact that sales and purchasing were measured at different times in pounds of different purchasing powers. The company would need to take into account the purchasing power of the money at specific time intervals. The company would need to identify the depreciation rate applicable, or agree one with the tax authorities. An example using a discount rate of 10% to reduce the value of stock to a standard value is provided below.

Alpha Co.			
Year	Cash flow	Discount Factor	Net Present Value
Today	1000	1	1000
1	250	0.90909	227.27
2	400	0.82645	330.58
3	400	0.75131	300.53
4	300	0.68301	204.90
	2350		2063.28

This shows that money received by Alpha Co. would count for £2,350, when in fact the purchasing power is only £2063. A tax allowance could be agreed with the taxation authorities to retain the balance with a tax exemption.

This situation is made even more complex by any 'factoring' that the company may engage in. The company will usually have to pay its suppliers on time, yet the company is not recuperating funds from its customers that owe it. Debt collection agencies may be used to recover late payments. It is possible to obtain cash from a credit agency, in a process called 'factoring', based on the expectation that payment will be made at a future date. Typically, 70% of the invoiced amount can be

obtained early this way. The balance is split nominally 28% to the company, 2% to the credit agency as their commission/charge. Management should ensure that their factoring commission charges are included in the cost of sales, else they will come out of profits that have been taxed.



Yet another complication is the Pareto effect. Womack and Jones' model appears to be all encompassing. The company would do well to focus its attention on managing the 20% of components that cause around 80% of the value of stock.

Rapidly depreciating stock, such as the parts and finished goods used to produce mobile phones and other fashion goods, can similarly affect profit - called 'stock loss'. In 2000, a brand-leading producer of electronic goods charged itself 10 pence per day for each bill of materials in its pipeline. This provided the budget for rework in-house. Stock loss is critical for service industries, particularly retailers and other points of sale. Japan is an extreme example. Mobile phones come to the market typically at 40,000 yen. After six months they are being sold for 5 yen. New models are introduced twice per year. Stock holding cost in most Western companies is estimated between 25% and 40%. A conservative estimate for Japan market is between 300% and 600% per annum. This therefore stimulates Just-in-Time methods based on pull systems - make or assemble to order.

One method of avoiding this paradox is to recognise the invoice for goods when the materials, components or modules have been assembled into the finished product - ie. at the end of the production line, or at despatch. This could then be enhanced with the conventional method of delaying payment to, for example 120 days after receipt.

## UNCONVENTIONAL MANAGEMENT ACCOUNTING WISDOM

Three out-of-the-box suggestions are:

- Stock is a liability because it has taken cash from other investment opportunities, particularly improvement and change projects
- Only the period start and finish stock levels are important to show reduction in period stock level
- Buy only what is needed to make up any shortfall in materials during the transition period.

## CONCLUSIONS FROM CONVERSIONS TO LEAN

The project offers a one time saving on purchase expenditure. This can have a negative impact on suppliers resulting from using up stock instead of buying production requirements.

Low profit margins many suppliers operate under require a significant and stable annual volume to achieve break-even. During the conversion project from mass to lean, suppliers will receive orders for reduced volumes or none at all. Assemblers easily could put their suppliers out of business if they do not carefully consider the effect of over reliance on using up old stock during the changeover.

Temporal profit for the conversion year must be perceived in light of the temporal loss the following year as purchase spend returns to original level.

Numerical indices in this article showed doubling or halving does occur, though remain anomalise.

A principle benefit derived from converting to lean stems from reduced obsolescence risk associated with holding safety stock.

Going lean will likely mean material will be used up from safety stock. The safety stock may have been bought in a different time period. Agreements with taxation authorities should be in place prior to implementation. This would ensure that the company does not find itself paying tax on illusory profit resulting from the fact that sales and purchasing were measured at different times in pounds of different purchasing powers.

## REFERENCES

- [1] Christopher, M., *“Logistics and Supply Chain Management: Strategies for Reducing Costs and Improving Services”*, (2nd Ed), Pitman Publishing, London, 1997.
- [2] Kruse, G. Business Performance Improvement: Keeping the Wolves from the Door, *Control*, February, 2001, pages 14-17.

[3] National Research Council (U.S.), *Surviving Supply Chain Integration: Strategies for Small Manufacturers*, *National Academy Press*, Washington, D.C., 2000.

[4] Womack, J., Jones, D., and Roos, D., *“The Machine That Changed The World”*, Harvard Business Review, New York, 1990.

[5] Womack, J. and Jones, D. *“Lean Thinking: Banish Waste and Create Wealth in Your Corporation”*, Simon & Schuster, New York, 1996, p138.

## About the authors

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