Domestic Apparel Manufacturing: When Is It Competitive?

S99-MD16

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Project Goals

Apparel industry executives continue to move manufacturing offshore in their efforts to lower costs. Offshore manufacturing is characterized by long lead times and a significant, up-front, cash investment. On the other hand, corporate headquarters are pressuring subsidiaries to reduce inventories, while retail stores are demanding instant response to their orders. Thus, there is a conflict between low cost, offshore manufacturing and the desire to create an agile, responsive corporation.

Another victim of the export of manufacturing is the loss of product development expertise--the intellectual step that converts a designer's prototype into a quality garment that can be sewn efficiently. Without this expertise, markets cannot be developed for new, innovative textiles. Therefore, the loss of production to offshore plants is severely detrimental to the continued viability of the textile industry in the U.S.

The goal of this project is to develop formal Quick Response Manufacturing (QRM) business models for apparel products and demonstrate that cooperation and sharing of data between buyers, designers, onshore, and offshore producers can be cost efficient and beneficial for everyone involved. Manufacturers desire the cost advantages of offshore production. However, quick response capabilities are extremely valuable to buyers who are, unfortunately, seldom willing to pay extra for them. Therefore, we are also pursuing the goal of attempting to persuade buyers to question their single-minded obsession to manufacture everything offshore.

Abstract

Employment in the U.S. apparel industry has declined dramatically since the 1960s. Will it fall inexorably to zero, or is there some base level that can endure? If so, what strategic characteristics are required to survive? There is considerable interest in QRM, not only as a reason to support domestic manufacturing, but also as part of the larger goal of reducing supply chain costs. However, since Domestic Manufacturing is more expensive, ÒWhy should anyone bother considering it?ÓIn this project we have developed an analytical model of a Òteam approachÓthat includes both domestic and offshore manufacturing. Despite the additional costs associated with U.S. manufacturing, our model predicts that including a domestic contractor is legitimate and cost effective. However, the alliance must be genuinely cooperative, as partners share data and participate in the planning. The model allows us to describe the characteristic roles and capabilities required. Using this model for guidance, we anticipate that retailers will increase profits, while have the stock to satisfy more customers with fewer markdowns. Manufacturers will see increased margins and lower inventories.

1.0 Relevance to the NTC Mission:

The export of apparel manufacturing has ramifications well beyond the loss of sewing jobs. Apparel manufacturing remains the engine of the textile business. Therefore, as apparel manufacturing moves offshore, the textile industry loses one of its major markets. Textile manufacturers must continually seek markets for new fibers and products. Turning those products into apparel requires innovative designers cooperating with manufacturers. Without the manufacturers, graduates from design schools have no outlet for their ideas.

Corporations continually attempt to reduce inventories and respond faster to customer requirements, characteristics that are in direct conflict with the goal of manufacturing offshore. Therefore, maintaining competitiveness may depend on maintaining a quick response apparel manufacturing capability. Our goal of determining an appropriate domestic manufacturing environment is therefore central to the NTC goal of enhancing industrial viability.

2.0 Technical Approach

The retailing trend is to seek lower labor rates since most merchants look at pre-season product margins, and thus wholesale cost, as the determining factor in a sourcing decision. However, several studies (King, et al, 1999) have suggested that QRM can lead to higher margins for both retailers and manufacturers.

This project throws light on the above issues by presenting a model of a team that includes both domestic and offshore contracting. The model is analytical, which has the advantage that its parameters are readily observable and can be tuned to an organizationÕs individual business situation. The model links the accuracy of sales forecasting to the need for quick response contracting, and can be used to determine precisely when domestic, quick response manufacturing is cost effective.

2.1 Preliminary Retail QR Analysis

The figure shows retail sales data for a coordinated line. One can discern rough buying patterns and there is enough information to determine what would have happened if QR had been applied. While the data quality is not good enough for a definitive answer, the results are intriguing. QR would have:

- increased sales by 25%
- decreased excess inventory by 46%
- decreased lost sales by 41%.

A number of technical issues would have had to have been be resolved, including:

- Is fabric available to satisfy the in-season demand?

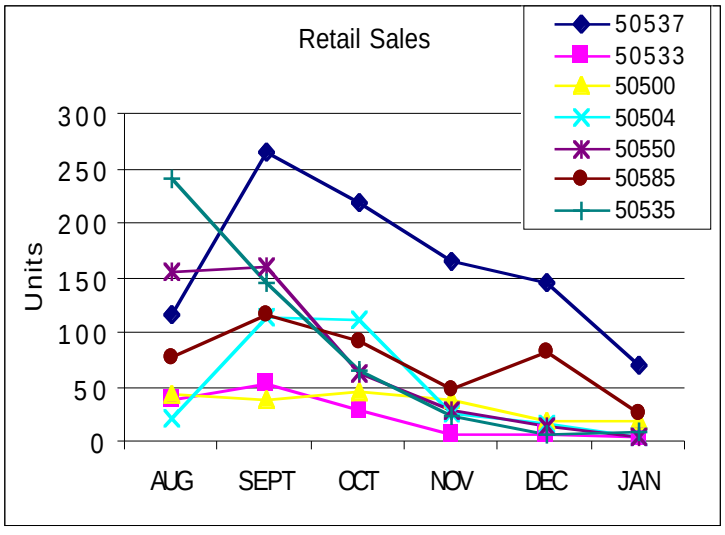

Figure 1: Retail Sales

- Is sales data available early enough to manufacture the garments?
- In a 12-week season, can a manufacturer deliver when markdowns begin in week 6?

Forecast Errors and the QR Approach

The importance of forecast errors should not be underestimated. Offshore sourcing is prone to considerable forecasting errors resulting from the necessity of committing to large orders far in advance of the selling season. For example, consider a typical women's athletic wear garment retailing for $20.00, with a wholesale cost of $10.00 and a US labor cost of $1.50. Moving the manufacturing offshore can save $1.00 per garment. If the retailer forecast sales of 1,000 units, then the total potential labor savings from offshore manufacturing is $1,000.

Retail forecasts are often in error by 20%, and occasionally in error by much more. If the retailer only sells 800 garments, the excess inventory cost of the 200 garments is $2,000. The loss in excess inventory is twice the savings from offshore manufacturing.

Protective Capacity vs. Protective Inventory

Inventory protects against order fluctuations. The model shows retailers that when employing QR, they are trading inventory for manufacturing capacity. That is, they lower their stock and replace it with a production agreement. If sales decline, retailers must still fill the manufacturer's plant. In this project, we have uncovered several innovative approaches to this trade-off.

Looking Beyond the Offshore Cost

QR is a complex strategy that will require retailers to look beyond the least possible wholesale cost (i.e. offshore) as the determining factor in a sourcing decision. Standard accounting practices often make offshore manufacturing appear more financially attractive than it actually is. One has to look very carefully at the raw Caribbean labor rates because staff turnover often exceeds 40%, while sewing efficiencies may be only 25% of that in the U.S. Also, there is evidence that logistics costs actually exceed labor costs. Also, offshore minimums, guaranteed contracts, and long lead times all conflict with quick response requirements. Therefore, it is vital, but quite difficult, to determine the true offshore manufacturing costs.

2.2 Margin Calculation

We consider a style with a seasonal sales cycle. We define the product's margin, m, as follows: The selling price of a garment is s, and the wholesale cost, w. The product's margin is defined as:

$$m = \frac{(s - w)}{w} = \frac{s}{w} - 1. \qquad (1)$$

This is of course the gross product margin and does not include overhead. If an item sells for $20 and the wholesale cost is $10, then the margin is 100%.

2.2 The Case of an Under-Selling Style

Suppose the manufacturer's forecast for this style is f items. Then, f items will be ordered from the contractor, to be delivered just before the selling season. The manufacturer's forecast

always has some error, and we assume that the style under-sold by an amount σ, and these σ items were sold at a reduced price, thus reducing the overall margin for this style.

The retailer sold f-σ items. The excess inventory is usually sold off at a discount, and the wholesale cost, w, is a fair estimate of the average discounted price. Therefore, the sales for this item for the season, S, were: $S = (f - \sigma)s + \sigma w$. The manufacturer purchased all of the items at the wholesale cost, so the manufacturer's cost was $C = fw$. Hence, the actual, reduced margin was:

$$m' = \frac{Sales - Costs}{Costs} = \frac{S}{C} - 1. \tag{2}$$

Substituting, and inserting the product's margin, m, from (1), gives:

$$m' = m\left(1 - \frac{\sigma}{f}\right). \tag{3}$$

σ / f is the percentage error in the forecast. Therefore, we now see the importance of the forecast accuracy—the overall margin declines as the forecast accuracy falls. Equation (3) clearly establishes the direct relation between the margin and the forecast accuracy.

2.3 Forecasting Errors

In discussions with manufacturers (Saupe and Pierce, 1999), we have found that the following measure of forecast accuracy is frequently used: Before the season begins, the sales for each style and color combination are forecast. After the season is over, the accuracy of each style/color combination is determined.

A style's forecast is a "success" when the sales for that style are within 25% of its forecast. Many organizations plan on a 70% success rate. That is, they aim for 70% of the styles to have sales within 25% of their forecast. When we calibrate our model, and measure its predictions, this is a useful standard benchmark with which to begin.

2.4 Quick Response Manufacturing Model

We now turn to our proposed QRM model, which includes a domestic contractor. There may be non-financial benefits to QRM, but they will not matter if QRM cannot first be cost-justified. Therefore, if the team includes domestic QRM, then the margins have to be equal or better than equation (5), which represents the current way of doing business.

The difference in the QRM case is that the manufacturer decides to order only a percentage of the forecast from an offshore contractor. Since the offshore contractor's price is lower, the manufacturer would like this percentage to be as high as possible. On the other hand, because manufacturers cannot forecast accurately, they should probably order somewhere between 70% and 90% from offshore. Any shortfall in demand is to be met through domestic QRM.

For highly predictable styles, (e.g., basics) the offshore percentage can be above 90%. However, for highly unpredictable styles (e.g., fashion items) ordering a lower percentage from offshore makes more sense. In both cases, the manufacturer only orders what is needed to meet projected sales, there will be no extra items to be liquidated. With no garments to be liquidated, there is no corresponding reduction in margin. An important point immediately emerges from the analysis:

> *While using a domestic contractor increases the cost, the reduction in excess inventory lowers it. Our goal is to determine the most efficient situation.*

The manufacturer decides to order most of the forecast from an offshore contractor. The initial forecast is again f units for each style. However, the manufacturer orders f-α units from the offshore contractor. The forecast may be high or low, but we will consider the case when sales are below the forecast, and by the amount σ units.

When the season begins, the manufacturer should monitor sales for approximately the first 25% of the season. Then, using real-time sales data, a prediction can be made for the final sales. At the 25% point, the manufacturer places an order with the domestic manufacturer, just enough to fill the projected need.

The model can be generalized to include several styles, but it is not intended that this model be applied across a wide variety of products. Applying the model from socks to suits is unrealistic. Rather, the model applies to a collection of styles, such as a line of clothing, styles with a common look, or perhaps a group from a single manufacturer.

We again assume that all styles have the same sales price, s, and wholesale price, w. We define the overall forecast accuracy, A%, as follows: Of the N styles, the forecast accuracy for A% of them is exactly correct, i.e., these NA styles sell exactly 100% of their forecast. The remaining styles, N(1-A), sell less than their forecast. The factor (1-A)% is the style forecasting error, E. The forecast for each of the E% of the styles that are incorrect is defined to be low by the amount σ units. Thus, (σ/f)% will again measure the individual style's forecast error.

The difference between this model and the previous one is that the domestic contractor is called upon to make α - σ units. These domestic units are more expensive than the offshore versions because the domestic labor is more expensive. The degree to which this affects the overall wholesale cost depends on the ratio of the labor cost to fabric, trim, logistics, and other costs. In this model we define the cost of a domestic garment as w(1+d), i.e., the wholesale cost of an offshore garment plus the domestic premium, d%. Proceeding as before, we can compute the margin when a combination of offshore and domestic contracting is employed:

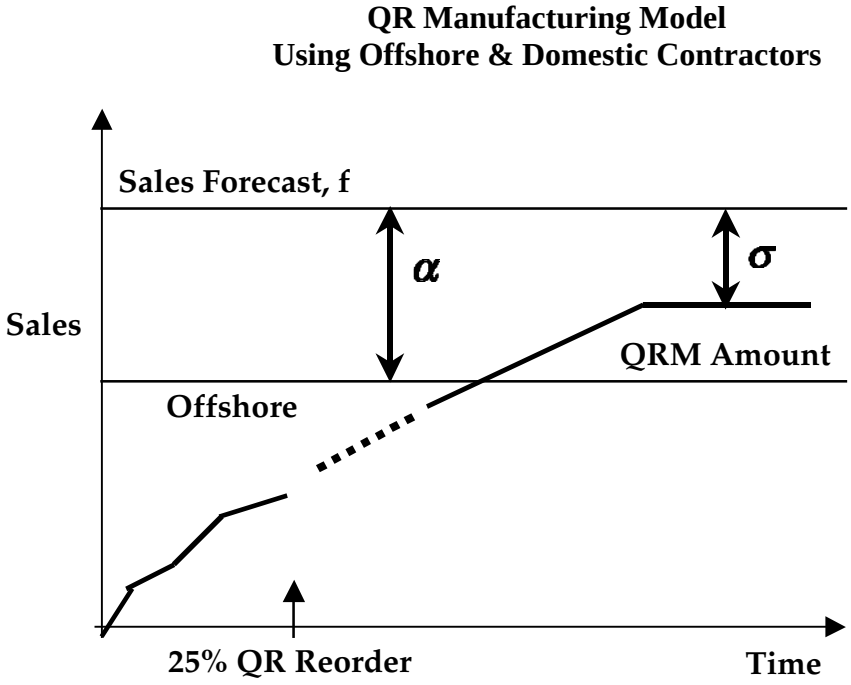

Figure 2: Parameters in the QR Model for the Under-Selling Case. The forecast is to sell f units, and f-α are ordered from offshore. 25% into the season, a new prediction is made for the final sales. The QRM contractor produces α-σ units. The total manufactured amount is equal to the actual sales, so there are no leftover inventory items to liquidate.

In this model, which includes the effects of domestic, quick response manufacturing, the expression for the margin is:

$$M = \frac{(1+m)\left\{1+-\frac{E\sigma}{f}\right\}}{\left\{1+\frac{\alpha d}{f}-\frac{E\sigma(1+d)}{f}\right\}}-1 \qquad (4)$$

2.5 Analysis of the Model

We can use equation (4) to determine the effects of the various parameters on margin. We begin by estimating the domestic premium. A useful rule is that for the manufacturer, the costs of garments can be roughly divided into three categories: 1/3 labor, 1/3 fabric and trim, and 1/3 overhead. Further, suppose that offshore garment production costs are 1/2 of domestic. Of course the labor costs will be significantly less (maybe 1/10th), but when duty, shipping, and logistics costs are added, the overall cost savings are significantly reduced. We will use a value of 50% savings, and note that we have probably exaggerated the savings. Thus the saving on the garment cost is approximately 1/3 x 1/2 = 1/6, or around 17%. Therefore, a useful estimate of the domestic premium is 20% of the wholesale cost.

We continue to employ the 70/30 rule, i.e., the forecast success rate is that 70% of the style forecasts are within 25% of their prediction. Figure 2 shows the effect on margin for the case of the QRM model. In the figure, the line designated as ÒMargin for Current ApproachÓ represents the current way of doing business: ordering everything from offshore and dumping any excess inventory. The curves labeled 0% - 40%, show the margin for different values of the styleÕs forecast error, σ. The other parameter, E, labels the percentage of styles whose forecasts are in error. The curves show the effect on margin as the forecast and style errors increase.

The curves peak when there is zero domestic manufacturing, i.e. when the forecast error is such that $\alpha = \sigma$. The peak in the curve is obviously the best point at which to operate. It defines the situation in which the sales are equal to the quantity chosen to be manufactured offshore. In that particular case, the forecast was f, but the sales were actually low, and coincidentally by the exact amount required to make the demand equal to the amount ordered from offshore. While it is optimal to work at this point, it is entirely unrealistic to assume that one can consistently order the exactly correct amount from offshore.

We now elaborate on the suggestion that the appropriate point for the manufacturer to issue the replenishment order is 25% of the way through the selling cycle. The later in the cycle the replenishment order is placed, the more accurate will be the prediction of the final sales. But, the later that decision is delayed, the less time there is available for production and delivery of the goods before the season is over.

King (1999) has suggested that 25% is a reasonable compromise. If one tries to predict the final sales based on less than 25% of the sales season, the prediction becomes inaccurate, and delaying the decision past 25% doesnÕt greatly improve the forecast accuracy. King also suggests that multiplying the sales at the 25% point by four gives a reasonable estimate of the final sales.

Another interesting fact emerges when one compares actual sales to a forecast: The first few data points are absolutely critical. Sales figures for the first week that an item goes on sale will often immediately reveal which styles are the great sellers. If these initial sales are closely monitored, and a Quick Response capability is available, then extra inventory can be procured to take advantage of these hot selling items.

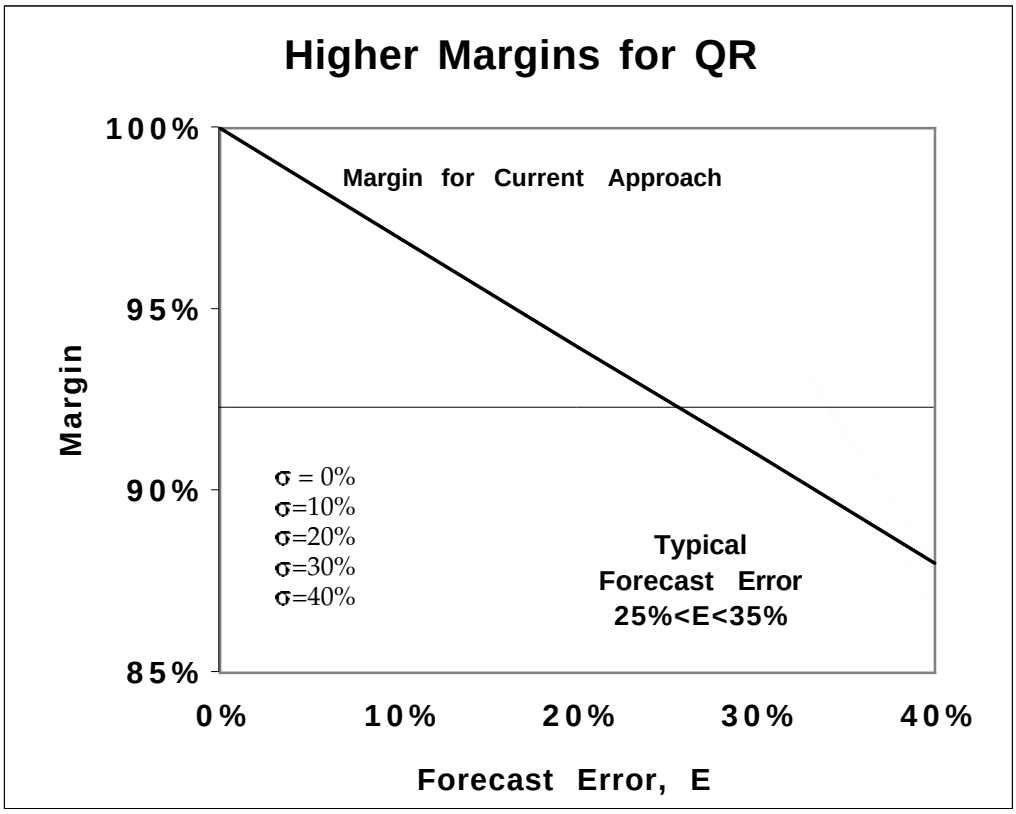

Figure 3: Improvement in Margin when Utilizing QRM.
The straight line shows the margin for the current way of doing business: Ordering everything up-front, and dumping excess inventory. The remaining lines show the improvement in margin when QRM is employed. The actual sales are below forecast for E% of the styles, and low by σ units. Typical forecast errors are that 70% of the styles are within 25% of their forecast.

The good news is that by actually planning for some forecasting errors, the overall margin can be improved. Significantly, the margin curves in Figure 2 when domestic QRM is included are higher than the corresponding margin curve for the current approach. Also, the margin is higher in precisely the range of forecast errors that most people work in: the 70% with 25% range.

3. Conclusions

Our research has uncovered an important link between the accuracy of sales forecasting and the need for Quick Response Manufacturing. We presented a model in which an agile, domestic contractor is added to the traditional retailer-manufacturer-offshore contractor team. The model suggests that retailers and manufacturers should examine their history of forecasting across various product lines to estimate the size of the errors they typically make. Using the

forecast errors in conjunction with our model, a retailer (or a manufacturer) can predict how much domestic manufacturing is required, and when it is cost effective.

The model shows that using a domestic contractor as an integrated partner can financially reward all members of the team. Using this model for guidance, we anticipate that the retailer will have the stock to satisfy more customers with fewer markdowns, while the manufacturer (designer) will see increased margins and lower inventories. The offshore contractorÕs production can be smoothed out, a significant benefit when considering the typical fixed commitment, offshore contracts.

To make the model work, extensive cooperation is required at all levels of the partnership. As an example of the types of cooperation required, retailers should provide POS data to manufacturers. In addition, specifications, approvals, and quality control require interactions up and down the chain. Again, communication and sharing of information is essential.

We believe a domestic contractor can make the case that they have a legitimate and cost effective role. We began by asking if domestic apparel employment will fall to zero, and we can now begin to answer the question. One survival approach for U.S. contractors is to aggressively seek out cooperative ventures with manufacturers, retailers, and even offshore contractors. U.S. contractors need to employ modern technology to ensure the role of quick response manufacturing is within their grasp.

4. Web Site

The project web site can be found at:
http://www.umassd.edu/1academic/cengineering/textiles/index.html

5. Acknowledgements

a) The Team

Roger Warburton is experienced in apparel manufacturing and had access to production and cost data. Steven Warner (U mass Dartmouth) provided textile expertise and contacts in textile companies. We also worked with the Sourcing Simulator group, particularly Russell King and Henry Nuttle, (NCSU) to validate their algorithms.

To study the retailersÕperspective, we created a Retailers Working Group including several members of the Textiles, Fashion Merchandising and Design Department at the University of Rhode Island: Yvette Harps-Logan, Josephine Moreno, Patricia Trautman, and Linda Welters.

b) Graduate Students

Elizabeth Lykken at the University of Rhode Island conducted literature surveys on retail issues. Maged S. Fanous at the University of Massachusetts, Dartmouth completed his Master's Thesis entitled "When is Domestic Manufacturing Competitive?" Raghavendra Ramamurthy is finishing his Master's Thesis entitled "Quick Response System Based On XML For The Textile And Apparel e-Supply Chain."

c) Presentations and Papers

"Domestic Manufacturing: When is it Competitive?" Roger D. H. Warburton has given this talk to over 1,000 people. A technical version was presented at half a dozen conferences. A student friendly version, which stressed the importance of manufacturing to students, was given at several universities to hundreds of students. Roger Warburton also accepted dozens of invitations to speak to professional and trade organizations. Manufacturers were particularly interested in the QRM approach, and several changed their company's operating philosophy as a result.

"How much domestic quick response manufacturing can a business afford?" Roger D. H. Warburton, Steven B. Warner. Society of Photonics Engineers Conference on Issues in Manufacturing, November 2000.

"Questioning the Relentless Shift to Offshore Manufacturing" Roger D.H. Warburton and Roy Stratton, Int. J. Supply Chain Management, Vol. 7, 2, 2002, 101-108.

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