Analysis of Apparel Production Systems to Support Quick Response Replenishment

Russell E. King, Thom J. Hodgson (NCSU Engineering); Trevor Little, Carol Carrere (NCSU Textiles); Michelle Benjamin, Tim Currin (Textile Clothing Technology Corporation)

TEAM LEADER: Russell King

PROJECT GOALS

The apparel manufacturer is often blamed as the weak link the apparel supply chain. Typically a small to medium size enterprise, the manufacturer must deal with the conflicting objectives of the larger fabric suppliers and retailers. The objectives of this project are to provide analysis and develop prototype software to understand better the role of the manufacturing configuration and production planning and control system in supporting quick response replenishment to retail, as well as to quantify the impact of the fabric supply system on the manufacturers ability to meet retail orders.

Earlier work by part of our team led to the development of an analysis tool, the Sourcing Simulator, that is used to quantify financial, inventory and service performance at retail for a line of garments. Analysis with this tool has supported quantitatively what Quick Response proponents have touted for years, i.e., a flexible and rapid, apparel supply system leads to superior performance at retail. In fact, studies with the Sourcing Simulator have shown that, depending upon the level of uncertainty, i.e., forecast error, the retailer can afford to pay a QR vendor as much as 50% or more per garment and still achieve gross margins in excess of that which is achieved using a lower cost traditional, and often offshore, vendor.

We are addressing a natural question that arises from our previous sourcing analysis work, that is, How can the manufacturer achieve cost effective and flexible QR replenishment? We will analyze, in detail, existing manufacturing systems such as Progressive Bundle, Modular and Team Sewing in concert with the major supply chain channels to market to understand what form best supports a quick response supplier in terms of cost and performance. We are also developing analytic models to understand optimal manufacturing planning and control policies under a variety of operating scenarios. We are developing realistic systems that are characteristic of the optimal policies.

ABSTRACT

The goal of this project is to determine the structure and operational policies of apparel/softgoods supply systems to best support rapid replenishment to retail in order to maximize performance. A variety of analytical and simulation-based tools are being used with the objective of theoretically sound and implementable systems that take advantage of the data-rich environment now available.

I. PROJECT OBJECTIVES AND RELEVANCE TO NTC GOALS

The almost daily erosion of apparel manufacturing in the U.S. is well documented. The trend is to seek lower labor rates since most retail merchants look at pre-season gross margins (and thus wholesale cost) as the determining factor in a sourcing decision. Part of our team has spent the last two years using the Sourcing Simulator tool to convince retailers that wholesale cost is not necessarily the best measure to use. While this has been effective, retailers note that most apparel manufacturers are not currently able to provide QR replenishment. Manufacturers are typically staff lean and, thus, cannot directly support their own research and development. The objective of this project is to provide the basic research necessary to
help manufacturers understand which manufacturing system best supports their business both from a financial and service viewpoint.

A major thrust of this work directly involves students in this research and with partnering industry. The goal is the development of understanding and expertise within the students so that they can transfer this to industry as they join it.

Finally, we have put together a diverse team involving personnel from the College of Textiles and the College of Engineering at N.C. State University along with expertise from the Textile Clothing Technology Corporation ([TC]2). This provides us with the breadth of expertise to be successful in this project.

The advantage of the modeling approach in understanding and exploring the modification of the supply chain operation, as well as for education and training, is the ability to observe the results of operational changes quickly, inexpensively, and without risk to the actual production system.

We are working closely with Sandia National Laboratories in support of the DAMA project to provide a flexible modeling capability for the analyzing and comparing sourcing strategies in the retailing of seasonal and basic softgoods.

II. TECHNICAL APPROACH

For the past several years under separate funding, part of our team has been developing tools for and performing analysis of supply chains and the impact on retailing. One aspect of this work has been the development of the Sourcing Simulator, a.k.a. Apparel Retail Modeling System (ARMS) package. Over the last two years this tool has been taken to industry and based upon feedback modified to meet the requirements from a retailer’s standpoint. The tool provides a thorough analysis of the performance at retail of a line of garments based upon a set of user inputs. A major use of the tool is to understand the financial and service impact of the choice for the manufacture of the garments. The tool allows the user to understand the true value to the retailer of a sourcing decision including the impact of speed, flexibility and quality of stock replenishment as well as the cost of lost sales and price markdowns. It can answer such questions as: How much more can the retailer afford to pay a Quick Response vendor for a garment and still achieve better performance than a traditional source? or What is the value of reducing the supply lead time by two weeks?

Other members of our team began work in the area, at the strategic level, evaluating various manufacturing systems including Progressive Bundle, Line Systems, Modular and Unit Production Systems. The questions addressed included how well each could support the kind of order streams from retail that would result under Quick Response partnerships.

The textile industry has an interesting production scheduling environment. Products are continually moving into and out of the active mix. In addition, much of the demand is seasonal. There are certain times of the year that are critical. This has significant ramifications for manufacturing facilities as well as on the material and piece-part supply chain. Over the last few years we have studied production problems with the focus on intra-plant operations. A methodology (Wolfpack Scheduling System, WPS) was developed that determines the optimal time to release a shop order to the floor. Clearly, releasing an order too late will result in unmet commitments. It turns out that releasing to the floor too early, can also result in poor quality schedules. The methodology is relatively simple. It provides detailed execution schedules into the future up to, say, 3 months for industrial-sized problems, and guarantees meeting of all due-dates (if at all possible).
The natural evolution of this work is to extend the analysis to the detail necessary to thoroughly understand the manufacturing domain from small, single plant manufacturers to brand manufacturers involving a set of manufacturing contractors. Issues range from selecting the appropriate manufacturing system or systems to capacity allocation to raw material supply to capacitated resource scheduling.

This project involves seven major efforts.

1. First, the strategic analysis is being extended to characterize existing alternative manufacturing systems for the range of manufacturing domains. This involves working with our industry partners to characterize a set of representative operating scenarios. In today’s marketplace, manufacturers, distributors, and retailers are expanding the number of “channels” through which products are moved to reach the consumer. This expansion is being enabled by the rapid development and deployment of information technology, coupled with faster and cheaper means of transportation. The traditional retail store – chains, mass merchandisers, specialty – are giving way to catalog and online sales of goods which are distributed through express delivery systems. These technology advances also opens up global sourcing of materials and products. In addition, many traditional “functions” necessary to a channel are being bundles differently among the participants to improve channel service, efficiency, and reliability. Research has begun to identify the major channels of distribution that apparel items go through to reach the consumer. We plan to determine the distribution of companies among these channels and to differentiate company distribution by sales, volume, and other business criteria. These companies will be examined for general information about the company, their manufacturing practices and processes, and the amount of business that is generated through that particular channel.

2. We performed a study of the existing constraint-based scheduling tools on the market. This kind of software has become a very hot issue in industry of late. In an effort not to duplicate capability already on the market, we performed a thorough analysis of existing tools.

3. We are developing analytic models of the manufacturing systems to understand optimal strategic operating policies. Through earlier research efforts we have developed a methodology using Markov Decision Processes that has been very effective. We are extending this methodology to apparel manufacturing domains and, in particular, using it to study the optimal production/inventory control coming into and out of peak seasons. Characterization of optimal policies is a crucial part of the process in gaining insight into effective and implementable candidate systems.

4. This effort expands the research to consider the tactical issues of a supply chain involving multiple plants (within the company) as well as the vendors of material and piece parts. In separately funded research, we are in the process of developing a virtual factory model to include multiple parallel machines and ‘batch processors.’ A batch processor is a resource that can process a number of items simultaneously. Dyeing is a batch processor. A transportation device (forklift truck, truck (over the road), conveyor, etc.) is a batch processor. The ability to model transportation within the WPS will allow us to model a multi-plant environment. Thus, we will be able to deal with supply chain issues while simultaneously dealing with scheduling issues within all the plant facilities.

With all these developments, we have continued our work on showing that the solutions we provide are provably close to the best possible solution (optimum), and we have continued to require that our
approaches will work on industrial-sized problems while requiring relatively small amounts of computer time. We are, we believe, well positioned for the next phase of our research.

The WPS is primarily a tool for plant planning, scheduling and management. We plan to extend the model to incorporate multiple facilities with plant to plant transfers. Conceptually, the problem is similar to the intra-plant scheduling problem, for example, trucking between sites can be thought of as batch processing, alternative suppliers can be thought of as alternative routes, etc. However, such things as stock inventories add a level of complexity beyond the existing technology of the WPS.

In the first phase of the work we are extending the existing WPS model include multiple facilities. Next, we will enhance the existing software and data structures to handle the supply chain representation. Finally, we will consider the incorporation of stock inventories residing at various points in the supply chain. Effort will be focused on the development of a robust model that encompasses the issues of supply chain management and execution.

Emerging technologies can provide secure internet communication between partners in a supply chain. Several companies are now offering such solutions. This allows supply chain partners to share information on inventories, plant/order status, capacities, etc. In other words, there is now an opportunity for real-time visibility throughout the chain.

5. This effort involves development of simulation models to test the policies gleaned from the analytic models in a more realistic and robust environment. The goal here is to develop a relatively generic and flexible software tool to allow analysis of a number of environments. The \([TC]^2\) models will be built upon to develop this capability.

6. Using the simulation models we will analyze the various candidate manufacturing systems under the range of scenarios identified as part of the first effort described above.

7. Finally, we are applying the technologies that we develop to actual industry problems. The first of these applications was a detailed study of the conversion from traditional sourcing of infant apparel to a proactive replenishment strategy. This involved a major U.S. retailer and a domestic manufacturer. Based upon the recommendations of the study, a trial was performed. The post-mortem of this trial has shown that the proactive replenishment strategy resulted in about a 30% improvement in gross margin and sell through over the traditional sourcing.

It has been our observation that to be successful we must directly engage industry in the research. We have already established contacts with a number of apparel manufacturers and retailers who are eager to participate. We have visited with several manufacturers, suppliers and retailers to discuss the important strategic aspects to the apparel manufacturing industry in responding to retail demand, i.e., what are the important questions and issues? Distribution strategies are also addressed as a portion of this work.

However, to maintain the level of involvement necessary for the long term goals, we must provide short term results. In our experience, this is best achieved through software rich in GUIs (graphical user interfaces) that enables industry to use the tool to understand and benefit from the research. To that end we will develop new prototype software that can be used by manufacturers to evaluate various manufacturing strategies in the context of their own business. We have a long history of developing software tools as part of past research and will use the technique of user-development feedback to directly involve industry in the development.

III. RESOURCE MANAGEMENT AND TECHNOLOGY TRANSFER
Through our involvement in the DAMA project we have spent a great deal of time this year meeting with the companies discussing the issues related to Quick Response manufacturing. We have identified several manufacturers willing to provide test case scenarios and data as well as guidance. As mentioned earlier we will develop usable software tools to help maintain industry interest in the research.

We will also continue our involvement with the DAMA project. Over the last year part of our team has been working daily DAMA personnel. DAMA and [TC] will provide important avenues to both transfer the research to industry and engage new industry partners.

IV. PRESENTATIONS


V. PUBLICATIONS