

OPERATIONAL CONTROL: MERGING GLOBAL OPERATIONS VIA AN ERP SYSTEM

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Abstract: The development of global supply chains during the last decade of the twentieth century has had a great impact on the apparel industry. Apparel industry firms face a wide array of challenges relating to the proliferation of product variety, changing product styles, shortened lead times, and reduced prices. As a result of these pressures, apparel companies have been forced to redesign their manufacturing and distribution organizations and to build supporting information systems. These tasks are complicated by the need to support widely dispersed and frequently changing manufacturing organizations while maintaining efficient logistic and inventory systems. At the same time, the apparel company is faced with coping with the cost pressures endemic to the apparel industry. This paper presents a synthesis of the global supply chain concept as it applies to the apparel industry and relates how one company is attempting to use an Enterprise Resource Planning (ERP) system to provide the basis for operational control of an increasingly complex operating environment. Copyright 2002 IFAC

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1. INTRODUCTION

The globalization of markets has resulted in a great deal of both industry interest and research into supply chain management. A supply chain is recognized as the combination of suppliers and customers that range from the processing of raw materials to delivery to the final consumers (Melnik and Denzler, 1996). Global supply chains have existed for more than a hundred years in the petroleum industry. Exxon and Royal Dutch/Shell extract crude oil in Saudi Arabia, refine it in another country, and sell the petroleum products in other parts of the world. More recently, global supply chains have arisen in the automobile, electronic components, and apparel manufacturing industries. The petroleum, automobile production, and electronics components manufacturing industries are characterized by a high degree of automation and relatively few stock keeping units. Conversely, the apparel industry is both labor intensive and has a large number of frequently changing stock keeping units. A study of industry global supply chains by Cohen and Mallik (1997) reported that the apparel industry (with a Kobrin's index of 0.12) is ranked behind 12 other industries in

terms of supply chain integration. This is in sharp contrast to the electronic components industry (with a Korbin's index of 0.43) and the automobile industry (with a Korbin's index of 0.39). The globalization of the apparel industry in the US has been significantly spurred by The North American Free Trade Agreement (NAFTA), U. S. Tariff Item number 807 (popularly called 807), and the Caribbean Basin Initiative (CBI). The criteria of cost, quality, delivery speed, delivery reliability, and flexibility are still critical for apparel companies even though they are labor intensive. Apparel products must still meet the requirements of the customer in terms of design, quality, cost, and delivery even as the industry attempts to cope with the intense cost pressures.

Traditionally, the textile and apparel industry's supply chain includes the fiber producer, fabric (textile) manufacturer, sundries supplier, apparel company, distributor/retailer, and the end-user/consumer. In this paper, an apparel company is defined as a firm that manufactures and distributes apparel products and is headquartered in the United States. Firms meeting this criteria include VF Corporation and Levi Strauss and

Company which are the largest apparel companies in the world. Since the apparel supply chain is not highly integrated, it will generally include contractors, vendors/suppliers, and retailers in addition to the apparel company. A contractor is defined as any company that is contracted by an apparel company to manufacture (cut, sew, and finish), assemble (sew and finish), or package apparel. These contractors are increasingly located outside the United States. A vendor/supplier is any company that supplies fabric (such as denim, cotton fabric, etc.), buttons, thread, and trims (such as clips, plastic bags, etc.) for packaging to the contractor/apparel company. Vendors/suppliers are located all over the world. While some apparel companies have subsidiary retail stores, most apparel company sales are made to retailers unaffiliated with the apparel company.

US apparel companies began to locate or out-source the cutting and sewing operations internationally only in the last quarter century. More recently other elements of the supply chain such as fiber and fabric manufacturing, finishing, and packaging have moved outside the US. Prior to this globalization, companies like VF Corporation and Levi Strauss were manufacturing all the garments they sold in-house in facilities located in the US. Currently these companies extensively utilize both company owned facilities and contractors outside the country. Worldwide, VF Corporation owns 120 manufacturing and distribution facilities and has numerous contractors. Levi Strauss has 21 plants and over 600 contractors in 60 different countries. The mix of facilities and contractors employed by large US apparel companies changes frequently (Meixell and Gargeya, 2001).

Information Technology (IT) has long been recognized as a vital resource for operations planning and control. Over the years it has manifested primarily in Material Requirements Planning (MRP) systems and Manufacturing Resource Planning (MRP II) systems. These systems have typically been intra-company and national in character. The adoption of electronic data interchange (EDI) supported the migration to inter-company systems. ERP systems have added the global dimension to previous uses of IT for operations management. Thus the blending of ERP systems with the global operations of the apparel industry would seem to be a natural transition. This paper describes the approach taken by one apparel company (VF Corporation) in adopting an ERP system to enhance their planning and control systems on a global scale.

2. DECISION MAKING IN GLOBAL APPAREL SUPPLY CHAINS

Reviews of global sourcing problem in the literature include Vidal and Goetschalckx (1997), Cohen and Mallik (1997), Prasad and Babbar (2000), and Schmidt and Wilhelm (2000). Decision models reported in literature that are relevant to the apparel industry include Cohen and Lee (1989), Cohen and Huchzermeier (1998),

and Arntzen, Brown, Harrison, and Trafton (1995). While these articles offer some guidance for the decision making required to manage the global apparel supply chain, they do not address all the elements that make the apparel supply chain management so challenging (Gargeya, Birdwell, and Martin, 2000). Specifically, the elements that contribute to the challenges of managing global chains in the apparel industry relate to technology, the production process, communications, cultural relationships, supplier arrangements, and transportation.

Critical management decisions include: (1) how much of the finished product is to be made at in-house manufacturing plants? (2) how much of the finished product is to be bought from external subcontractors? (3) how much of the raw material (fabric, buttons, etc.) is to be bought from each of the raw material suppliers, and which raw material supplier would supply (and in what quantities) to which of the subcontractors and in-house plants? These decisions have to be consistent with the goal of minimizing total system-wide costs. System-wide costs are comprised of tangible costs (labor costs, overhead costs, transportation costs, raw material costs, duties, taxes, and inventory carrying costs) and intangible costs (inability to reliably supply quality products with short lead times). Appelbaum and Gareffi (1994) noted that there are pressures in the entire apparel supply network to lower costs and maintain profits. Furthermore, Bowman (2000) pointed out that companies should evaluate the entire supply chain on an on-going basis for improving performance. The total system-wide cost constantly varies depending on which supplier is selected to supply to which subcontractor/plant and as a consequence, apparel supply chains tend to be dynamic rather than static. A formal model specifying the relevant decision variables for a single period is found in Meixell and Gargeya (2001).

Supply chain decisions can be viewed as a dynamic product allocation problem where the key decision is the location of specific production sites for products. The decision objective is to minimize costs to meet specified demands, with facility capacity and import quota constraints. However, the variety of changing and shifting operational options make the decision process far from routine. There are two types of manufacturing facilities available to the decision maker. One type is comprised of those that are owned and operated by the apparel company. The second type is comprised of those that are owned and operated by external contractors to whom production is contracted. For their own plants and for some of the external contractors, the apparel company selects the suppliers of fabric and trims. Other external contractors select and manage their sourcing activities so long as the overall specifications and quality are approved by the apparel company. The options available to the decision maker in constructing a supply chain for a product (or even a single production run of a product) is shown in Figure 1.

Two cost categories are applicable for this production allocation problem. These are the variable costs for the

manufacturing operation and the fixed costs for setting up production of any item at any facility. In some cases the fixed costs are negligible. However, selecting a new supplier in an international location not previously utilized could result in substantial fixed costs. The international nature of this problem means that the types of costs to be considered are quite diverse. Taxes, duties, and transportation are costs that become very relevant in international outsourcing decisions.

How much to produce and where to produce are the decisions made by the apparel company on a recurring and frequent basis. The frequent introduction of new styles significantly impacts these decisions. Production for the planning period is assigned either to the apparel company's plants or to a contractor. These resulting products are inventoried at warehouses owned by the apparel company. These warehouses then supply the apparel in the required quantities to the retailers. The apparel company warehouses maintain inventory to support retailer orders and thus represent a convenient point to end the supply chain. The products produced and shipped in the apparel supply chain are very numerous, as a stock keeping unit (SKU) is set by style, size, and color. VF Corporation and Levi Strauss carry thousands of SKUs for their respective jeans divisions alone. The production planning decisions may aggregate SKUs into product families rather than allocate production location by individual SKU. In this supply chain, then, there are three tiers: customers (i.e. warehouse locations), production plants, and vendors providing raw materials. There are multiple products and input raw materials. These decisions are a tactical supply chain management problem, as described by Shapiro (1998). Shapiro asserted that there is an inter-class of supply chain problems at the tactical level, between the strategic and operational levels of manufacturing planning.

3. INFORMATION TECHNOLOGY AND GLOBAL SUPPLY CHAINS

A key issue in developing effective supply chains is the ability to create what has been termed a virtual organization in which the supply elements are closely integrated. Various studies of highly integrated supply chains (Dyer, Cho and Chu, 1998; Lee, So and Tang, 2000; Shore, 1996) have concluded that information technology can positively affect highly integrated and closely linked supply chains. Cohen and Mallik (1997) point out the problems that may arise when supply chains are not highly integrated and able to support adequate information flows. In supply chains which have spread across national boundaries, the challenges of integrating the supply chain and supporting adequate information flows are more difficult (Chopra and Meindl, 2000).

Shore (2001) presents a supply chain IT linkage capability model that is based on concept that the supply chain's information sharing is affected by the characteristics of the customer, supplier, and the

environment of the customer and supplier. The accompanying case studies illustrate the potential problems associated with information sharing in supply chains when the supply chain is global and/or unstable and when there is a significant difference in customer and supplier firm characteristics. Shore provides a four stage classification for information sharing in supply chains ranging from minimal use of technology to highly integrated systems based on extensively integrated systems between the supplier and customer.

ERP systems have become a key component of the information technology infrastructure of numerous companies by providing support for many back office operations that are essential to supply chains. More recently, specific supply chain management software has appeared in the marketplace with the intent of building upon ERP systems to provide support for managing the entire supply chain. However, this approach is generally predicated on the assumption that the ERP system is adequately able to support the back office operations of elements of the supply chain and are thus dependent on the adequacy of the ERP system. In the classification scheme of Shore, the use of ERP systems in a supply chain could enable a firm to operate with extensive internal information sharing (level 3) and support extensive external information sharing (level 4).

In the apparel industry, the organizational complexity of the supply chain creates special problems in the information sharing which is needed for creating efficient supply chains. While the apparel supply chain is comparatively simple in terms of the manufacturing operations, it may become quite complex organizationally. When the apparel supply chain is composed of firm owned operations, the supply chain may be established with a high potential for information sharing supported by an ERP system. However, when the apparel supply chain contains contracted tasks, the supply information sharing is much more problematic. In reality, the large apparel company will be supporting a diversity of supply chains which are often a function of product lines and even specific styles within product lines. In addition, the relentless cost pressures of apparel manufacturing tend to create frequent changes in the supply chains. Due to the labor intensive nature of some apparel manufacturing operations, many contractor organizations are located in lower wage countries and commonly do not have advanced information systems. As a consequence, the large apparel firm is faced with the extremely challenging task of providing information systems which can support the information sharing necessary for efficient supply chains when faced with a collection of diverse and changing supply chains, contractors who frequently have minimal information technology, and ongoing pressures from customers to lower costs.

4. ERP IN THE VF JEANSWEAR SUPPLY CHAIN

VF Corporation has grown from its origins in 1899 to

become the largest apparel manufacturer in the world with sales in 2000 of \$5.7 billion. By 1996, VF Corporation had 17 divisions producing a wide variety of apparel and other sewn products in plants throughout the world. These divisions generally operated as independent companies with the incumbent overlap of services and lack of synergy in business operations. In an effort to better manage such a diverse organization VF Corporation was reorganized into five product groups (Jeanswear, Intimates, Workwear, Playwear, and Childswear) with the plan for all groups to use common information systems and other shared services. In 1997, VF Services was formed as a free-standing company to provide all shared services. Re-engineering decisions involving the shared core business processes of the VF Corporation operating companies resulted in a plan to adopt packaged software solutions for many common systems with custom operating company programs generally limited to actual manufacturing operations.

The consolidation and standardization of systems across the individual product groups was projected to provide better management information, more dependable and competitive systems, and provide better opportunities for sales growth. Specific financial goals were to increase both sales and income by 8-10% annually, produce a return on equity of 17-20% annually, and maintain an on hand inventory of \$1 billion by Q1 2002 (Cone, 2001). The goal of reducing inventory was expected to be a direct outcome of the new corporate information system model.

The resulting corporate information system model was based on the integrated use of software packages from SAP for ERP, i2 for production planning, Logility for sales planning and forecasting, Gerber for product development, as well as custom legacy systems which were developed for manufacturing operations. To further complicate the situation, VF Corporation determined that the standard SAP R/3 software was inappropriate for its operations and formed a partnership with SAP to develop an industry specific Apparel and Footwear Solution (AFS) to handle VF Corporation's requirements. Following its development in partnership with VF Corporation, AFS became an SAP industry specific solution. The largest VF Corporation working group, VF Jeanswear, was chosen as the focus for the development and initial implementation of this integrated information system. The risks to VF Corporation of this plan were multifaceted. In addition to high systems development costs, VF Corporation was faced with the potential for serious interference in the operations of its largest apparel group if the new integrated systems failed to work properly. The active date for the use of the SAP/R3 (including AFS) in the Jeanswear Group was February 2, 2000. The system at VF Corporation represents a particularly challenging ERP implementation since it involved support for truly global operations, extensive interfacing with legacy systems, and the development of a new industry specific application (AFS)

The implementation of AFS in the apparel industry was not a seamless development. The original concept was that AFS development would be directed by the specific requirements of VF Corporation and Reebok. Other firms including Sara Lee Hosiery and Wolverine World Wide were among the early adopters of the system. However, the development of AFS was not completely finished by the time that VF Corporation began to use it in their Jeanswear division. Some of the original customers of SAP AFS (such as Sara Lee Hosiery and Wolverine World Wide) have dropped AFS as a method for providing back office operations for supply chain management even though they are still using other SAP R/3 functions. A substantial part of the difficulty is the inherent conflict that exists between the use of a software product (SAP/R3) with rigid standards for data and process and the lack of consistent and compatible information systems in contracting firms. The SAP AFS solution is well suited to the support of a high volume, stable supply chain with manufacturing information systems which meet SAP standards for data integrity and completeness. The nature of the apparel marketplace is that this type of supply chain does not fit the realities of contemporary apparel production.

There are essentially four areas of significant potential conflict between an ERP system (such as SAP R/3 AFS) and the global apparel supply chain. First, the economics of the apparel business result in both diverse and frequently changing supply chains while ERP systems function more effectively in the world of the fixed, repetitive supply chain. Reconfiguring the ERP system to reflect changes in the supply chain is both time consuming and costly but apparel companies frequently change both individual contractors and the supply chain itself. Second, the ERP system requires a very high level data integrity and data completeness while contractors in the apparel supply chain are often unable to provide complete, accurate data for all supply chain transactions. ERP systems are extremely sensitive to either inaccurate or missing data. International apparel contractors will frequently have very rudimentary information systems and may rely on paper based information sharing which can result in both inaccurate and incomplete data. Third, the ERP system imposes a strict cause and effect document control scheme to manage the supply chain while international apparel contractors are frequently remiss in coordinating the flow of data and products in the supply chain. The control structure of the ERP system generally does not allow an event (such as shipping an order) to occur until the control event (such as a production run completion) has occurred. The international contractors often submit event notices that do not reflect actual events and thus can result in the ERP control structure being out of sync with the supply chain. Finally, much of the benefit that is derived from supply chain management is lost if demand forecasting and supply chain management are not congruent. When global contractors are included in the supply chain, the apparel company is often unable to implement the adjustments needed to keep the supply chain in compliance with demand forecasts since the contractors

are often unable to make rapid adjustments in production runs which may be required to adjust to demand.

After completing the infusion of SAP into the VF Jeanwear group, VF Corporation delayed plans to infuse SAP into the operations of the Intimates group in the summer of 2001. This delay was substantially caused by a general downturn in economic conditions in the apparel industry. Additional causes for the decision to delay was the difficulty in getting the SAP order management module consistent with the apparel industry requirements, the cost and time required to implement SAP, dissatisfaction with the SAP forecasting capability, and the scope of the Intimates group project. The primary benefit realized at this time is an improvement in scheduling. VF Corporation remains committed to the concept of an integrated information system to manage its global operations (Cone, 2001).

5. CONCLUSIONS

The use of integrated information systems in global supply chain management is a prerequisite for creating the highly integrated, efficient supply chain. A key element of integrated information systems to support supply chains is often an ERP system. The economics of global apparel supply chains create barriers to the use of an efficient, effective use of an ERP system. Much of the potential benefit of the use of an ERP system in supply chain management is mitigated by the inherent conflicts that arise between ERP system requirements and global apparel supply chain realities. Consequently, the use of an ERP system in supply chains that have low levels of integration and substantial global components will create greater management problems and provide less potential benefits than when the ERP system is used in supply chains with more integration and less globalization.

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FIGURE 1: ELEMENTS OF GLOBAL APPAREL SUPPLY CHAINS

