DLA-ARN Short-Term Project Report

DLA ARN Short-Term Project Report

for

US Defense Logistics Agency
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on

Nomex® Supply Chain Total Asset Visibility

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Project to coordinate the collection of total asset visibility (TAV) across the extended military Nomex and one additional supply chain (SC).

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1. Executive Summary

Problem Statement. Within the clothing and textiles (C & T) supply network (SN), the most upstream manufacturers of military unique products often are the single source and have the most constrained capacity of all the manufacturing members on the SN. Examples are Nomex®, Kevlar®, NYCO, ECWCS, and poly/wool products. It is imperative that these manufacturers use their constrained capacity to make the mix of products that is most needed by the SN for the SN to meet readiness requirements at the lowest possible cost.

Today these upstream manufacturers are able to respond only to the demands of their customers who rightfully attempt to do everything they can to optimize their own individual business performance. In addition, raw materials and components of military unique end-items must be launched early or "at risk" before military deliver orders are generated to maintain a flow of products down the SN at a reasonable replenishment lead-time for meeting readiness needs. Often this risk is too high for the SN to support and gaps appear in the flow of product resulting later in extreme problems for the military and all SN players. This results in large excesses of some products and stock outs of others because the upstream manufacturers do not know what is really needed down the entire SN nor are the upstream partners able to distribute available products downstream in an effective manner.

Scope. This project uses the DuPont Nomex® scheduling process to demonstrate that an initial upstream manufacturer can actually establish appropriate capacity and launch into production a mix of products that maintains SN-wide inventory balance without participation from any SN manufacturers between the most upstream partner and C & T.

Technical Discussion. The best method of reducing the risk of manufacturing early and also of optimizing SN performance is using pull scheduling to replace forecast scheduling. Forecasting is then only used to create total capacity ahead of and manufacturing. Pull scheduling requires SN partners to collaborate with each other for their mutual benefit. Specifically, pull scheduling requires the downstream partners to provide the "pull" of product shortages to the upstream partners. The goal of this project was to demonstrate that pull scheduling can be accomplished efficiently within the Nomex® SN.

This was done successfully by taking advantage of the fact that the real "pull" in military SNs is the generation of military delivery orders and other procurement actions rather than by the normal pull of product shortages. Data available from military systems was extracted and presented to DuPont in spreadsheets representing web-based screens in a manner that enabled DuPont to make appropriate risk assessments of the expected demand and then generate optimum production schedules for minimum risk production well ahead of customer orders. At

the same time, DuPont was able to see during the scheduling process the total need for each fiber downstream in the SN and launch manufacturing in a manner to maintain a SN balanced in days of supply.

Conclusions. This project determined the information that should be shared in a collaborative environment with upstream SN partners and demonstrated that it exists in, and can be extracted from, current systems and presented to upstream SN partners in an efficient manner. This not only minimizes the risk of early production, but also can be executed in a manner to schedule constrained manufacturing capacity according to SN-wide priority requirements.

The success of this demonstration can be used to automate scheduling for upstream SN partners of all C & T SNs. Embedded in this scheduling approach are the techniques necessary to significantly improve the flow of products down the SNs, reduce line shutdowns, reduce end-item stock outs, and minimize replenishment and manufacturing costs.

2. Introduction

2.1 Definition of the Problem

The portion of the C & T supply networks upstream of C & T function best when there is a constant flow of product. This flow is normally maintained by upstream SN partners or converters forecasting future military purchases and launching their own replenishment and manufacturing orders "at risk" before C & T releases firm delivery orders. However there are times when the upstream partners are not willing to assume this risk so the SN is broken or "gapped." This means the military products are taken out of production and replaced with other work or equipment is left standing. When demand picks up again there are delays because of higher priority backorders and because of start-up challenges. It is in the military's interest to minimize this risk and enable the flow of products down the entire SN.

Furthermore, the product flow should consist of the right items at the right time in the right quantities and at the right places. This frequently does not happen today because upstream SN partners are very conservative in forecasting and making military unique products because there is no secondary market for these items. Even if the most upstream manufacturer of a military unique raw material is willing to make sufficient quantities, there is no way today to know what sufficient quantities are nor is there a way to know how to distribute what is made to the right places in the right quantities.

Full collaboration is being used more and more in commercial SNs to improve the operational performance of all SN partners with good success. This project uses modified, advanced manufacturing concepts to demonstrate that formal and automated collaboration between DuPont, the single manufacturer of Nomex® fibers, and C & T can minimize DuPont's risk of manufacturing early. In addition C & T can provide all the information DuPont needs to optimize the performance of the upstream SN.

The purpose of this project is to demonstrate that (1) all the inventory and procurement status available to C & T managers can be provided to the most upstream SN partner on an automated basis and that (2) the partner can use this information to reduce the risk of producing early to optimize the availability of military unique raw materials and components downstream to end-item manufacturers.

2.2 Project Scope

The original statement of work directed CAR to serve as the focal point and coordinator to identify and attain SC-wide total asset visibility (TAV) data for two families of combat clothing items, develop the technical details for adding the new data to AAVS, and participate in the process as a full participant until data access was finalized. This included enlisting support from the targeted SC partner firms in accordance with the established criteria and ARN guidance. The specific objectives were to obtain willing participation by each key SC partner, to train each partner in the use of modified VIM-ASAP, and to finalize TAV data utilization.

The project evolved through the year to demonstrating successfully through a series of spreadsheets simulating web-based VIM screens that full collaboration between C & T and DuPont could enable DuPont to schedule Nomex® fiber production to minimize stock outs and excessive inventories in the upstream portions of the SN.

2.3 Keyword Definitions

Military Nomex® Enterprise. All retail military units that use Nomex® items plus DLA wholesale operations and all upstream supporting supply network companies.

Military Nomex® Supply Network (SN). All Nomex® end-item contractors and their upstream suppliers through initial raw material manufacturers.

Military Nomex® Supply Chain (SC). An individual section of the military Nomex® SN consisting of an end-item contractor and all of their upstream suppliers for one or more defined Nomex® items.

2.4 Background

Past ARN research determined that standard business processes in three major areas of the C & T enterprise must be changed to achieve total optimized performance. They are:

- Retail to wholesale collaboration and synchronization. Much work has been accomplished by the ARN in this area primarily by taking over ownership of retail inventories and replenishing through traditional business processes. Prior ARN research projects have created advanced solutions to eliminate stock outs, reduce inventories, and lower operating costs, but they have not been implemented primarily because of a lack of collaboration between C & T and the Services.

- Awarding of delivery orders. C & T's delivery orders drive the upstream portion of the SN. C & T conducts capacity **planning** ahead of production so the projected capacity requirements will be in place when needed. This planning consists of forecasts, solicitations, bids, contracts, and option years. For example, awarding a contract with option years consisting of minimum and maximum quantities establishes flexible capacity. The awarding of delivery orders should also be a planning event, but is an **execution** event because the military system is not capable of awarding delivery orders at the PGC level. In addition, C & T elects to award delivery orders very infrequently (every 90 days while plants schedule every 7 days). These two business practices together result in extremely high levels of costly expediting in an unsuccessful attempt to eliminate stock outs. The solution to this problem was presented in prior ARN research, but has not been implemented primarily because of the implementation of BSM.

- Upstream SN collaboration and synchronization. The focus of this ARN project is on the remaining uppermost portion of the SC above the level of garment manufacturing. It focuses on the natural constraint within the Nomex® SN which is DuPont's fiber manufacturing. If DuPont can schedule fiber production at a rate equal to downstream

demand and do this in a manner that constantly re-balances the inventories of Nomex® fibers from DuPont's WIP to C & T's wholesale inventories, this then only leaves one secondary challenge of distributing the Nomex® fibers, yarns, threads, and fabrics in an optimum manner to end-item manufacturers.

3. Technical Discussion

3.1 Overview

Our ultimate objective is to enable DuPont to generate a forecast that minimizes the risk of manufacturing prior to the receipt of firm fiber orders. We used the drum-buffer-rope (DBR) advanced model of pull scheduling for manufacturing as the basis for our solution and modified it for our unique military situations and application to the extended SN. The DBR model eliminates forecast risk by eliminating forecasting from scheduling and only uses it for planning capacity ahead of execution. Demand pull based on inventory shortages is used to drive scheduling rather than forecasting push. However, in military SNs, contracting actions have to be substituted for inventory shortages in order to create the "pull" in the upstream portions of the SN.

DBR requires the identification of the constraint operation within the SN and the designation or creation of strategic buffers on either side of the constraint. DuPont's fiber manufacturing is the known constraint and there is no shortage of raw materials for fiber manufacturing. Therefore, the only major strategy question was what buffer between DuPont's WIP and retail demand would be the strategic buffer for our demonstration. We soon determined we could actually designate all of the inventory beginning with DuPont's finished goods downstream through C & T's wholesale inventory as a single "virtual buffer" and thereby implement DBR by "black boxing" all of the SN partners' inventories between C & T and DuPont for this first critical step. The reason that we do not need to know actual inventory levels in this part of the SN is that we can assume that open military delivery orders equate to the minimum amount of inventory that must be in the SN upstream of C & T wholesale inventories.

Most of the research effort was in developing and validating through simulated web-based VIM screens (spreadsheets) how the necessary data could be extracted from existing military data bases and presented to DuPont in the modified DBR model to generate a risk-free manufacturing schedule that can optimize upstream SN performance based on DuPont's manufacturing decisions.

In conjunction with developing the special DBR strategy, we had to determine how far into the future to forecast retail demand in order to know the level at which DuPont's constrained capacity should be set. We determined that this is simply equal to the replenishment lead-time for filling C & T's delivery orders. The challenge is that this time can vary greatly unless the SN is flowing at a steady level. We defined SN evolution or maturity stages as a method of readily communicating the steps in attaining ultimate SN performance. We defined these SN maturity stages beginning with a new product for which no capacity or components exist (Stage 1) and progressed through the ultimate SN which includes full synchronization and fast-turn manufacturing (Stage 6).

By defining SN evolution in this manner, we can clearly portray how this and previous ARN solutions fit together to optimize total SN performance. The solution developed in this project will take the C & T SN from the common Stage 3 level in use today up to Stage 4. The application of two other major ARN solutions reviewed above can take the SN up to Stage 5 and Stage 6 can be achieved only if/when C & T recognizes the value of and rewards fast throughput.

3.2 Creating DuPont's Constraints-based Pull Scheduling

Forecasting. All SNs are driven primarily by each SN partner upstream of retail forecasting future downstream customer orders and launching their own component purchases and manufacturing orders prior to the receipt of firm orders. These early launches are "at risk" because there is no guarantee that purchases will follow. Thus, generating low risk forecasts is vital for meeting consumer requirements and optimizing SN-wide in-stock performance and profitability. The generation of low risk forecasts is even more important in military SNs like our Nomex® SN because there are virtually no secondary markets for disposing of excess raw materials, components, or end-items made to military requirements.

Collaboration for Risk Reduction. Risk assessment is a vital part of the forecasting process because the severe negative consequences of over ordering and producing must be weighed against the consequences of missing sales. The lower the business risk associated with the forecast, the more aggressive will be the actions taken based on the forecast. Research has shown that SN partners who generate collaborative forecasts and execute against them do a much better job of meeting consumer demand than do those who forecast independently because collaborative forecasts are much less conservative based on interactions, current knowledge, and shared risks and rewards.

Demand Pull. Lean Manufacturing has clearly demonstrated that fast-turn manufacturing increases forecast accuracy by reducing forecast periods and that replacing forecasts with demand pull virtually eliminates the need for forecasts and associated risks for SN execution. Prior Clemson ARN projects demonstrated that ***collaboration***, ***fast-turn manufacturing***, and ***demand pull*** all work extremely well to enhance military supply chain performance. Since the primary objective is to reduce the risk of upstream SN partners producing early in the absence of military delivery orders, creating demand pull is clearly the optimum strategy.

Constraints-Based Demand Pull. The best method of implementing demand pull in manufacturing is the drum-buffer-rope (DBR) model. In this model the capacity of the most constrained process in the plant is set to match market demand. A strategic buffer of finished goods (FGs) is placed between market demand and manufacturing to absorb minor demand variations so constrained manufacturing capacity does not have to react immediately to changes in demand, but can be increased and decreased slowly. As market demand pulls inventory from the FGs buffer, the pace of the constraint process becomes the drumbeat that is tied, in turn, to the gating operation of the production line through a schedule (the rope). The schedule then introduces new work at a rate that neither starves nor overloads the constraint process. As demonstrated in prior ARN research, the DBR model works extremely well when applied to entire supply networks as well as within individual manufacturing plants.

When SN partners in addition to a single manufacturer participate in collaborative, synchronized SN scheduling, the DBR concept can be replicated many times across the SN or it can be applied to the extended SN in a single application. Since the natural constraint of the military Nomex® SN is DuPont's fiber manufacturing the single application model is the ideal place to begin to achieve the greatest benefit in the shortest time.

Traditional Pull. If C & T could establish the pure DBR model within the Nomex® SN, DuPont would be contracted to maintain a finished goods strategic inventory buffer or "supermarket" from which all manufacturers would withdraw Nomex® fibers as needed. DuPont would set its constrained manufacturing capacity to meet ***total cumulative forecasted fiber withdrawal*** and generate a manufacturing schedule or rope to introduce raw materials into their gating process at the same rate of their constraint process and in a manner that always maintains a balance in days of supply (DOS) of work in process (WIP) plus FGs at the individual fiber level. Then DuPont would schedule production based on a "pull" of shortages or need at the fiber level from their own FG inventory while honoring their constraint. Thus the forecast would only be used for planning at the Nomex® family level and would correctly play virtually no role in execution. This would be a significant improvement over traditional forecast-based scheduling, but DuPont still must forecast market demand to create appropriate capacity well ahead of execution.

Thus, we still have the basic forecasting inaccuracy and associated risk for establishing our total Nomex® capacity. What if we could both forecast need all the way downstream to retail consumption and "pull" the DuPont manufacturing needs at the individual fiber level from much further down the SN than just the DuPont FGs? We can in fact do this, but only by establishing full collaboration between C & T and DuPont.

Full Collaboration. Full Collaboration can clearly improve the forecast greatly and generate a very satisfactory scheduling pull based on contracting actions and intentions. First, C & T can share as much information as possible to minimize DuPont's risk of manufacturing prior to receiving firm orders. Second, C & T can help DuPont set the total capacity at the expected retail demand rate one full SN lead-time into the future rather than just at one DuPont WIP lead-time into the future which is as far as DuPont alone can forecast. Third, C & T can add information to enable DuPont to schedule production that maintains inventory balance at the individual fiber level all the way downstream through C & T's wholesale inventory rather than just through DuPont's FGs inventory. The following figure shows the application of this modified DBR technique to the Nomex® SN:

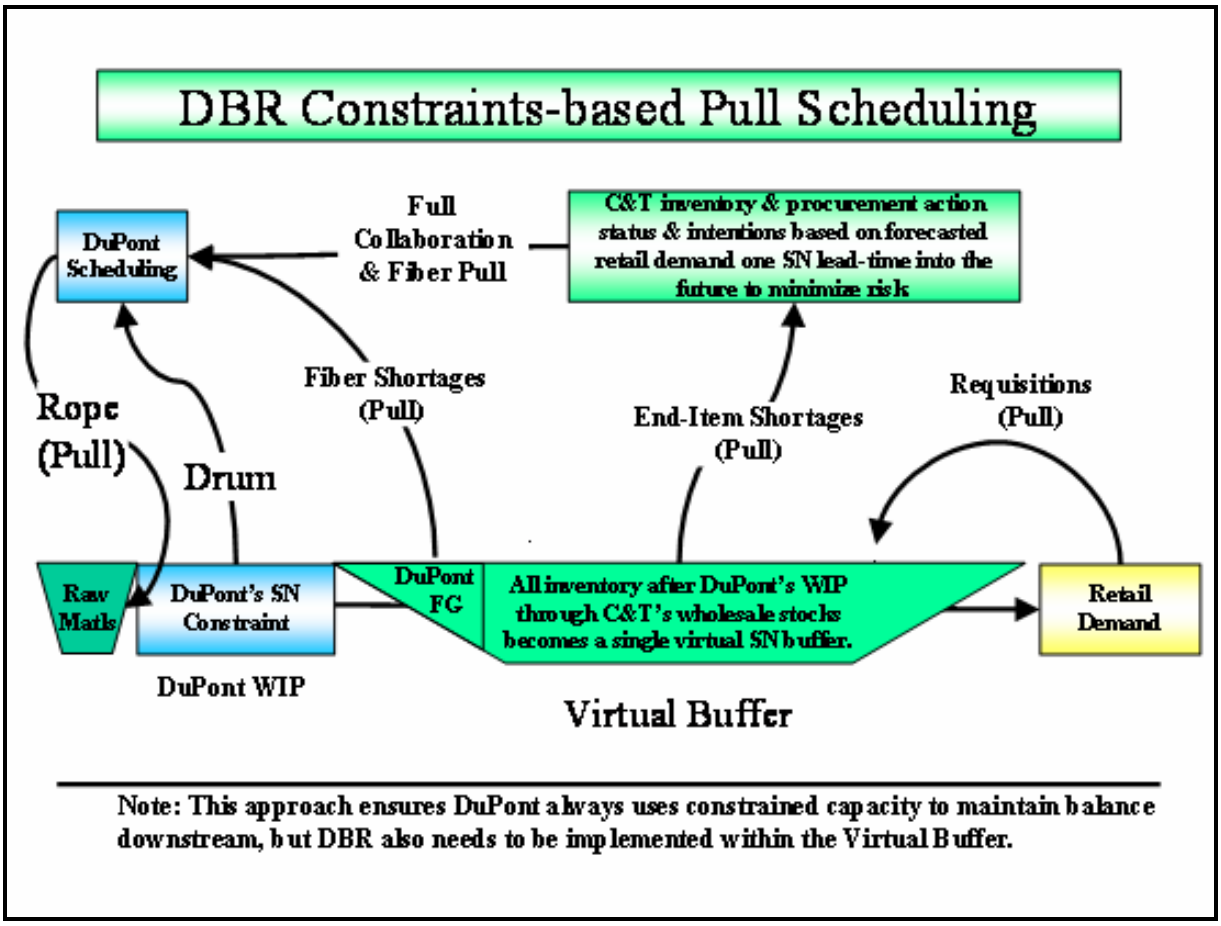

Figure 1 – DBR Constraints-based Nomex® Fiber Pull Scheduling

The optimum DBR scheduling approach re-stated for our Nomex® SN is that DuPont must first collaborate with C & T to set its constrained production capacity of fiber manufacturing to forecasted demand one SN lead-time into the future. The solution for doing this is presented in Section 3.3. Next DuPont must use the additional information provided by C & T to generate a pull-based schedule that insures raw materials are introduced into the DuPont gating process at the same rate as the constraint (fiber extrusion) is producing ***and in a manner that maintains balanced days of supply of all fibers in WIP plus downstream through the virtual buffer***.

All of the processes and inventory buffers between retail demand and DuPont's WIP become one virtual buffer as shown above. For this to work C & T must provide as much information as possible in support of the scheduling process to eliminate risk, optimize balance, and help set DuPont's constrained capacity to match the appropriate forecast period. We also have to convert end-items and fabric shortages in the virtual buffer into pounds of Nomex® fiber so we can drive DuPont's manufacturing appropriately. This conversion is based on a special bill of material (BOM) that already exists at DuPont. DuPont uses it now to compute fiber requirements based on C & T end-item procurement actions. Finally, the vast majority of the time all work within the virtual buffer is supported by military delivery orders which, in turn, covers our virtual buffer shortages plus forecasted needs one SN replenishment lead-time into the future. However, some work in the virtual buffer may be "at risk" beyond the quantities supported by delivery orders or

more work may be necessary than is supported by current delivery orders. Therefore, sometimes we will have to reach further into the future than the time periods that the delivery orders cover by including open contracts and solicitations in our information sharing.

Military delivery orders are the key to our solution because they almost always cover the necessary forecast period, inventory normally exists in the SN only to cover delivery orders, and DuPont uses them already as their basis for tracking completed and "open to make" production requirements. DuPont knows for every C & T delivery order how much of the fiber requirement they have and have not launched into production.

Thus, now we have a strategy for substituting the pull of C & T's procurement status and intentions for the pull of inventory shortages from the virtual buffer while eliminating virtually all risks that would preclude DuPont from manufacturing early.

With this model in place, nothing more can be done to optimize DuPont's contribution to the performance of the Nomex® SN from a manufacturing standpoint and this is extremely important because of the fact that fiber production is the constraint of the entire Nomex® SN. However, lower priority work still must be done to ensure the fiber released from DuPont's finished goods is distributed in an optimum manner downstream through the SN partners to the end-item manufacturers.

The research challenge now becomes how to effectively and efficiently use information existing in the C & T wholesale system to create the DBR pull schedule for DuPont.

C & T managers actually practice a combination of demand pull and forecasting each time that they generate new contract actions. They first determine current shortages and then add forecasted demand for the period of time that their contract actions will cover. By assuming these contracting actions reasonably reflect accurate future demand, they can be used as our pull signals for the upstream SN partners. These SN partners, except for end-item manufacturers, sometimes launch their own component replenishment and manufacturing orders to their conservative demand forecasts. The reason that they do not launch early "at risk" is that the risk levels are normally too high. Major risk factors are that competitors will win the business, products made to current technical requirements will become obsolete because of technical changes, or C & T will significantly reduce expected procurement quantities.

Risk Elimination. In the case of Nomex® end-items, DuPont is the only fiber producer so there is no risk that another company will win the business. Since DuPont makes a huge effort to know about and participate in all possible technical changes, there is little risk that they would get caught with obsolete inventory and this risk will be reduced significantly because our project will shorten lead-times and reduce inventories significantly. The final risk of significantly reduced procurements will also be mitigated greatly as our project enables C & T to automatically share inventory and procurement status as well as procurement and technical change intentions on a systematic and timely basis.

The key to minimizing these two risk factors and, at the same time optimizing upstream SN performance, is to balance and then minimize inventories from DuPont's WIP through receipt of end-items into C & T's wholesale inventory.

3.3 Creating the Supply Chain Forecast

Let's first review traditional forecasting requirements that C & T uses currently and then modify them to determine DuPont's capacity requirements only at the total Nomex® fiber level.

The following figure shows the basic components of the typical apparel SN and typical textile production lead-times when orders, raw materials, components, and end-items are flowing at a rate approximately equal to retail demand:

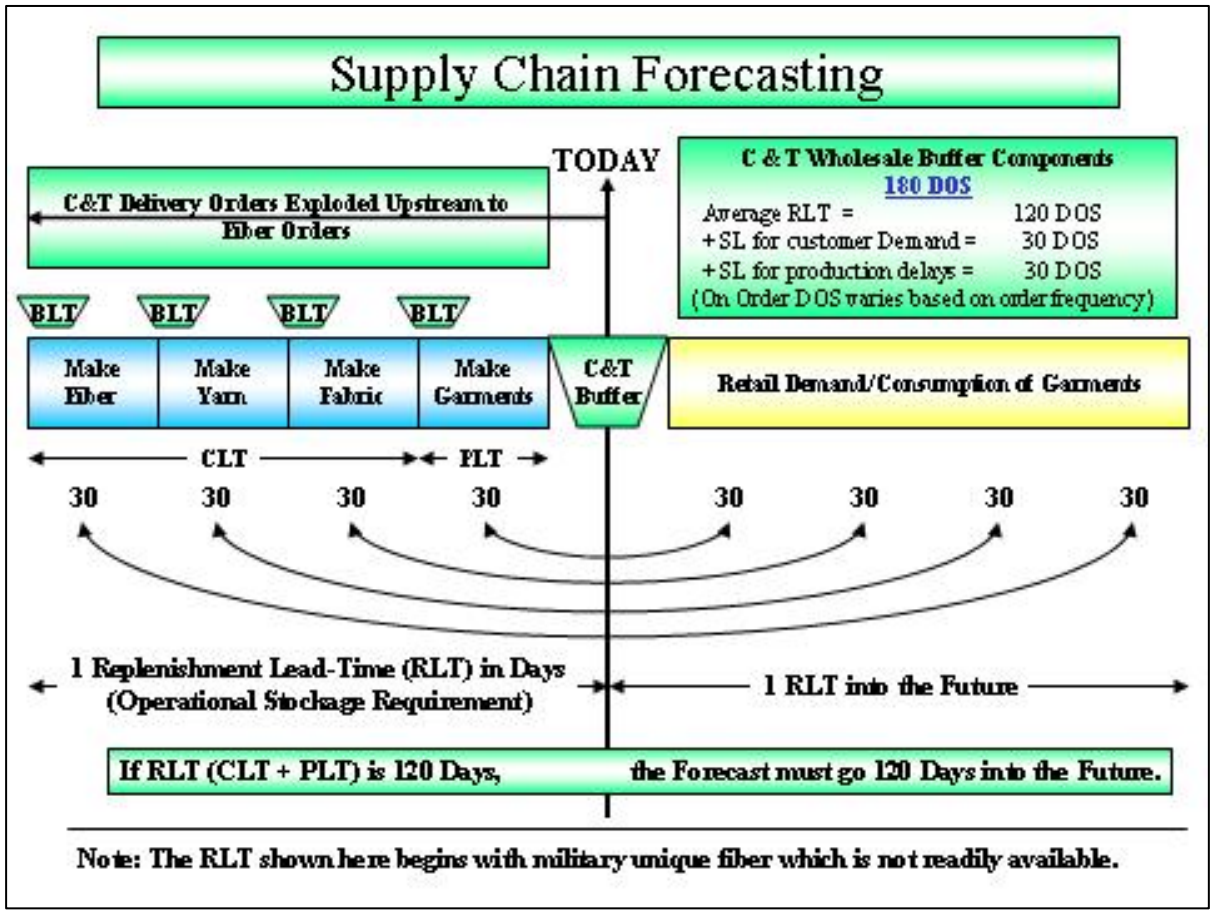

Figure 2 – Stage 2 or 3 SN Supply Chain Forecasting

The first key operational question is how much inventory must be in the C & T Buffer to avoid stock outs. The inventory target in days of supply (DOS) is determined by the average days required to fill replenishment delivery orders at the average retail demand rate per day or the operational replenishment lead-time (RLT) plus the safety levels necessary to cover up-side variations in customer demand and RLT. Since the C & T system uses the standard forecasting

replenishment model, the second operational question is how far the forecast period must extend into the future. This amount of time is simply the RLT.

If the RLT is only 30 days, then the forecasted demand is for only 30 days in the future. On the other extreme, if the RLT is 120 days, the forecast period must extend 120 days into the future as shown above. Historically 120 days have been allowed to fill the first delivery orders of new contracts and 90 days to fill follow-on orders. Thus, the historical forecasting period for retail demand has been 90 to 120 days into the future. This is adequate as long as the real RLT is less than or equal to the assumed RLT.

Let's next examine the five total RLT components. The first two are controlled by C & T, both are normally completed by the award of new contracts, and because of this neither is included in our RLT:

- Administrative lead-time (ALT) is the time required to prepare the initial procurement package.

- Procurement administrative lead-time (PALT) is the time required to award contracts.

The three lead-times within manufacturing that together sum to our RLT are:

- Production lead-time (PLT) is the time from the beginning to the end of the manufacturing process.

- Component lead-time (CLT) is the time from ordering components to the receipt of the components.

- Backorder lead-time (BLT) is the time that production orders must wait until higher priority orders are released into production. PLT, CLT, and especially BLT vary greatly from SN to SN and over time depending on overall business conditions. Normally these three replenishment lead-time (RLT) components are not totally additive because there is overlap between CLT and BLT.

The above figure shows the situation in which each manufacturer requires a total lead-time of 30 days to move production through their portions of the total SN for a RLT of 120 days. If the garment manufacturer has no BLT or CLT, the C & T wholesale RLT would only be 30 days. However, in the case shown here, the garment contractor must wait 90 days of CLT to receive fabric before garment manufacturing can commence. These 90 days of CLT are actually 30 days each of PLT for the three upstream manufacturers. If the fabric were an immediately available commercial fabric, the RLT would be only the 30 days of PLT plus about 7 days of CLT for the garment manufacturer.

The period of time from Today into the future that the forecast must extend is simply the RLT. The RLT depends on the PLT, BLT, and CLT. The shorter the RLT, the more accurate the forecast. RLT can be shortened by reducing the PLT with Lean Manufacturing, the BLT can be

reduced by not permitting a “gap” to occur in the SN, and the CLT can be reduced by synchronizing the SN and implementing Lean Manufacturing at each upstream SN partner.

Thus, the first key to avoiding stock outs with minimum inventory in the current replenishment system is to replenish from a forecast of retail demand that goes as far into the future as the upstream SN requires to provide raw materials, components, and end-items. Stated differently, for optimum performance military delivery orders must drive every upstream SN partner to flow product in an unbroken stream at the same rate that the retail customers are consuming product. Otherwise, the SN is broken or “gapped” and military work is taken out of production causing the RLT to become extremely variable because of other higher priority backorders.

For setting DuPont’s capacity requirements in our demand-pull model this means the collaborative C & T-DuPont forecast must be for one SN lead-time into the future. The above figure becomes our DBR model if we simply combine the last 3 “Make” entities with the C & T Buffer and depict our “pull” as net fiber shortages within our virtual buffer. Thus, our capacity forecasting lead-time requirement is 120 days and our DBR pull is the net “open to deliver” pounds of Nomex® fiber computed from procurement actions minus the pounds DuPont has already launched into production. The following Section addresses the SN maturity stage evolution and shows how the work accomplished in this project can be used to attain Stage 4.

3.4 Defining Supply Chain Maturity Stages

With this background established, let’s now review how SNs evolve and position this project to move the typical C & T SN to the next level. There are six stages of supply chain evolution, each representing a step up in maturity and operating performance.

Stage 1 – Minimum Throughput. This stage occurs when there are no raw materials or components flowing down the SN because the components of a new end-item are not commercially available or no one in the SN is willing to order components or produce at their own risk without firm military delivery orders. Replenishment orders must be passed sequentially upstream and unique components and raw materials such as Nomex® fiber are placed into production without forecasting or risk only in response to firm purchase orders.

Delivery orders for Stage 1 SNs must be placed much earlier than the 120 days shown in the above figure because each SN partner normally has a highly variable “backlog” lead-time (BLT) of waiting work that must be placed into production before new orders can be launched. Thus the actual total component and end-item lead-times for Stage 1 SNs are highly variable and significantly longer than when a flow of raw materials and components is established in later Stages. Typical lead-times are 16 months at best for Stage 1 textile and apparel SNs that begin with fiber production.

Thus, the C & T forecast upon which the initial Stage 1 delivery orders are based must reach 16 months or longer into the future so the fiber manufacturer can launch production of the quantity of fiber that will be required one full upstream lead-time before the need occurs. In this situation, the C & T portion of our Virtual Buffer must support retail needs for 16 months or longer if there is nothing else on order.

Stage 2 – Unstable Throughput. In this stage, product is flowing down the SN at a rate equal to forecasted demand 120 days into the future for the fiber manufacturer, 90 days into the future for the yarn spinner, 60 days into the future for the fabric manufacturer, and 30 days into the future for the garment manufacturer. Production capacity is committed to this level and each SN partner is maintaining this level without orders having to wait their BLT turns in backorder queues. The key to achieving Stage 2 is that the risk of producing early is acceptable to all SC manufacturing partners. However, this stage is very fragile in that the failure of timely delivery orders from the military or replenishment orders from any SN partner can create a break or gap in the SN, forcing a return to a dysfunctional Stage 1 with its highly variable lead-times.

Since the military's budgeting and procurement processes frequently create gaps in the flow of military delivery orders, the risk of producing early is too great for conservative manufacturers and the natural tendency is to revert to a Stage 1 SN. However, for most textiles this risk is removed by the entry of converters into the SN. Converters are today's SN managers and they stabilize most C & T SNs at Stage 3.

Stage 3 – Converter Stabilization. This is historically the most common Stage of C & T SNs. The converters schedule and finance production orders of fiber, spinning, weaving, dyeing and finishing, and often help end item manufacturers with their proposals and waivers. They carry the full risk of producing early to their own forecasts. The key to their success is that they do place their production orders early so end-item manufacturers must come to them in order to meet contractual delivery schedules. A few military textiles including Nomex® are "converted" by textile manufacturers or finishers, but most are "converted" by third party players. Whoever does the converting are today's SN managers and they add value by carrying the full inventory risk, keeping product flowing, and enabling C & T to operate with replenishment lead-times significantly shorter than those of Stage 1 SNs.

The existence of Stage 3 SNs permits C & T to significantly reduce lead-times for first deliveries under new contracts and bridge SN gaps when funding constraints or contracting disputes delay the release of new delivery orders or contracts. Otherwise, C & T's investments in RLT safety buffers would have to be significantly larger than the 180-day historical levels necessary to maintain the historically low stock out levels. (SNs that only suffer the loss of revenue because of stock outs tend to be in stock about 75 percent of the time. Since C & T's in stock rates have always averaged over 85 percent, they are carrying far more inventory than commercial counterparts to avoid the penalty of readiness failures.) The transition to a Stage 5 SN would eliminate the remaining stock outs at significantly reduced inventory levels, but this would require a basic change in operating processes.

Stage 4 – Synchronized Gatekeeper. This is the Stage that this ARN project is demonstrating and it exists when:

- Sufficient C & T procurement actions and intentions plus DuPont inventory status are acquired and shared routinely to enable DuPont to reduce risks of producing early to acceptable levels in the absence of reliable delivery orders.

- The scope of shared information also includes all possible risk-reducing information including C & T's on-hand inventories, inventory targets, delivery orders, contract quantities beyond existing delivery orders, solicitations, planned solicitations, and contemplated technical changes.

- DuPont uses this data and information to maintain capacity that reasonably matches expected demand a SN lead-time into the future and launches manufacturing in a manner that maintains SN-wide total Nomex® fiber balance in days of supply.

Stage 5 – Fully Synchronized SN. This Stage extends collaboration and TAV from retail consumption to the upper-most unique raw materials manufacturing and synchronizes all corresponding ordering, shipping, and manufacturing launches on a frequent and automated basis. Synchronization includes planning at the family or PGC level and executing or scheduling at the NSN level as frequently (normally weekly) as each manufacturer conducts scheduling.

Stage 6 – Maximum Throughput SN. This final Stage recognizes the value of flexible, fast-turn manufacturing and ensures a sufficient portion of each manufacturing level of unique products operates in this manner. The recognition is primarily in the forms of valuing fast throughput and the bundling of all possible end-items that are made interchangeably on the same production lines into single contracts for maximum surge flexibility.

3.5 DuPont Objectives

Since DuPont is the only producer of Nomex® fiber and the melt spinning capacity is limited, a collaborative forecasting effort directly between C & T and DuPont can significantly reduce DuPont's risk of producing fiber prior to receiving firm orders from downstream weavers. In addition, past ARN lessons learned can be applied to enable DuPont to schedule the fibers in shortest supply and thereby maintain an optimum, balanced Nomex® supply network.

From DuPont's standpoint, the primary objectives are to minimize DuPont's risk of producing fiber before firm customer orders are in hand and, at the same time, to enable DuPont to schedule production to minimize their trade-off between changeover costs and inventory ownership costs.

DuPont's secondary objective is to generate a production schedule to meet the primary objectives with a minimum amount of work by DuPont's scheduling department.

3.6 Detailed Solution

The general approach was to use data available from C & T systems to generate three web-based forecast files or screens consisting of all information available to Item Managers and provide this information to DuPont. However, we first had had to create two cross reference files to convert NSN-level data to PGC-level data and Nomex® fiber number level of data:

1. The Bill of Material (BOM) File at Appendix 1 cross references PGCs and end-item names to DuPont Nomex® fiber numbers, names, and a special BUSINESS CONFIDENTIAL fiber bill of materials (BOM). These BOM values are used to convert quantities of items to

pounds of Nomex® fibers by PGCs and fiber numbers. PGC specification numbers were added for convenience in looking up PGCs. BOM values are all set at 1 pound per end-item in this report to avoid classifying it BUSINESS CONFIDENTIAL.

2. The Master Cross Reference (X-Ref) File at Appendix 2 cross references NSNs, NSN sizes, PGCs, PGC names, Nomex® fiber numbers, and BOM values. The primary reason for creating this file was that PGCs were not available in the contract files. Nomex® fiber numbers and BOM values were added for convenience and a roll-up cross reference capability was created at the PGC and fiber number levels.

Next, we had to create four files to compute expected demand and on-hand quantities of items and convert this demand and on-hand status into pounds of Nomex® fibers:

3. The Average Monthly Demand (AMD) File at Appendix 3 computes the AMD of each NSN and rolls the demand up to the PGC level.

4. The PGC On-hand (PGC OH) File at Appendix 4 computes the months of supply (MOS) on-hand at the PGC level from the quantities on hand at the NSN levels. Backorders were originally included in this file so we could generate net shortages. The original intent was to use this file as the basis for computing the wholesale inventory shortages required for classical DBR pull scheduling, but procurement actions and intentions were used instead. The PGC OH File is used for information only. The reason it is not used is that the Item Managers almost always have both shortages and replenishment quantities included in open delivery orders and delivery orders rather than shortages are the real pull recognized by the upstream SN players. ***If this assumption is not valid at any time in the future, this file should be used to compute the shortages that are not on existing delivery orders or there will be a potential shortfall of Nomex® fibers.***

5. The C & T Fiber On-hand (Fiber OH) File at Appendix 5 computes the pounds of Nomex® fibers on-hand at wholesale based on wholesale inventories and the Nomex® BOM. It rolls the PGC sub-totals up to the Nomex® fiber number level for use in the Scheduling File.

NOTE: Spreadsheets 2 through 5 can be combined in the relational data base to generate all values computed separately in this Excel workbook provided the confidentiality of the BOM conversion factor is adequately protected within the database and upon display. Individual screens can then be designed based on these spreadsheets for access and display to meet different needs.

6. The Fiber Average Monthly Demand (Fiber AMD) File at Appendix 6 computes the AMD of Nomex® fibers from the PGC AMD quantity demand and the BOM. It rolls the PGC sub-totals up to the Nomex® fiber number level for use in the Scheduling File.

Then we created the three web-based demand status files or screens for DuPont to use to accept various amounts of demand at various levels of risk:

7. Delivery Order (DO) Status File at Appendix 7 shows the open delivery orders at the CLIN level and rolls them up to the Nomex® Fiber level. It adds the 2 percent allowance that everyone takes and displays the DO open quantity that has not yet been received into wholesale inventory. The last part of the file computes the DO open pounds of Nomex® fiber, permits DuPont to record the pounds of fiber already scheduled or made against the contract delivery order number level, and computes the net fiber pounds open to schedule and launch into manufacturing. Open delivery order requirements are considered to be essentially risk free production requirements for DuPont.

8. Contract Status File (Contracts) at Appendix 8 shows the same information and conducts the same calculations as the DO File above. The purpose of this file is to capture the open to make contractual quantities that exist beyond the delivery orders addressed above. This means that a subjective estimate must be made as to how far into the future to record open to make requirements. DuPont has an additional field in which to record the open to make quantities that they would be willing to make should they have sufficient capacity. Close-in open to make requirements carry little risk, but further out requirements on multiple year contracts can be extremely risky.

The original plan was to have Item Managers or Procurement Specialists validate the accuracy and completeness of the delivery order and contract data on each screen. However, during testing, we determined that sufficiently accurate information could be extracted automatically for delivery orders and contracts without the need for validation.

9. Solicitation and Other (Solicitation) File at Appendix 9 shows all available information for solicitations and planned solicitations in the same general format as the Contract Status File. This file had to be completed manually by Procurement Officers since this data was not available from military sources in any standardized format. Modulant was tasked to build a standard VIM screen for Procurement Specialists to use for creating solicitations. The objectives were to standardize the creation of solicitations, capture this data in the ARN database, and use it to populate automatically all of the required solicitation processes.

Finally, we created a scheduling screen for DuPont:

10. Scheduling (Schedule) File at Appendix 10 compiles at the fiber level pounds of fiber covered and open to make from the DO, Contract, and Solicitation Files; sums months of supply (MOS) open to make; permits DuPont to enter candidate pounds of fiber to schedule by fiber type and risk level while honoring constrained capacity and balancing the downstream SN in MOS; computes the total pounds of each fiber to schedule; and shows the balance level of the SN in MOS.

    The DuPont scheduler must consider all current knowledge including contractual requirements and rated orders as he enters candidate scheduling pounds of fiber. This permits the creation of an optimum, balanced SN while honoring business and legal commitments as well as the fiber extrusion constraint.

11. The final Schedule File is also at Appendix 10. This contains the key fields of the Scheduling File sorted by beginning days of supply so DuPont can see by priority the type and quantity of each fiber that must be made during the next scheduling cycle.

In the example in the Appendix DuPont should launch into production its assumed capacity of 300,000 pounds of the 9 military Nomex® fibers the quantities and priorities shown in Table 10 from top to bottom. This will result in a balance of just over 4 months of supply in the virtual buffer plus DuPont's WIP. This is the most important single step that can be taken to improve the Nomex® SN.

4. Conclusions

Accomplishments

This project determined the information that should be shared in a collaborative environment with upstream SN partners and demonstrated that it exists in, and can be extracted from, current systems and presented to upstream SN partners in an efficient manner. This not only minimizes the risk of early production, but also can be executed in a manner to schedule constrained manufacturing capacity according to SN-wide priority requirements.

Benefits

The stage is set to drastically reduce readiness issues and lower the costs of inventories, manufacturing, and managing shortages across entire supply networks of most of C & T's key products.

Lessons Learned

Synchronized pull scheduling which is known to be far superior to forecast-based scheduling can be readily implemented for entire SNs that originate with a sole producer of the defining end-item component such as Nomex®. This is extremely important because the advanced functionality of most military apparel items resides in unique fibers produced by single sources. This can be done in a modified DBR model. The first step is recognizing that Item Managers already attempt to match the drumbeat of retail demand with new contracts and delivery orders and actively improving this as part of our optimization strategy. The second step is converting this drumbeat of new contracts and delivery orders into required pounds of individual fibers in a manner that the fiber manufacturer can use to maintain SN-wide fiber balance through the scheduling process. Full collaboration between C & T and the gatekeeper of the particular SN is the mandatory foundation for this to work.

Recommendations

Implement the pull scheduling concepts developed in this project as a standard way of synchronizing the introduction of military unique raw materials, fabrics, and other key products into their respective supply networks. This will make a huge difference in the cost and readiness of high technology items that originate from single sources. Examples other than Nomex® are

the BDU SN of combat uniforms, the ECWCS SN, the Kevlar® SN, and the poly wool dress uniform SN.

Extend the synchronized SN concept downstream into the virtual buffer of players to ensure the first products produced are distributed through the yarn, fabric, and finishing manufacturers to the end-item manufacturers in a balanced manner.

Master Nomex Bill of Materials (BOM)

Labels	Computed	SAMMS Input	IM Input or Change	DuPont Input

Table 1 - Master Nomex Bill of Materials (BOM) - BOM includes all Working Losses from Fiber Forward (Updated 18 Jul 05)

			Fiber Bill of Materials (BOM) Lbs/Item			Fabric BOM Yds/Item			Yarn BOM Lbs/Item		
PGC	END ITEMS	End-Item Spec	Fiber Name	Fiber#	BOM	Fabric Name	Fabric#	BOM	Yarn Name	Yarn#	BOM
470	Coveralls, Flyers 27/P Green (Men's)	PD-96-17	N303 Staple Sage Green	N303SG	1.00	(for future use)			(for future use)		
491	Drawers, Flyers, Aramid, Natural, CWU-43/P	MIL-D-85040	T450 Natural NOMEX®	T450N	1.00						
526	Gloves, Flyers, Summer, Green	MIL 81188	N303 Staple Sage Green	N303SG	1.00						
621	Jacket, Flyers, Winter, 45/P, Green	MIL-J-83388	N101 Filament Sage Green	N101SG	1.00						
622	Jacket, Flyers, Summer, 36/P, Green	MIL-J-83388	N101 Filament Sage Green	N101SG	1.00						
683	Trousers, Cold Weather, 18/P	MIL-T-83385	N101 Filament Sage Green	N101SG	1.00						
781	Undershirt, Flyers, Aramid, Natural,	MIL-D-85040	T450 Natural NOMEX®	T450N	1.00						
1656	Gloves, CVC	MIL-G-44108	N303 Staple Camo Green	N303CG	1.00						
1755	Body Armor, CVC, Outer Shell	MIL-B-44194	N303 Staple Camo Green	N303CG	1.00						
1766	Liner, Coat, CVC, Green	MIL-L-44299	N303 Staple Camo Green	N303CG	1.00						
1767	Liner, Trousers, CVC, Green	MIL-L-44299	N303 Staple Camo Green	N303CG	1.00						
1931	Coveralls, Flyers, Cold Weather, CWU-64/P	MIL-C-87230	N101 Filament Sage Green	N101SG	1.00						
2176	Coveralls, CVC Tan 380	MIL-C-44077	N303 Staple Desert Tan	N303DT	1.00						
2179	Jacket, CVC Tan	MIL-J-43924	N303 Staple Desert Tan	N303DT	1.00						
2259	Jacket, Flyers, ACWCS, Woodland, Shell	MIL-DTL-31010	N330 Staple Printable	N330SP	1.00						
2260	Jacket, Flyers, ACWCS, Jacket Lining	MIL-DTL-31010	N330 Staple Printable	N330SP	1.00						
2281	Coveralls, Flyers, 27/P Tan (Women's AF)	PD-99-04	N303 Staple Desert Tan	N303DT	1.00						
2284	Coveralls, CVC Green	MIL-C-44077	N303 Staple Camo Green	N303CG	1.00						
2285	Jacket, CVC Green	MIL-J-43924	N303 Staple Sage Green	N303SG	1.00						
2370	Gloves, Cold Weather, HAU 15/P	NAWC PD	N303 Staple Sage Green	N303SG	1.00						
2376	Coat, Combat, Woodland (ABDU)	PD-02-12	N330 Staple Printable	N330SP	1.00						
2377	Trousers, Combat, Woodland (ABDU)	PD-02-13	N330 Staple Printable	N330SP	1.00						
2378	Coat, Combat, Tan (ABDU)	PD-02-12	N303 Staple Desert Tan	N303DT	1.00						
2379	Trousers, Combat, Tan (ABDU)	PD-02-13	N303 Staple Desert Tan	N303DT	1.00						
2442	Coveralls, Flyers 27/P Tan (Men's)	PD-96-17	N303 Staple Desert Tan	N303DT	1.00						
2456	Suit, Anti-G, Green	MIL-W-81116	N303 Staple Sage Green	N303SG	1.00						
2578	Gloves, Flyers, Summer, Tan	MIL 81188	N303 Staple Desert Tan	N303DT	1.00						
2579	Gloves, Flyers, Summer, Black	MIL-81188	N303 Staple Black	N303SB	1.00						
2753	Jacket, Flyers, Summer, 36/P, Tan	MIL-J-83388	N101 Filament Desert Tan	N101DT	1.00						
2754	Jacket, Flyers, Winter, 45/P, Tan	MIL-J-83388	N101 Filament Desert Tan	N101DT	1.00						
2773	Jacket, Cold Weather, Navy	PD-4-99Rev B	Type 462 NOMEX®	N462	1.00						
2826	Coveralls, Flyers, 27/P Green (Women's AF)	PD-99-04	N303 Staple Sage Green	N303SG	1.00						

Appendix 1 – Nomex® Bill of Material (BOM) File

Table 2 - Master X-Reference of Fiber #, BOM value, PGC, NSN, & Item Name						
Fiber	**BOM**	**PGC**	**NSN**	**Item Name**	**Item Size**	**Count**
		00470	8415010438376	coveralls,flyers'	32 short	1
		00470	8415010438377	coveralls,flyers'	32 regular	1
		00470	8415010438378	coveralls,flyers'	34 short	1
		00470	8415010438379	coveralls,flyers'	34 regular	1
		00470	8415010438380	coveralls,flyers'	36 short	1
		00470	8415010438381	coveralls,flyers'	36 regular	1
		00470	8415010438382	coveralls,flyers'	36 long	1
		00470	8415010438383	coveralls,flyers'	38 short	1
		00470	8415010438384	coveralls,flyers'	38 regular	1
		00470	8415010438385	coveralls,flyers'	38 long	1
		00470	8415010438386	coveralls,flyers'	40 short	1
		00470	8415010438387	coveralls,flyers'	40 regular	1
		00470	8415010438388	coveralls,flyers'	40 long	1
		00470	8415010438389	coveralls,flyers'	42 short	1
		00470	8415010438390	coveralls,flyers'	42 long	1
		00470	8415010438391	coveralls,flyers'	44 short	1
		00470	8415010438392	coveralls,flyers'	44 regular	1
		00470	8415010438393	coveralls,flyers'	44 long	1
		00470	8415010438394	coveralls,flyers'	46 short	1
		00470	8415010438395	coveralls,flyers'	46 regular	1
		00470	8415010438396	coveralls,flyers'	46 long	1
		00470	8415010438397	coveralls,flyers'	48 regular	1
		00470	8415010438398	coveralls,flyers'	48 long	1
		00470	8415010439529	coveralls,flyers'	42 regular	1
		00470	8415014370741	coveralls,flyers'	52 regular	1
		00470	8415014370743	coveralls,flyers'	50 long	1
		00470	8415014370744	coveralls,flyers'	50 regular	1
		00470	8415014373941	coveralls,flyers'	52 long	1
N303SG	1.00	**00470 PGC**	8415014373941	coveralls,flyers'		28
		00491	8415004674075	drawers,flyers'	small	
		00491	8415004674076	drawers,flyers'	medium	
		00491	8415004674078	drawers,flyers'	large	
		00491	8415004674100	drawers,flyers'	x-large	
		00491	8415010434036	drawers,flyers'	x-small	
T450N	1.00	**00491 PGC**	8415010434036	drawers,flyers'		0

Appendix 2 – Master Cross Reference File

Table 3 C&TNSN & PGC Annual Demand & AMD QTY				
PGC	**NSN**	**Customer**	**ADq**	**AMD**
470 Total			136948	11412
491	8415004674075	NonRTC	3477	290
491	8415004674076	NonRTC	16417	1368
491	8415004674078	NonRTC	19075	1590
491	8415004674100	NonRTC	9046	754
491	8415010434036	NonRTC	368	31
491 Total			48383	4032
526	8415010290109	NonRTC	26382	2199
526	8415010290111	NonRTC	50108	4176
526	8415010290112	NonRTC	113384	9449
526	8415010290113	NonRTC	130555	10880
526	8415010290116	NonRTC	95904	7992
526	8415010401453	NonRTC	6287	524
526	8415010402012	NonRTC	5721	477
526	8415014828417	NonRTC	973	81
526	8415014828420	NonRTC	14060	1172
526 Total			443374	36948
621	8415003101111	NonRTC	981	82
621	8415003101126	NonRTC	3576	298
621	8415003101133	NonRTC	7306	609
621	8415003101140	NonRTC	6262	522
621	8415014221505	NonRTC	1241	103
621 Total			19366	1614
622	8415010101910	NonRTC	8340	695
622	8415010101911	NonRTC	2360	197
622	8415010101912	NonRTC	996	83
622	8415010101913	NonRTC	5704	475
622	8415014790017	NonRTC	501	42
622 Total			17901	1492

Appendix 3 – Average Monthly Demand File

Table 3a C&T PGC OH QTY & MOS			
PGC	NSN	OHq	MOS
470 Total		86672	**7.59**
491 Total		47010	**11.66**
526 Total		49364	**1.34**
621 Total		30659	**19.00**
622	8415010101910	4125	
622	8415010101910	19	
622	8415010101910	11	
622	8415010101910	280	
622	8415010101912	94	
622	8415010101913	3420	
622	8415010101913	1	
622	8415010101913	2	
622	8415010101913	13	
622	8415010101913	100	
622	8415010101913	14	
622 Total		8079	**5.42**
683	8415010654956	45	
683	8415010654957	74	
683	8415010654959	26	
683	8415010654959	32	
683	8415010654963	31	
683	8415010654963	3	
683 Total		211	**70.33**
781	8415004856548	2009	
781	8415004856680	2163	
781	8415004856680	29	
781	8415004856681	219	
781	8415004856681	122	
781	8415010438375	317	
781	8415010438375	26	
781	8415010438375	26	
781	8415010438375	12	
781 Total		4923	**1.00**
1656	8415010749428	21	
1656	8415010749429	115	
1656	8415010749430	41	
1656	8415010749430	7	
1656	8415010749430	11	
1656	8415010749432	2852	
1656	8415010749432	10	
1656 Total		3057	**12.19**

Appendix 4 – PGC On-hand Quantity File

Table 4 C&T OH PGC QTY & MOS				OH PGC & Fiber			
PGC	NSN	OHq		PGC	Fiber #	BOM	Fiber Lbs
2753	8415014916184	56		2753	N101DT	1.00	56
2753	8415014916188	243		2753	N101DT	1.00	243
2753	8415014916188	224		2753	N101DT	1.00	224
2753	8415014916190	742		2753	N101DT	1.00	742
2753	8415014916190	521		2753	N101DT	1.00	521
2753	8415014916192	548		2753	N101DT	1.00	548
2753	8415014916192	553		2753	N101DT	1.00	553
2754	8415014916122	12		2754	N101DT	1.00	12
2754	8415014916122	77		2754	N101DT	1.00	77
2754	8415014916124	278		2754	N101DT	1.00	278
2754	8415014916124	157		2754	N101DT	1.00	157
2754	8415014916125	408		2754	N101DT	1.00	408
2754	8415014916125	561		2754	N101DT	1.00	561
2754	8415014916127	320		2754	N101DT	1.00	320
2754	8415014916127	423		2754	N101DT	1.00	423
		5123			**N101DT Total**		**5123**
621	8415003101111	2208		621	N101SG	1.00	2208
621	8415003101111	1846		621	N101SG	1.00	1846

Appendix 5 – Fiber On-hand Pounds File

Table 5 - AMD by PGC & Fiber				Nomex Fiber	
PGC	BOM	Demand	AMD	Fiber #	Lbs AMD
2753	1.00	1026	86	N101DT	86
2754	1.00	1033	86	N101DT	86
		2059	172	**N101DT Total**	**172**
621	1.00	19366	1614	N101SG	1614
622	1.00	17901	1492	N101SG	1492
683	1.00	36	3	N101SG	3
1931	1.00	1834	153	N101SG	153
		39137	3261	**N101SG Total**	**3261**
1656	1.00	3010	251	N303CG	251
1755	1.00	3290	274	N303CG	274
1766	1.00	234	20	N303CG	20
1767	1.00	504	42	N303CG	42
2284	1.00	36769	3064	N303CG	3064
		43807	3651	**N303CG Total**	**3651**
2176	1.00	27812	2318	N303DT	2318
2179	1.00	10381	865	N303DT	865
2281	1.00	6000	500	N303DT	500
2378	1.00	37947	3162	N303DT	3162
2379	1.00	44635	3720	N303DT	3720
2442	1.00	92430	7703	N303DT	7703
2578	1.00	66078	5507	N303DT	5507
		285283	23774	**N303DT Total**	**23774**
2579	1.00	9288	774	N303SB	774
		9288	774	**N303SB Total**	**774**

Appendix 6 – Fiber Average Monthly Demand File

Table 6 - SORTED and Sub-Totaled Delivery Order Launched and Open Fiber Status FOR August 15 COMPUTATIONS																			
Delivery Order End-Items														Lbs of Nomex Fiber					
Fiber #	Fiber BOM	PGC	PIIN/ Contract Number	CAGE #	D.O. #	CLIN	NSN	Award QTY	Award Date	Ship QTY	Ship Date	AWD QTY + 2%	DO Open QTY	Awd Lbs Fiber	Open Lbs Fiber @ DSCP	LBS Launched	MFG Order #	Lbs Open to Launch	Excess Lbs Launched	Net Fiber Lbs Open to Launch
N101DT Total								**12820**		**5564**		**13076**	**7512**	**13076**	**7512**	**0**		**13076**	**0**	**13076**
N101SG	1.00	622	SP010005D4158	1SSG5	1	0001AA	8415010101910	848	03/25/05	0		865	865	865	865			865	0	865
N101SG	1.00	622	SP010005D4158	1SSG5	1	0001BA	8415010101910	852	03/25/05	96	05/27/05	869	773	869	773			869	0	869
N101SG	1.00	622	SP010005D4158	1SSG5	1	0002AA	8415010101911	3008	03/25/05	640	07/29/05	3068	2428	3068	2428			3068	0	3068
N101SG	1.00	622	SP010005D4158	1SSG5	1	0002BA	8415010101911	2992	03/25/05	944	06/24/05	3052	2108	3052	2108			3052	0	3052
N101SG	1.00	622	SP010005D4158	1SSG5	1	0003AA	8415010101912	2000	03/25/05	672	07/29/05	2040	1368	2040	1368	7000		0	4960	-4960
N101SG Total								**9700**		**2352**		**9894**	**7542**	**9894**	**7542**	**7000**		**7854**	**4960**	**2894**
N303CG	1.00	1755	SP010003D4024	62283	1	0002AA	8470011106107	700	01/30/03	644	04/18/05	714	70	714	70	428		286	0	286
N303CG	1.00	1755	SP010003D4024	62283	2	0004AA	8470011106107	1500	04/16/03	1290	07/14/05	1530	240	1530	240	918		612	0	612
N303CG	1.00	1755	SP010003D4024	62283	2	0006AA	8470011106111	900	04/16/03	820	07/29/05	918	98	918	98	551		367	0	367
N303CG	1.00	1755	SP010003D4024	62283	2	0007AA	8470011106109	530	09/21/04	400	07/29/05	541	141	541	141	324		216	0	216
N303CG	1.00	1755	SP010003D4101	70343	5	0001AA	8475013123144	718	07/18/05	0		732	732	732	732	439		293	0	293
N303CG	1.00	1755	SP010003D4101	70343	5	0001BA	8475013123144	722	07/18/05	0		736	736	736	736	442		295	0	295
N303CG	1.00	1755	SP010003D4101	70343	5	0002AA	8475013123145	389	07/18/05	0		397	397	397	397	238		159	0	159

Appendix 7 – Delivery Order Status File

Table 7 - Contract QTY by Contract # and Due In Dates Beyond Existing Delivery Orders																	
Contract End-Items - IMs manually post contractual status beyond Delivery Orders covered in Table 7											Lbs of Nomex Fiber						
Fiber	Fiber BOM	PGC	PIIN/ Contract Number	CAGE	Option Year	Open Annual MIN QTY	Open Annual MAX QTY	IM DO Planned Qty	First End-Item Delivery Date	DuPont Planning QTY	Plan Qty + 2%	Open Lbs Fiber on Options	Lbs Launched	MFG Order #	Lbs Open to Launch	Excess Lbs Launched	Net Fiber Lbs Open to Launch
N101SG	**1.00**	621	03-D-4128	1SSG5	1	100	40000			100	102	102	0		102	0	102
N101SG	**1.00**	621	03-D-4128	1SSG5	2	100	40000			0	0	0	0		0	0	0
N101SG	**1.00**	622	05-D-4158	1SSG5	1	11500	40000			11500	11730	11730	13000		0	1270	-1270
N101SG	**1.00**	622	05-D-4158	1SSG5	2	11500	40000			0	0	0	0		0	0	0
N101SG Total										0	11832	11832	**13000**		102	1270	**-1168**
N303CG	**1.00**	1656	05D4100	1V524	1	15000	30000			15000	15300	15300	1500		13800	0	13800
N303CG	**1.00**	1656	05D4100	1V524	2	15000	30000			0	0	0	0		0	0	0
N303CG	**1.00**	1656	05D4100	1V524	3	15000	30000			0	0	0	0		0	0	0
N303CG Total										0	15300	15300	1500		13800	0	**13800**
N303DT	**1.00**	2442	05D4114	06GQ8	1	79000	190000			79000	80580	80580	0		80580	0	80580
N303DT	**1.00**	2442	05D4114	06GQ8	2	79000	190000			0	0	0	0		0	0	0
N303DT	**1.00**	2578	03D4154	1CB38	2	18000	43200			0	0	0	0		0	0	0
N303DT	**1.00**	2578	03D4154	1CB38	3	18000	43200			0	0	0	0		0	0	0
N303DT	**1.00**	2578	03D4155	1V524	2	12000	28800			0	0	0	0		0	0	0
N303DT	**1.00**	2578	03D4155	1V524	3	12000	28800			0	0	0	0		0	0	0
N303DT Total										0	80580	80580	0		80580	0	**80580**
N303SB	**1.00**	2579	03D4154	1CB38	2	4200	7800			0	0	0	0		0	0	0
N303SB	**1.00**	2579	03D4154	1CB38	3	4200	7800			0	0	0	0		0	0	0
N303SB	**1.00**	2579	03D4155	1V524	2	2800	5200			0	0	0	0		0	0	0
N303SB	**1.00**	2579	03D4155	1V524	3	2800	5200			0	0	0	0		0	0	0
N303SB Total										0	0	0	0		0	0	**0**
N303SG	**1.00**	526	03D4154	1CB38	2	108000	169320			0	0	0	0		0	0	0
N303SG	**1.00**	526	03D4154	1CB38	3	108000	169320			0	0	0	0		0	0	0
N303SG	**1.00**	526	03D4155	1V524	2	72000	112880			0	0	0	0		0	0	0
N303SG	**1.00**	526	03D4155	1V524	3	72000	112880			0	0	0	0		0	0	0
N303SG	**1.00**	2370	05D4205	1CB38	1	36000	210000			36000	36720	36720	0		36720	0	36720
N303SG	**1.00**	2370	05D4205	1CB38	2	36000	210000			0	0	0	0		0	0	0
N303SG	**1.00**	2370	05D4205	1CB38	3	36000	210000			0	0	0	0		0	0	0
N303SG	**1.00**	2370	05D4206	6K235	1	24000	140000			24000	24480	24480	0		24480	0	24480
N303SG	**1.00**	2370	05D4206	6K235	2	24000	140000			0	0	0	0		0	0	0
N303SG	**1.00**	2370	05D4206	6K235	3	24000	140000			0	0	0	0		0	0	0
N303SG Total										0	61200	61200	0		61200	0	**61200**

Appendix 8 – Contract Status File

Table 8 - Planned and Actual Solicitation QTY (SOLq) by Solicitation # & DI Dates and DuPont At Risk Inventory																
End Items by Solicitation Number or Forecast Beyond Solicitation by Ims and/or PCOs											Lbs of Nomex Fiber					
Fiber	**Fiber BOM**	**PGC**	**Solicitation Number**	**Number of Years**	**First Delivery Date**	**Annual MIN QTY**	**Annual MAX QTY**	**IM DO Planned Qty**	**DuPont Planning QTY**	**Plan Qty + 2%**	**DuPont Estimated Open Lbs of Fiber**	**Lbs Launched**	**DuPont MFG Order #**	**Lbs Open to Launch**	**Excess Lbs Launched**	**Net Fiber Lbs Open to Launch**
N303CG	1.00	1656	04-R-0110	3	Aug 05	15,000	30,000		30000	30600	30600	0		30600	0	**30600**
N303CG	1.00	1766	04-R-0019	1	Oct 05	5,100	7,000		7000	7140	7140	7000		140	0	**140**
N303CG	1.00	1767	04-R-0019	1	Oct 05	2,100	3,500		2100	2142	2142	0		2142	0	**2142**
N303CG	0								0	0	0	0		0	0	**0**
N303CG	0								0	0	0	0		0	0	**0**
N303CG	0								0	0	0	0		0	0	**0**
N303CG	0								0	0	0	0		0	0	**0**
N303CG	0								0	0	0	0		0	0	**0**
N303CG	0								0	0	0	0		0	0	**0**
N303CG	0								0	0	0	0		0	0	**0**
N303CG	0								0	0	0	0		0	0	**0**
N303CG		**Total**							**0**	**39882**	**39882**	**7000**		**32882**	**0**	**32882**
N330SP	1.00	2259	04-R-0039	2	Sep 05	2,500	10,000		10000	10200	10200	0		10200	0	**10200**
N330SP	1.00	2260	04-R-0039	2	Sep 05	2,500	10,000		10000	10200	**10200**	**0**		10200	0	**10200**
N330SP	0								0	0	**0**	**0**		0	0	**0**
N330SP	0								0	0	**0**	**0**		0	0	**0**
N330SP	0								0	0	**0**	**0**		0	0	**0**
N330SP	0								0	0	**0**	**0**		0	0	**0**
N330SP	0								0	0	**0**	**0**		0	0	**0**
N330SP	0								0	0	**0**	**0**		0	0	**0**
N330SP		**Total**							**20000**	**20400**	**20400**	**0**	**0**	**20400**	**0**	**20400**

Appendix 9 – Solicitation File

Table 9 Nomex FiberStatus and Scheduling Needs																					
Fibers & AMD			Fiber Lbs & MOS Covered (Launched) by DuPont						Open Fiber Lbs & MOS DuPont can Launch by Risk Level								Lbs to Launch & Capacity:			300000	
Fiber	PGC	Total Fiber Lbs AMD	C&T MOS OH by Fiber #	On Open Delivery Orders	On Open Contracts	On Open Solicitations & Forecasts	Total Lbs Covered	Begin MOS Covered	DO Lbs Open	DO MOS Open	Contract Lbs Open	Contract MOS Open	SOL Lbs Open	Sol MOS Open	Total Lbs Open	Total MOS Open	Launch DO Lbs	Launch Contract Lbs	Launch Sol Lbs	Total Launch Lbs	End MOS OH
N101DT	All	172	30	0	0	0	0	0.00	13076	76.21	0	0.00	0	0.00	13076	76.21	750	0	0	750	4.37
N101SG	All	3261	13	7000	13000	0	20000	6.13	2894	0.89	-1168	-0.36	0	0.00	1726	0.53	0	0	0	0	6.13
N303CG	All	3651	14	10792	1500	7000	19292	5.28	43737	11.98	13800	3.78	32882	9.01	90419	24.77	0	0	0	0	5.28
N303DT	All	23774	1	75000	0	0	75000	3.15	406690	17.11	80580	3.39	0	0.00	487270	20.50	38700	0	0	38700	4.78
N303SB	All	774	1	0	0	0	0	0.00	19968	25.80	0	0.00	0	0.00	19968	25.80	3400	0	0	3400	4.39
N303SG	All	87994	2	150000	0	0	150000	1.70	887006	10.08	61200	0.70	0	0.00	948206	10.78	208000	0	0	208000	4.07
N330SP	All	2579	2	5000	0	0	5000	1.94	263770	102.26	0	0.00	20400	7.91	284170	110.17	5500	0	0	5500	4.07
N462	All	2233	11	2000	0	0	2000	0.90	5140	2.30	510	0.23	0	0.00	5650	2.53	5650	0	0	5650	3.43
T450N	All	8953	6	0	0	0	0	0.00	181376	20.26	0	0.00	0	0.00	181376	20.26	38000			38000	4.24
Total:	All	133390	3	249792	14500	7000	271292	2.03	1642282	12.31	154922	1.16	53282	0.40	1850486	13.87	300000	0	0	300000	4.28

Table 10 Schedule (Needs Sorted by Begin MOS OH)			
Fiber	Begin MOS OH	Launch Lbs	End MOS OH
N101DT	0.00	750	4.37
N330SP	0.00	3400	4.39
N101SG	0.00	38000	4.24
N303SG	0.90	5650	3.43
N303CG	1.70	208000	4.07
N303DT	1.94	5500	4.07
N462	3.15	38700	4.78
T450N	5.28	0	5.28
N303SB	6.13	0	6.13
Totals:	2.03	300000	4.28

Appendix 10 – Scheduling File and Sorted Schedule File

Appendix 11 - Acronyms

ALT	Administrative Lead-time. Time required to prepare a procurement action for initial release.
AMD	Average Monthly Demand computed by dividing the total demand for a year by 12.
ARN	The Apparel Research Network.
BLT	Backorder Lead-time. The time an order has to wait to go into manufacturing because other orders arrived first or have a higher priority for production.
BOM	Bill of Material. Conversion factor for each Nomex® end-item (averaged for all sizes at the PGC-level) used to compute pounds of the Nomex® fiber DuPont must enter into production for each contract or delivery order.
BSM	Business System Modernization.
C & T	Clothing and Textiles.
CAR	Clemson Apparel Research.
CLIN	Contract Line Item Number.
CWT	Customer Wait Time.
CLT	Component Lead-time. The time required from order placement to item receipt.
DBR	Drum Buffer Rope. Constraints based pull scheduling technique.
DO	Delivery Order.
DOS	Days of supply.
FG	Finished Goods.
MOS	Months of Supply.
NSN	National Stock Number.
OH	On Hand. Inventory quantity or days of supply on hand.
OST	Order Ship Time.
PALT	Procurement Administrative Lead-time. Time from contract award until first lot is entered into production.
PCO	Procurement Contracting Officer.
PGC	Procurement Group Code.
RLT	Replenishment Lead-Time.
SC	Supply Chain.
SN	Supply Network.
TAV	Total Asset Visibility.
VIM	Virtual Item Manager.
VIM-ASAP	Virtual Item Manager Web-based tool for providing delivery order status and collecting manufacturing and shipping status.
WIP	Work In Process.