Distribution On Demand

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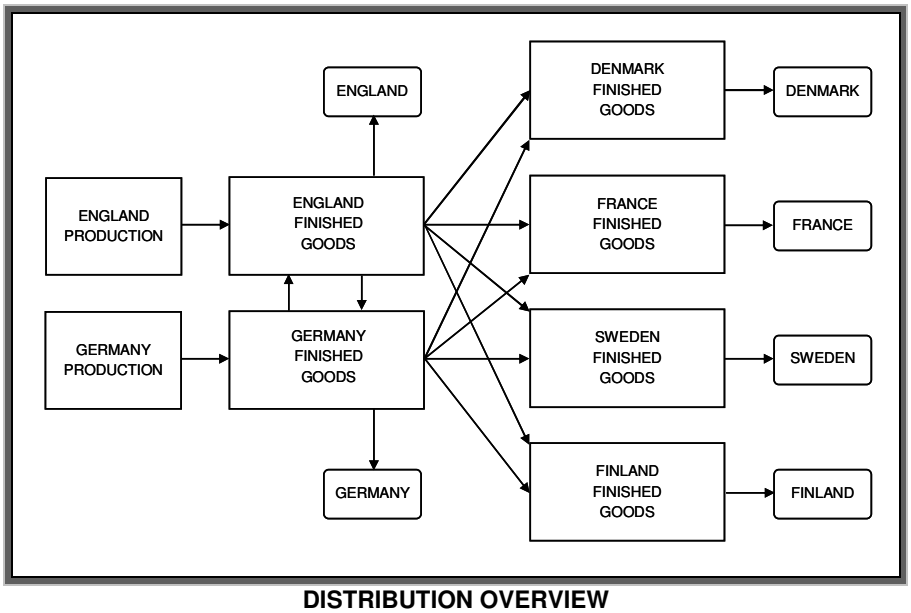
BUSINESS OVERVIEW

The subject company, which we will call RivetCo, produces and distributes rivets for the European industrial and consumer markets. Of total sales, which are produced by two manufacturing units, about 35% is sold through four affiliated distributors. Each manufacturer supplies finished rivets to domestic customers and to all affiliates, as well as a small amount of goods to the other manufacturer (see **DISTRIBUTION OVERVIEW**). The manufacturing units are located in England and West Germany; the distribution units are located in Denmark, France, Sweden, and Finland. Although RivetCo enjoys a majority market share, that share is in jeopardy of erosion because of increased competitive pressure, primarily in customer service and delivery lead times.



DISTRIBUTION OVERVIEW

At the request of RivetCo management, SYNCHRONOUS MANAGEMENT has provided assistance in revising the rivet supply and distribution system. The objective of this effort was to devise an approach which would enable RivetCo to supply and distribute rivets with the market-required customer service level of 95% and with a minimum of inventory.

FINDINGS AND ANALYSIS

UNIT PERFORMANCE provides an overview of the flow of materials and orders in the RivetCo distribution system. Customer required deliveries range from one day to sixty days after receipt of order, and on-time delivery performance ranges from 30% on-time (England) to 99% on-time (Denmark). Finished goods inventories range from 19 days worth (Germany) to 93 days worth (Sweden). As **SYSTEM THROUGHPUT TIMES** shows, total system throughput time averages 86 days, from receipt of order at the manufacturer to shipment by the distributor.

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LOCATION	PRODUCTION LEAD TIME DAYS	DAYS OF INVENTORY	MARKET LEAD TIME DAYS	EARLY/ ONTIME/ LATE DELIVERY
ENGLAND PRODUCTION	43	84		
ENGLAND FINISHED GOODS		24	3-30	35/30/35%
GERMANY PRODUCTION	20	54		
GERMANY FINISHED GOODS		19	3-60	35/35/30%
DENMARK FINISHED GOODS		88	1-20	0/99/1%
FRANCE FINISHED GOODS		64	3-20	20/70/10%
SWEDEN FINISHED GOODS		93	1-20	0/92/8%
FINLAND FINISHED GOODS		87	2-60	0/95/5%

UNIT PERFORMANCE

Distributor finished goods inventory levels are set by each unit based on the total system throughput times (see **SYSTEM THROUGHPUT TIMES**). Thus, each distributor finds it necessary to carry three to five months of inventory. Each unit provides each manufacturer with long-range "dollar" forecasts of anticipated requirements, and rivets are ordered via individual purchase orders. Production is driven by manufacturing efficiencies, customer order backlogs, and by finished goods order points.

CYCLE	DAYS	CUM DAYS
PRODUCTION BACKLOG	44	86
PRODUCTION WORK IN PROCESS	13	42
PRODUCTION UNASSEMBLED STOCK	18	29
PRODUCTION ORDER PROCESSING	2	11
TRANSPORTATION	7	9
AFFILIATES ORDER PROCESSING	2	2

SYSTEM THROUGHPUT TIMES

UNIT PERFORMANCE and **SYSTEM THROUGHPUT TIMES** reveal the basic correlation among lead times, inventory levels, and delivery performance. Note that the on-time delivery performance in Denmark, Sweden, and Finland is quite high (over 92%) and the days of finished goods inventory on hand at those units is in all cases greater than the total system throughput time of 86 days. On the other hand, the on-time delivery performance in France is lower (70%), and France carries only 64 days of inventory. This suggests that in order to maintain a high level of customer service, the affiliates must carry large inventories to cover the average replenishment cycle.

For the two manufacturers, on-time delivery performance is very low, only 30-35% on-time. The weighted average material throughput time from release to work in process to shipment in England and Germany is fifty-three days ((43+20+24+19)/2), and the market required lead time is much shorter, ranging from three days (high volume items) to 60 days (a few special items). Because of this difference, the manufacturers must start much of their production based on a forecast. Unfortunately, the accuracy of item forecasts drops off rapidly beyond the average market lead time required. The result is that in many cases the wrong items are produced, while the items which actually turn out to be required for shipment must be expedited at the last minute. Thus, the spread of early, ontime, and late shipments.

This problem is exacerbated by a policy at each manufacturer of maintaining a high customer order backlog (forty-four days), which enables production to combine future requirements for like items in order to maximize manufacturing efficiencies. This production ahead of need results in extended lead times and high inventories throughout the system, and compounds the manufacturers' delivery performance problem.

Our conclusion is that the key to improving delivery performance is to improve the flow of materials through the system - *to reduce system throughput times and therefore inventories*. This will enable RivetCo to produce much more closely to actual customer requirements - converting productive capacity into shipments, rather than excess inventory.

RECOMMENDATIONS

MATERIAL PLANNING: RivetCo should implement a forecasting system which enables each unit to generate sales forecasts for each end item rivet. Forecasts for stocked items should be generated by the selling unit, and manufacturing should forecast the capacity required for non-stock items. The forecasts should be statistically generated based on actual sales, and modified by the Marketing Department based on their knowledge of special orders, outside factors, etc. Most importantly, these forecasts would become the basis for setting target inventory levels on each item - not for the actual production of rivets. Finished goods inventories should be sized and positioned in the distribution system such that product can be shipped within the market required lead times 95% of the time.

MATERIAL REPLENISHMENT: A simple, manual system should be implemented which would enable RivetCo to replenish the inventory buffers by producing to actual sales - not to the forecast. Each selling unit must provide the manufacturers with timely notification of actual sales, and prompt shipment from each manufacturer will be required. Rivets should then be assembled based on actual shipments from the manufacturers' finished goods.

The manufacturing cycle for each rivet should be stabilized in order to ensure a predictable replenishment lead time. CAPACITY-BASED LOT SIZING was applied to calculate, for each assembly machine, the length of time over which some quantity of each rivet could be produced, given the forecasted sales volumes and available machine and labor setup capacity. The resulting cycle was one week; that is, assembly could produce some of everything every week, obviating the need to maintain high backlogs to gain "efficiency". **REVISED SYSTEM THROUGHPUT TIMES** illustrates the revised system throughput times which would result.

CYCLE	DAYS	CUM DAYS
PRODUCTION BACKLOG	10	29
PRODUCTION WORK IN PROCESS	10	19
PRODUCTION ORDER PROCESSING	2	9
TRANSPORTATION	5	7
AFFILIATES ORDER PROCESSING	2	2

REVISED SYSTEM THROUGHPUT TIMES

PERFORMANCE MEASUREMENT: In addition to the above, a system should be implemented which enables each unit to monitor supply and distribution performance. Constraints to the flow of information and materials should be identified and addressed, and adjustments in inventory locations and levels made accordingly. Areas to be measured should include on-time delivery performance, delivery lead times, inventory turnover, and inventory replenishment and transportation lead times. Timely feedback and corrective action should be taken whenever actual performance deviates from plan.

PILOT PROGRAM

The first step in implementing the above recommendations was to select a "test group" of rivets around which a system could be developed. After input and concurrence from all units, the 5-size open-end, aluminum rivet product line was selected. This group was chosen because its mix of sales dollars and piece-part volume is representative of total rivet mix, and because the manufacturing resources involved are essentially dedicated to the test group.

Key constraints were then identified in both the supply and marketing of rivets. On the demand side were historical and forecasted sales volume and mix, and the delivery lead times and customer service levels required for market competitiveness. On the supply side were actual lead times and customer service levels, transportation and order processing lead times, and manufacturing lot-sizing policies, inventory levels, and lead times.

STOCKING LOCATION	SERVICE CATEGORY
ENGLAND PRODUCTION	NONE
ENGLAND FINISHED GOODS	1 & 2
GERMANY PRODUCTION	NONE
GERMANY FINISHED GOODS	1 & 2
DENMARK FINISHED GOODS	1
FRANCE FINISHED GOODS	1
SWEDEN FINISHED GOODS	1
FINLAND FINISHED GOODS	1

INVENTORY LOCATIONS BY CATEGORY

Then, a plan was devised to position finished goods inventories to provide 95% customer service at the market required lead times. The stocking location of each item was based on the market delivery lead time required as compared with the actual lead times which would be experienced in the supply and distribution system after implementation (see **INVENTORY LOCATIONS BY CATEGORY**). For example, if the market required lead time for an item is three days after receipt of order, and the transportation and order processing lead time from manufacturer to the distributor is nine days, the part is stocked at the distributor, with a backup inventory at the manufacturer (designated as Service Category 1). On the other hand, if the market required lead time is sixty days, and the manufacturing, plus order processing, plus transportation lead time is twenty-nine days, the part is made to order (Service Category 3). Any items with a required delivery of between nine and twenty-nine days would be stocked at the manufacturer only (Service Category 2).

Finally, a supply and distribution system was designed and implemented to meet the above objectives. The system consists of three major subsystems, FORECASTING, INVENTORY REPLENISHMENT, and PERFORMANCE MEASUREMENT.

SUBSYSTEM	COMPONENT	FUNCTION
FORECASTING	FORECAST	BUFFER SIZING
		ASSEMBLY LOT SIZING AND REPLENISHMENT CYCLE
	ASSEMBLY CYCLES	PRODUCTION REPLENISHMENT FREQUENCY
INVENTORY REPLENISHMENT	WEEKLY ORDER REPORT	AFFILIATE DEMAND ON FACTORY
	ASSEMBLY SCHEDULE	TOTAL DEMAND ON PRODUCTION
	INVENTORY REALLOCATION REPORT	BALANCE INVENTORY FOR MAXIMUM SERVICE
PERFORMANCE MEASUREMENT	RECEIVING PERFORMANCE	ON-TIME DELIVERY TO AFFILIATES
		AFFILIATE STOCKOUTS
		TRANSPORTATION LEAD TIMES
	SHIPPING PERFORMANCE	ON-TIME DELIVERY TO CUSTOMERS
		LEAD TIMES TO CUSTOMERS
	INVENTORY TURNOVER	SYSTEM MATERIAL FLOW

PROPOSED SYSTEM COMPONENTS

FORECASTING SUBSYSTEM

The FORECAST program generates a statistical sales forecast for each item, using an exponential smoothing routine. Each unit's forecast is regenerated by its Marketing Department on a monthly basis, based on historical sales, and is reviewed and revised based on Marketing's knowledge of extrinsic factors. The FORECAST program is rerun quarterly to recalculate the target inventories. The quantity stocked of each item is based on historical and forecasted sales volumes, historical variability in market demand, and the replenishment lead time. Each unit carries sufficient inventory of stocked items to cover forecasted demand over the replenishment lead time, plus enough safety stock to provide a 95% service level over that lead time.

The ASSEMBLY CYCLE program is used by each manufacturer to establish the repetitive manufacturing cycle for each item. The cycles, which include stocked and non-stocked items, are recalculated quarterly for replenishment lead time input into the FORECAST programs. The assembly cycles approach will require that management abandon the policy of grouping orders for efficiency.

INVENTORY REPLENISHMENT SUBSYSTEM

A WEEKLY ORDER REPORT is generated weekly by each distributor, and lists the actual quantities of Service Category 1 items shipped the previous week, as well as future requirements of Service Category 2 and 3 items, with their required ship dates. The report is forwarded to the manufacturer, who enters the distributor's purchase order. The manufacturer then ships the Service Category 1 items from finished goods by the end of that week, the Service Category 2 items from finished goods on the required ship dates, and produces and ships the Service Category 3 items on the required ship dates.

An ASSEMBLY SCHEDULE is generated weekly for each rivet assembly machine. It lists, for the items produced on that machine, the quantities of Service Category 1 and 2 items which were shipped from the manufacturer's finished goods during the previous cycle, and any Service Category 3 items required for future delivery. The Assembly Supervisor is responsible for ensuring that the Service Category 1 and 2 items are assembled each cycle, and that Service Category 3 components are finished and assembled to meet their required ship dates. Note that components are supplied to assembly for all product via a separate internal pull signal system.

An INVENTORY REALLOCATION REPORT is used by RivetCo management to identify and move inventory from one unit to another. These are items which are held in excess supply at one unit, and are in insufficient supply or sold in greater volume at another unit. The report is generated semi-annually, based on actual on-hand and target inventories at each unit.

PERFORMANCE MEASUREMENT SUBSYSTEM

A RECEIVING PERFORMANCE REPORT is generated by each unit for its receipts to finished goods inventory. The purpose of the report is to measure transportation lead times, stockouts, and minimum inventory levels for comparison with the statistically generated target levels. It tracks each receipt of each item into finished goods, including the date shipped from the manufacturer, the date received into finished goods, and the quantity on hand just prior to receipt.

SHIPPING PERFORMANCE REPORTS measure the percent of all orders at each unit which are shipped early, on-time, and late to the customer requested ship dates. In addition, by comparing order receipt dates with customer requested ship dates, the programs provide updates to the market required lead times in the FORECAST programs.

INVENTORY TURNOVER REPORTS compare actual on-hand inventories with the target inventories as calculated by the FORECAST programs. They reflect days' supply on hand for each item in support of the INVENTORY REALLOCATION REPORTS, as well as total days' supply for measuring performance of each unit in total.

Each of the three performance measurement reports, RECEIVING, SHIPPING, and INVENTORY TURNOVER, are generated by each unit on a monthly basis. Adjustments in stocking locations and quantities are made when actual conditions differ from those on which the system is based.

If, for example, actual transportation lead times are other than seven days, the Service Categories and stocking locations of the affected items should be changed to reflect the actual lead times. If the minimum inventory of any item drops to zero more or less than 5% of the time, the target inventory level of that item should also be adjusted. If on-time delivery is less than 95%, or if actual on-hand quantities deviate from targets, they should be researched for cause and corrective action.

CONCLUSION

In addition to providing a 95% customer service level at the market required lead times, the Rivet Supply and Distribution System supports the reduction of inventories and system throughput times. Although the system is based on assumptions about required delivery performance, market lead times, and supply lead times, it provides the information necessary to verify those assumptions. As improved information becomes available, the system should be adjusted accordingly.

More importantly, this information should be used to focus improvements in the system constraints. Cycle times should be reduced, transportation and order processing should be streamlined, and demand data should be refined into shorter intervals. In this way, inventories and delivery lead times can and will be reduced, while maintaining the maximum flexibility and customer service.