

Quick Response Inventory Replenishment for a Photographic Material Supplier

by

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B.S. Mechanical and Aerospace Engineering
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Submitted to the Sloan School of Management and the Department of Mechanical Engineering in Partial Fulfillment of the Requirements for the Degrees of

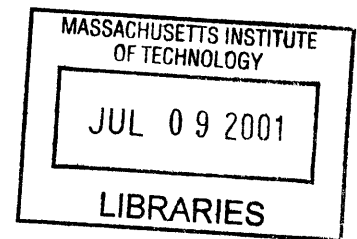
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BARKER



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ABSTRACT

This LFM thesis describes the implementation of a Quick Response/Automatic Inventory Replenishment methodology at Eastman Kodak Company (Kodak). The drive for this project came from the heightened pressure for Kodak to increase customer satisfaction and improve the effectiveness of the supply chain in the United States. From a business unit perspective, there are two key areas of focus in response to this pressure: Improve customer satisfaction in the order-to-cash transaction process, and making it easier to do business with Kodak. From a manufacturing perspective, significant demand variability has caused Kodak to hold large finished goods inventories to buffer against this demand uncertainty. The goal of this thesis is to explore the benefits associated with the implementation of a quick response inventory model based on the actual results obtained at several of Kodak's key customers, and document how this model addresses the concerns of both the Business Unit and the Manufacturing organization at Kodak.

This research work was conducted during a six and a half-month internship at Kodak Park in Rochester, New York, as well as brief on-site visits to participating customers. The internship was affiliated with the Massachusetts Institute of Technology's Leaders for Manufacturing Program.

This thesis describes the quick response methodology, the implementation details of a pilot program at Kodak and one of its customers, the results of this implementation, and estimated benefits and hurdles in a larger scale implementation of the methodology. In the interest of protecting company confidentiality, some numbers presented in this analysis have been disguised. The justifications for pursuing this particular strategy within Kodak as well as generic guidelines for when these strategies may be applicable are discussed in the context of this thesis.

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Chapter 1: Introduction and Overview

1.1 Project Description

Eastman Kodak Company has been facing significant pressure to increase customer satisfaction and improve the effectiveness of its supply chain in the United States. While the supply chain for any company includes the entire chain of raw materials supply, manufacture, assembly and distribution to end customers, decisions made by these customers ultimately determine success or failure for a business. Customers place orders that trigger a chain reaction, and the supply chain must be able to coordinate the requirements of the customers with the flow of material from suppliers through manufacturing and distribution so as to achieve a balance between the often conflicting goals of high customer service, low inventory investment and low unit cost. Depending on the structure of the supply chain for a particular business, the demand signal that begins with an order may be distorted along the way as it passes through layers of intermediaries. This distortion most often comes in the form of amplification, thus making it more difficult to optimize the service, inventory, and cost trade-offs. While it may seem to many that the purchase of goods by the end customer might be the end of the supply chain from a manufacturer's perspective, it is not. Customers' actual usage rate of product might be substantially different from their buying rate as they attempt to optimize along the same levels as the manufacturer – service, inventory, and cost. When a number of customers optimize independently, the randomness adds together, thus creating a great deal of demand variability on the manufacturer which increases its need for inventory in order to satisfy its customer service goals.

1.2 Approach and Methodology

Quick Response is a methodology that is designed to help combat a virtually unpredictable demand stream by taking advantage of recent technological advances and cooperation throughout the supply chain. Through quick response, manufacturers receive visibility of their customers' actual usage of product, as opposed to simply visibility of the customers' orders. With this information, the manufacturer replenishes a customer's usage of product automatically – without the customer ever placing an order. The customer then reduces the transaction costs associated with monitoring usage and placing an order, while the manufacturer sees a smoother signal of demand. Further, inventory can be reduced on both sides since the customer would receive much more frequent replenishment of product and would not need to keep as much product in stock to survive between replenishments, while the manufacturer needs less finished goods safety stock due to a smoother demand stream. The hope is then to lower costs through

reduced inventory requirements while increasing customer satisfaction by streamlining the process of doing business with the manufacturer.

1.3 Project Goals

The goal of this project is to explore the benefits of the quick response methodology by means of an implementation between the Eastman Kodak Company and one of its key customers. Given that quick response had never been attempted at Kodak, nor could we find any data to help us understand the costs, benefits, or even the feasibility of implementing the program in Kodak's business environment, we needed to formulate the components of a business case for implementation of quick response. While the motivation for this program comes from Kodak, a successful implementation requires active participation from the customer as well. Through this project, we needed to keep in mind that without the participation of the customer it would not be possible to assess the benefits and feasibility of a quick response program. Ideally, this research would include enough actual data that would provide hard answers to all of the questions that may arise should a large scale implementation of quick response at Kodak be proposed. Furthermore, because the program had never been attempted at Kodak, there was a chance that it would not be successful. With the possibility of this outcome, we could not risk the costs associated with testing the methodology at a large number of customers. These costs would include not only that of implementing the methodology, but also of lost business should the program fail. With this in mind, this thesis will serve as a case study of an implementation of the quick response methodology at a single Kodak customer, and an estimation of the benefits that Kodak and participating customers might hope to achieve in further implementation of the methodology.

Chapter 2: Project Setting and Background

Because of the necessity to have a tight interaction between Kodak as a supplier and the customers involved in the quick response program, a key ingredient to creating a successful implementation was getting equal involvement from a specific Business Unit within Kodak¹ as well as from the manufacturing units responsible for providing the products to the end customers. The Kodak Professional Business Unit was chosen as the best fit for the pilot program given their blend of different customers, the sales volume of these customers, the observed historical ordering patterns, and the competitive pressures that were being applied by competitors in this business segment. This chapter will discuss the issues that each distinct party of the quick response program had in mind, and also the issues or areas of concern that the participating entities wanted to test.

2.1 Kodak Business Unit Perspective

The Kodak Professional business unit had identified two critical success factors associated with achieving their goal of improving the effectiveness of the supply chain in the United States²:

1. Improve customer satisfaction in the order to cash transaction process, and
2. Make it easier to do business with Kodak

The customers of this business unit could be broken down into two broad categories: Customers that deal directly with Kodak, and customers that deal with Kodak product resellers. The results of recent customer satisfaction surveys showed that the customers in the first category (dealing directly with Kodak) were significantly less satisfied than those who were buffered by a layer of reseller. Many of these Kodak-direct customers included laboratories who processed large jobs in-house, and whose volume was large enough that they are able to deal with Kodak directly. On the other end of the spectrum were customers such as individual photographers (wedding photographers, school photographers, etc.) that used professional quality products, but purchased their smaller volume of product through wholesale outlets. The survey results indicated that these customers were quite satisfied in “doing business with Kodak”, so it became less of a concern to address better service at this level.

¹ At the time of the research, Kodak was made up of several different organizational structures. Because of the broad range of products offered by the company, they separated the sales and marketing responsibilities for the different product families into different Business Units (i.e. Consumer Products, Professional Products, Health Imaging, Dental, Digital and Applied Imaging, Ariel Products, etc.). Additionally, there were separate structures in place for the different manufacturing families which could span across the business units (i.e. Color Film Manufacturing, Photochemical Manufacturing, Paper Production, etc.)

So, in this Kodak Professional business unit, there existed an opportunity to potentially have access to two unique types of customers through which to test the quick response program. I will categorize these two customers based on the way they use Kodak products. The first, photographic lab customers, can be considered point-of-use customers. These customers will typically buy products from Kodak and others, then store these products as inventory in a stockroom until they are needed to complete one of their own jobs. At this point, the product is removed from the stockroom and brought immediately to the production floor. The other customers that buy product from Kodak, and then resell to the smaller end-users will be referred to as point-of-sale customers. The main difference is that while these customers also hold product in stock and remove it when needed, they are actually reselling the product and normally will register the sale at a cash register, or some equivalent sales tracking unit. The equivalent type of customer in the Consumer Products business unit would be retail stores such as Wal-Mart, K-Mart, drug stores, grocery stores, etc. where a sale to the end-user gets registered by a scanner at the check-out counter.

In either case, Kodak's professional photographic customers receive orders from their own customers that must be satisfied through a combination of on-hand inventory, and on-demand order placement to Kodak. Required turnaround time for the point-of-use customers, in particular, has continued to shrink and therefore customer service becomes closely tied to the manufacturer's ability to quickly satisfy demand.

The typical point-of-use customer of the Kodak Professional business unit generally operates as follows:

1. Lab worker goes to stockroom, and removes product (Product A) necessary for a job
2. That evening, during a manual inventory screening, the stockroom manager notices that the current stock of Product A fell below their re-order point
3. Stockroom manager begins compiling an order for Kodak
4. He orders enough of Product A to fill the shelf space for Product A to capacity
5. He decides whether another product should be ordered (Product B)
6. He orders enough of Product B to fill the shelf, and continues with more products until he feels the order is complete

From here, the customer waits for the shipment, including invoice, to arrive from Kodak and restocks the stockroom upon receipt of product. Figure 2.1.1 shows the process at a high level.

² Goulet, Raymond. *iTrax: A Breakthrough in Supply Chain Excellence*, Focusing on Quality – A Celebration of Success. September 2000.

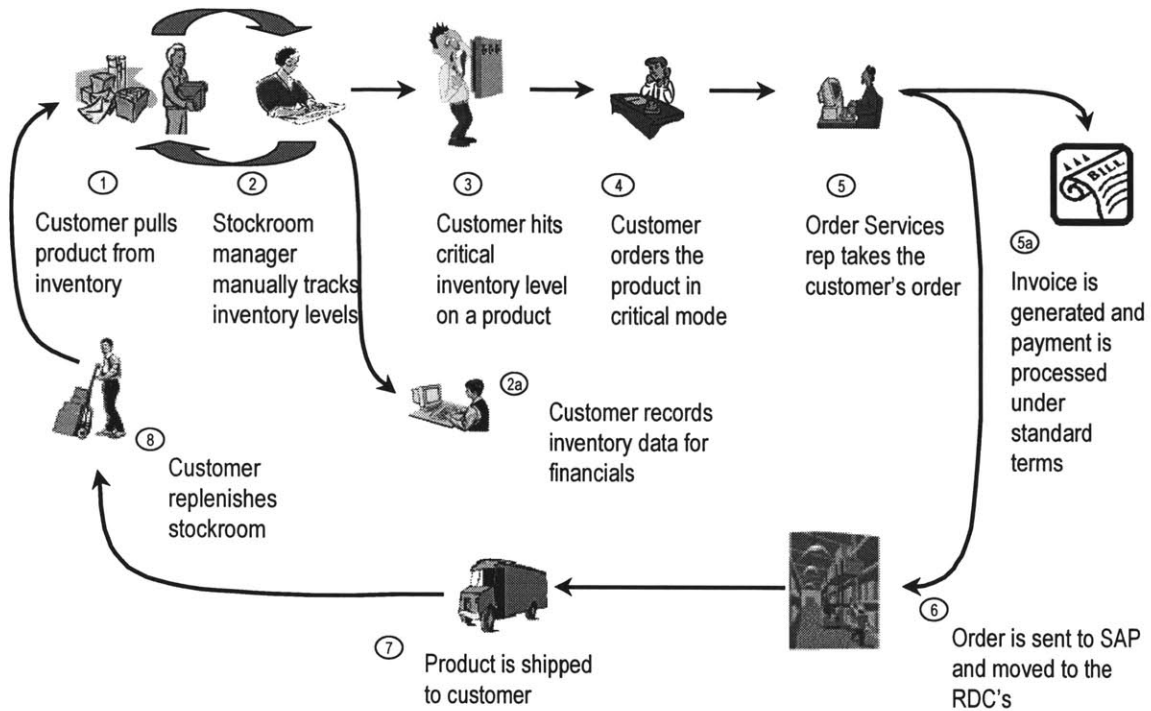


Figure 2.1.1: Traditional process flow from a Kodak customer to Kodak, and back to the customer

2.2 Kodak Manufacturing Perspective

Kodak offers a huge variety of products to their customers. Between film, paper, and photochemicals, the Kodak Professional business unit offers several thousand distinct products. Complicating this diverse product offering is the promise to the customer to have a great majority of the products as in-stock items that can be delivered within a designated shipping lead time. Because of the lengthy times required to produce photographic products, Kodak is forced to hold large work-in-process and finished goods inventory to meet customer demands.

Demand variability on manufacturing

For a number of reasons, customer orders to Kodak are highly erratic and unpredictable. Figure 2.2.1 below gives an example of what this actually means to the Kodak warehouse system with a sample of daily ordering volume for a typical product in the Kodak Professional business unit.

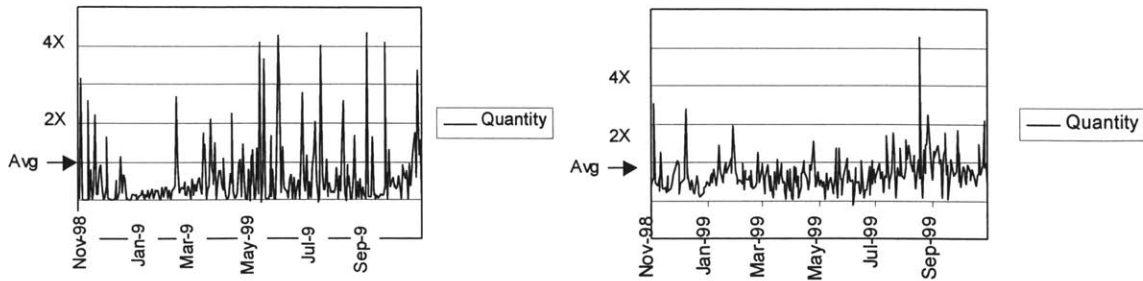


Figure 2.2.1: One year demand on Kodak Professional for two products

It is difficult to understand exactly why the demand is so variable, but there are several factors that are likely to be key contributors. First of all, the demand for professional photographic products is not seasonal. Laboratories and professional photographers process work throughout the year, and their production is dependent upon the fluctuating demand of their own customers. This demand is often very time sensitive, and jobs are often won or lost based on the laboratory that can deliver the job most quickly. To accommodate these requests, the laboratories must carry sufficient product in inventory so that they can compete on the dimension of time, and therefore they order relatively large quantities of product from Kodak. Secondly, there are some incentives for Kodak’s customers to order in quantities larger than what they may otherwise have. Promotional activity, although very small in the professional business, contributes to peaks in demand on occasion. Transportation costs also factor into customers’ ordering decisions, and will often cause large order quantities. Added together across the entire base of Kodak Professional customers, demand is highly variable and unpredictable.

In order to satisfy such lumpy demand requirements from its customers, Kodak has two options: Either maintain production capacity capability adequate to handle the peak periods of demand, or carry inventory at some stage of the pipeline that allows demand to be met. Given the non-seasonal, extremely unpredictable nature of the demand spikes, it is not feasible for Kodak to manufacture a great majority of its products during the lead time promised to customers. The multiple month chemical process times required for components of photography products such as film emulsions are significantly longer than those required for the latter stages of the manufacturing processes such as cutting and packing, and therefore impose inventory requirements at some point in the flow anyway. In this context, production must begin well in advance of a customer placing an order in order for the product to be delivered within a 1-4 day window depending on delivery options (air, UPS, truckload, etc.).

What does this variability in customer demand mean to Kodak from an inventory perspective? Kodak has been recently transitioning from a “Push” Manufacturing environment to a “Pull” Manufacturing environment. In this new pull environment, actual sales is a direct signal that “pulls” production from the factory, and hence production is based on actual sales, not on a production plan. This is a bit misleading, however since Kodak is operating in a dual echelon system in which manufacturing supplies a Central Distribution Center (CDC), which in turn supplies a network of 5 Regional Distribution Centers (RDC’s), who then supply the end customers with Kodak products. So, when it is stated that in this pull manufacturing environment actual sales triggers production of product, it is really the release of product from the CDC to RDC that initiates the order to manufacturing. Hence, because of this dual echelon system, there is inventory stored in each layer, not to mention the inventory stored by the end customers, which therefore adds a third layer of inventory in the overall supply chain.

Looking specifically at the inventory from Kodak’s perspective, a reorder point methodology is used to trigger orders between the different layers of the organization. Very simply, a reorder point is calculated as the sum of (Average demand over the lead time) + (Safety stock). The reorder point calculation is as follows:

$$ROP = \mu_D T + Z_\alpha \sigma_D \sqrt{T} = (\text{Average lead time demand}) + (\text{SS})$$

Where, μ_D = Average Demand per day

T = Lead Time (days), or the time from when an order triggers until inventory replenishment

Z_α = Z-value at specified service level³

σ_D = Standard deviation of demand

SS = Safety Stock

Analysis of demand patterns show that daily standard deviations of demand on specific products are, on average, double the average daily demand. To fill in the remainder of the variables in the reorder point formula, I will assume a leadtime of 11 days. In doing so, I am estimating the times required for Planning (system processing time), Manufacturing (in reality, WIP Finishing), and Logistics (pick, pack, and transport). Finally, I will assume a desired service level of 98%, which is typical of many manufacturers. Although these assumptions may differ slightly for some products, they can be incorporated to

³ Z_α is a safety stock factor. Because leadtime usage is highly variable, the differences in variation tend to be approximately normally distributed, even though the actual demand may not be. So, by assuming normality in the differences, Z values can be determined in conjunction with a specified service level, or probability of not running out of product during leadtime.

demonstrate some of the potential inventory savings given different reductions in demand variability, σ_D . Specifically, this affects the amount of safety stock that Kodak is required to hold.

$$SS = Z_\alpha \sigma_D \sqrt{T}$$

where :

$$\sigma_D = 2\mu_D$$

$$Z_\alpha = 2.05$$

$$T = 11 \text{ days}$$

$$SS = (2.05)\sigma_D \sqrt{11}$$

$$SS = 6.8\sigma_D$$

Now, let us assume that we can implement a program that would reduce the standard deviation of demand by 10%. This decreases the required reorder point by affecting the right hand side of the equation (safety stock). In other words, total demand does not decrease, but becomes less variable, and less safety stock is required to satisfy desired service levels. This 10% decrease in standard deviation would lead to a 10% reduction in safety stock requirements.

$$SS_{new} = (2.05)(0.9\sigma_D)\sqrt{11}$$

$$SS_{new} = 6.1\sigma_D$$

$$(6.8 - 6.1)\sigma_D / 6.8\sigma_D = 10\%$$

As stated before, although great simplifications were made in this example, it becomes clear that reduction in demand variability can have a significant impact on the end inventory requirements in the RDC network. From a manufacturing perspective, this desire to focus on demand variability reductions was the impetus for the research underlying this thesis, and for the implementation of Quick Response in general.

2.3 Kodak Supply Chain Perspective

Given the conflicting constraints imposed on one end from the customer requiring ever decreasing lead times for their orders to be filled (a couple of days or less), and on the other end from the manufacturing of photographic products that require lengthy lead times (a couple of months or more for the entire

process), something has to give. This task falls into the general category of the Supply Chain group. In implementing a program such as QR, many areas of the supply chain will be affected, and the concerns of those areas must be addressed.

Order processing

Order processing at Kodak, prior to quick response, was extremely manual. Customers could place orders through a variety of mechanisms including phone orders, and electronic orders. In all cases, a representative from Kodak (Customer Order Services) would receive the order and process it manually:

- Type the catalog numbers and order quantities of the products into an ordering system
- Check inventory levels to see whether an order quantity could be filled, and which RDC it could be filled from
- Assign some or all of the available inventory to the order where possible
- Assign shipping options to the order, or the different components of the order

Once the order was entered by a Customer Order Services representative, it then was sent automatically to the appropriate distribution center(s) for the order to be picked, packed, and shipped.

Distribution and transportation

Once the order had been received by a given distribution center (RDC), the RDC filled it and sent it on to the customer. From a processing and distribution perspective, it is much easier to prepare an order that contains less variety and more volume; the distribution centers find it much easier to pick product in pallet quantities and fill a truck than they do to pick multiple product boxes and ship them in small quantities. Because the quick response program was recommending automatic replenishment of any product usage at a participating customer site, flags quickly were raised by distribution personnel since this new methodology would likely lead to orders containing a greater variety of products in much smaller quantities than had typically been ordered in the past.

Financial transactions

The Professional business unit had an extremely long order-to-cash cycle. This is of great concern to management because of the opportunity cost associated with not receiving payment from customers more quickly. Besides the lengthy delay, much can happen to a customer's financial position during the course

of a couple of months, and often bad debt will arise as a result. Reducing this time window for payments was one key area identified in the initial evaluations of the quick response program.

In the past, an invoice for the customer was created at the point the Customer Order Services⁴ representative reserves the available inventory and sends the order to the distribution centers. Simultaneously, an email or fax would be sent to the customer summarizing the items ordered and promised for delivery, and also the customer's costs. Problems with this process occur, however, when an order must be filled through multiple distribution centers, and the customer receives multiple shipments that must then be reconciled against the original invoice that was emailed or faxed to them upon order placement. The quick response program would help to solve this problem since the customer would not actually be ordering anything themselves (their stock would be automatically replenished), and the first time they would see an "order" was when product was actually shipped. Additionally, Kodak saw this as an opportunity to introduce electronic funds transfer (EFT) into the customer payment process in order to help reduce the days-of-sales-outstanding, and bring cash to Kodak more quickly. In so doing, Kodak hoped to reach an agreement with the customers that would give Kodak access to the customer's bank account and allow Kodak to withdraw the funds necessary to pay for the order at the time that it was created. Clearly, with the exception of eliminating the paper invoice and manual handling/check writing, this is not a valuable proposition to the customer since they would be giving up a significant amount of time that they historically have used to collect payments from their customers, and collect interest. In order to convince them to participate in such an arrangement, some incentive was necessary. The proposal to the customer was to give a discount to anyone paying through this EFT method. A discounted price to the customer, and quicker and more reliable payments to Kodak – the gains would be shared with all of the partners involved.

2.4 Customer Perspective

To implement a program such as quick response, a key ingredient to success is to have the customer be an active and enthusiastic participant at the same level as the manufacturer. Even more important, there must be significant potential gains for the customer in order to make their switching of business processes worthwhile.

Ordering

Kodak's customers did a majority of their ordering via the phone (through a customer services representative) or through EDI, on a service called Biznet. The latter option was merely an online site

that allowed the customer to place orders for items in the Kodak catalog. The service did not have real-time inventory look-up and lead time estimators, but was simply a mechanism for placing orders. When there were backorders, or an abnormally long lead-time, the customer would receive notification at a later point. A customer order services representative was still necessary on Kodak's end to manually process these Biznet orders even though it may have seemed that it was a fully electronic transaction to those initiating the order.

Time requirements

Timeliness is an ever increasing component of customer satisfaction with Kodak's customers in today's business environment. Orders will come to them with requirements for quick turnaround. Often, the job will go to the laboratory offering the shortest lead time instead of the laboratory offering the lowest cost, or highest quality as the industry once tended towards. Many times the job requests are not standard and require product that may not be carried in inventory on a regular basis. When this happens, laboratories call multiple suppliers, and subsequently, this is where the lead time differentiation between manufacturers comes into play.

Potential Inventory savings

Aside from the relatively intangible goal of improved satisfaction, the most significant benefit to the customer in the implementation of a quick response program is the potential reduction in inventory levels. Traditionally, the Kodak customers would order a certain amount of product, store it as inventory, and use it over a period of time until a reorder point or critical level was reached, then order more. A simplified chart of this ordering pattern is shown in Figure 2.4.1, with the average inventory level residing somewhere about halfway between the peak levels.

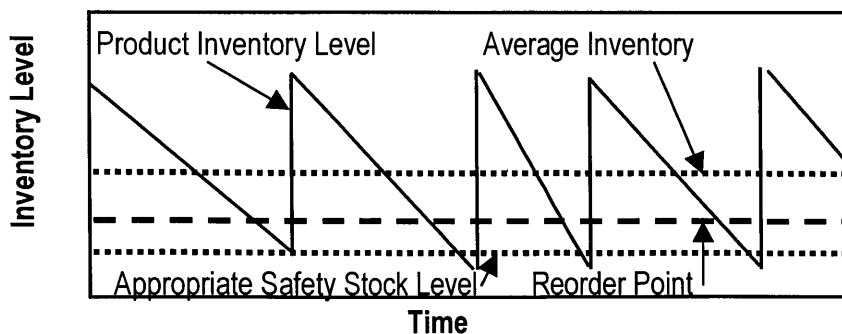


Figure 2.4.1: Typical inventory level for a product with consistent usage over time

⁴ Customer Order Services is the department at Kodak that is responsible for taking customer orders and processing them for transfer to the distribution system.

With quick response, the goal is to send more frequent product replenishments, so that the average level of inventory can drop to much lower levels. If product is replenished as it is used, the inventory should never fall to levels that would be historically considered safety stock. With no adjustments to base stock, inventory levels would be considerably higher than they were in the traditional environment. The customer would need to “bleed” off some inventory, probably in stages as confidence is gained in the QR program. The depletion of inventory must continue until the appropriate safety stock level is reached, as is depicted in Figure 2.4.2, below.

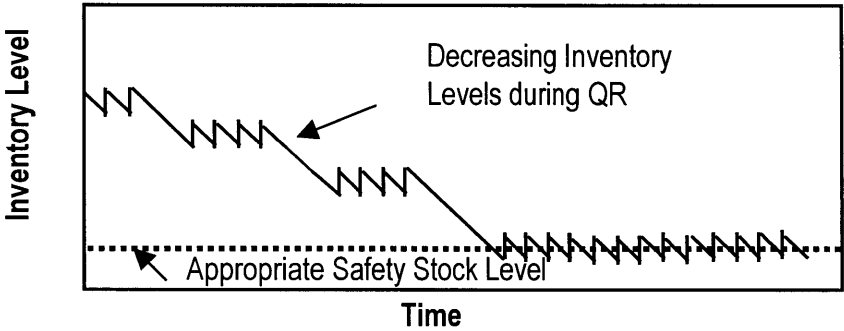


Figure 2.4.2: Product inventory level decreasing over time with frequent replenishment

Chapter 3: The Quick Response model

Today's competitive business environment is forcing organizations to adopt new strategies to respond rapidly to customer demand and rapidly changing business conditions. Greater market share and customer loyalty can be gained by quick and reliable response to customers' changing needs. Delivering goods and services faster than the competition in a marketplace where product quality is less of a differentiating factor than ever before has emerged as a key element in gaining new customers, retaining existing customers, and maintaining a position as an industry leader. For many companies this is true, but it is particularly so for Kodak, as competitors such as Fuji and Ilford have emerged with high quality, low cost products in a market that has traditionally been dominated by Kodak. While Kodak quality in the past has been the overriding factor that has positioned them at the top of the photographic market, the industry is quickly turning into one of time-based competition that is demanding management to shift focus from quality (which is a given) to time.

The quick response methodology gained its roots in the US textile and clothing industry in the mid-1980's when that industry faced pressures to improve its long-term competitiveness⁵. The major impetus for this methodology was excessive pipeline inventory throughout the textile industry. With the four major components to the textile industry – Fiber Manufacturing, Textile Manufacturing, Apparel Manufacturing, and Retail – there existed approximately 66 weeks of inventory (11 weeks of that inventory could be attributed to WIP, 40 weeks in warehouses or transit, and 15 weeks in stores), while an individual fiber spent only about 20 minutes actually being processed during this entire period. Obviously, there was significant duplication of inventory between suppliers, customers, and retailers and likely a significant lack of communication between all of the major players involved. Not only was this long supply chain expensive to finance, but it also resulted in major losses as either too much of a certain product was produced and couldn't sell through, or not enough was made, and lost sales were the result. The quick response methodology is the result of the textile industry's reaction to these inefficiencies, and while the basic premises behind the methodology are common throughout, it has since taken various forms in additional industries over the years.

⁵ Lawson, B., King, R., Hunter, A. *Quick Response – Managing the Supply Chain to Meet Consumer Demand*. John Wiley & Sons, 1999.

3.1 The Quick Response Approach

Definitions

To begin, I want to offer several definitions of quick response as given by a varied range of academicians.

“A state of responsiveness and flexibility in which an organization seeks to provide a highly diverse range of products and services to a customer/consumer in the exact quantity, variety and quality, and at the right time, place and price as dictated by real-time customer/consumer demand. QR provides the ability to make demand information driven decisions at the last possible moment in time ensuring that diversity of offering is maximized and lead-times, expenditure, cost and inventory minimized. QR places an emphasis upon flexibility and product velocity in order to meet the changing requirements of a highly competitive, volatile and dynamic marketplace. QR encompasses a strategy, structure, culture and set of operational procedures aimed at integrating enterprises in a mutual network through rapid information transfer and profitable exchange of activity.”⁶

“A mode of operation in which a manufacturing or service industry strives to provide products and services to its customers in the precise quantities, varieties and within the time-frames that those customers require.”⁷

“A strategy that uses Universal-Product-Codes (UPC) for inventory control and electronic information sharing... and a business philosophy that incorporates a just-in-time approach to manufacturing.”⁸

“A new business strategy to optimize the flow of information and merchandise between channel members to maximize consumer satisfaction.”⁹

Clearly, the definitions listed above carry common themes: customer satisfaction, information sharing, demand-driven decisions, just-in-time. While each implementation of the model probably varies significantly, the overriding concepts are the same, and certainly were in our minds as we began thinking about an implementation at Kodak.

Elements of the model

A review of the quick response literature indicates that most people recognize there to be 4 levels of quick response implementation, with each level representing increased levels of complexity and partnership

⁶ Lowson, B., King, R., Hunter, A. *Quick Response – Managing the Supply Chain to Meet Consumer Demand*. John Wiley & Sons, 1999.

⁷ Gunston, R., Harding, P. *QR: US and UK Experiences*, Textile Outlook Int., Vol 10, 1987.

⁸ Sullivan, PC. *A study of the adoption of Quick Response in the United States apparel manufacturing industry*, Unpublished doctoral dissertation, New York University, NY. 1992.

⁹ Ko, E. *A study of relationships between organizational characteristics and QR adoption*, Masters Abstracts Int. Vol 31, 1993.

between all parties involved. I will describe the general characteristics of each level, and summarize each in a table at the end of the section.

Typically, the first stage of quick response involves establishing the technical infrastructure for many of the processes required at higher levels of implementation. Much of this infrastructure is already in place at Kodak, many of their customers, and in many business entities today including automated point-of-sale (POS) or point-of-use tracking, standard product numbering schemes/Universal Product Codes (UPC's), bar coding, online catalogs and price lookups and electronic data interchange (EDI) for order entry and inventory management.

The second stage involves the automatic replenishment of inventory as it is used or sold through to another customer. Perhaps too, this stage includes electronic invoicing and payments through electronic-funds transfer (EFT). Here, with automatic inventory replenishment, orders are automatically generated based on actual product usage and forwarded to suppliers. On-hand inventory stocks must be pre-established and be maintained in quantities sufficient to cover supplier lead-times, and the inherent demand variability that the selling entity is subject to. Additionally, and although not an enabling factor to this second stage, electronic invoicing and EFT can increase efficiency and reduce transaction costs in some cases by allowing the supplier to withdraw funds from the buyer's bank account for payment of the replenished goods upon shipment.

The third stage takes advantage of the processes and infrastructure that have already been established to allow the customers and suppliers to form a closer alliance and make use of shared information to realize mutual gains. One of the areas of greatest potential impact when information sharing takes place is joint forecasting using the same sets of data. Whereas traditionally, forecasting has been performed by each entity separately using different models and different order requirements, it can now be combined to encompass the true end-customer demand and work to eliminate duplication in inventories necessary to overcome uncertainties.

Finally, in the fourth stage, suppliers can take over the inventory management functions that the customer traditionally has focused on. Otherwise known as Vendor Managed Inventory (VMI), the supplier manages an allocated amount of shelf space, is responsible for keeping the shelves stocked with the right products, runs promotions, and can be measured against pre-arranged criteria and agreements.

A summary of the four quick response stages are included in Table 3.1.1:

Table 3.1.1: Components of a Quick Response implementation

QR Stage	Components
1	Automated point-of-sale, or point-of-use applications supported with bar coding and universal product code labeling
	Automatic item and price look-up for customers
2	Automatic inventory replenishment triggered by usage or sale of product
	Electronic processing of orders and payments, electronic order status and advance shipping notices
3	Collaborative sales and inventory forecasting
4	Suppliers take over inventory management, accepting responsibility for yield and space management (VMI)

3.2 Information Technology

One of the underlying premises of the quick response methodology is the realization amongst all participating entities that there must be a move from the traditional adversarial relationships to those of partnership in order to realize the largest mutual gains. One of the key components in doing so is the linking of and expansion of information technology systems to act as enablers to this information sharing and building of partnerships. Information technology is not just an enabler for a successful quick response program, but a necessary component that must be embraced by all participants in order for the program to work. A functional quick response system cannot tolerate many of the data capture delays that are present in historical business environments, specifically in the areas of product usage and inventory accuracy. Whereas historically many businesses have employed manual inventory counts on a periodic basis in order to determine product stockage and usage, with quick response this information needs to be available at all times and updated as close to real time as possible. The increased accuracy that comes with real-time data capture and transmission allows the entire supply chain – manufacturers, suppliers, customers and distributors - to act with increased reliability and assurance. The focus of this research will be around bar coding as a means to record and transmit this data, although more sophisticated systems might make use of radio frequency transmissions. In either case, the key element is to eliminate as much as possible any manual steps required to track and distribute true demand information to all participating parties.

Barcodes, Universal Product Codes

Barcoding is a means by which product usage is tracked at the customer site, and registered electronically in order for product usage signals to be transferred back to the manufacturer. The existence of a unique item number for each different product is essential for an end customer-driven point-of-sale or quick response system to be established. Further, since the mapping of Universal Product Codes (UPC's) to actual products is not readily available across companies, it is important for all of the parties participating in a quick response implementation to identify all product/barcode combinations in a master list, and have the ability to easily update this list as new products are used by the customer involved. For instance, in the case of a quick response implementation by Kodak, should a customer want their usage of Fuji products to be visible (but still need to order from Fuji as they traditionally have), they must make sure that the Fuji barcodes get identified in a master list since Kodak likely does not have a mapping of Fuji products to their barcodes. Without an accurate mapping of all potential products involved, usage signals will be transferred as unidentified, leaving gaps in any reporting that might be done.

Point-of-sale/Point-of-use tracking

The most ideal scenario for an implementation of quick response is where the customer already employs a Point-of-Sale (POS) system to register all products as they are used (sold). POS systems gained significant popularity in supermarkets as scanning devices were used to read barcodes on packages as consumers brought items to the cash registers. Pilferaged losses aside, POS systems allow the distributor to electronically register all product outflow, and perhaps even feed inventory systems. It should be noted too that besides pilferage, POS systems are still subject to a slight degree of inaccuracy due to errors in barcode reading. Because of this, manual inventory counts are still necessary in all environments, even when a functional POS system is in place.

Some users of POS systems have configured accompanying software packages to determine optimal finished goods inventory, monitor reorder points, and create orders based on the information these programs gather and process¹⁰. Although similar in concept, these systems could be used in a quick response implementation to track usage, and transfer that usage information back to the manufacturer in order for the replenishment process to occur. Should this happen, Kodak would simply intercept a signal containing the customer's usage information of whichever product consumption the customer wants to

¹⁰ Lawson, B., King, R., Hunter, A. *Quick Response – Managing the Supply Chain to Meet Consumer Demand*. John Wiley & Sons, 1999.

share. The customer would still maintain responsibility for inventory management and setting appropriate safety stock levels.

Data exchange necessities

To this point, I have been discussing elements that must be in place for product usage to be collected at a customer site. Also needed is the ability to transfer this information back to the manufacturer. The most common, and perhaps the most desirable method of achieving this kind of data transfer is Electronic Data Interchange (EDI). EDI establishes a direct link between two companies and allows for the transfer of many types of information, most notably purchase orders, order confirmations, invoices, shipment notices, etc. There is, however, no true set of standards for EDI, and therefore there are many different methods and protocols that companies use to accomplish these data transfers. The beauty of EDI is, no matter what protocol one uses, once a connection is established there is no need for manual data entry into the company's internal system. This linking of systems across companies is a key requirement to a full-scale quick response system.

The automatic inventory replenishing component of the quick response program is enabled through this electronic exchanging of data. Product usage information can be captured at the time the product is used¹¹, and may be accomplished by scanning a barcode of the product with a scanning device as the product is removed from inventory, or through an existing POS system. The information should include some identification of the scanning device (serial number of the scanner, register ID, etc.), a time/date stamp, and the UPC for the product. Preferably all products used by a customer are scanned, even if the product is not manufactured by Kodak. The main reason for this is to maintain consistent business processes for the customer. If they are required to scan only certain products, there is a good chance that some items will be missed. By requiring everything to be scanned, there is no confusion, or need for additional business rules to be followed that may disrupt the normal flow of operations. In the situation where the customer is uncomfortable with all product usage (i.e. their usage of all competitors' products) being shared with the manufacturer involved in the quick response implementation, filters can be set up that prevent unwanted data from being transmitted. The first four digits in any barcode provide manufacturer identification, and allow for easy filtration of data.

Once the product usage information is collected, it can be transferred from the scanner or other device to the client device (most likely a PC, or web page that the customer has access to). For example, if a hand-

held scanner is used, the scanner can be placed into a cradle¹² attached to the client device. The client device should include a means for retrieving the information from the scanner, and may have an application installed on it for this purpose, or an applet or software application may be provided from the manufacturer's server for information retrieval. The application may be, for example, a Visual Basic application residing directly on the client device, or a Java applet provided over the computer network. The software application, whichever is deemed appropriate, preferably converts the retrieved information into the proper format for use with the database used on the server.

Depending on the particular implementation, or available resources, the steps necessary to actually transfer this data may vary. If the application for retrieving information from the scanner is provided from the server, a web browser would be opened from the client device at the customer location, and after logging into their secure, private website, go to a fixed URL which would provide the data retrieval application to the client device. The application could then read the information stored in the scanner and create the file with product usage information to feed the database on the manufacturer's server. If the application resides on the client device, a text file would likely be created prior to logging onto the website through a stand-alone application that reads the scanner, and then an upload step would be required to transfer the data to the server. With the exception of an established POS system, or the use of an expensive radio-frequency scanning device upload, customer intervention is required in order for the transfer of data to occur.

After the upload from the client device, the server can process the uploaded file by parsing the data collected from the scanning device into the format required for the database on the server. The most important part of this parsed data is the barcode information, which is associated with products in the master list of products (barcodes are translated to catalog numbers). This data can then be used for automatic reordering/replenishment of the products used, and also for reporting purposes to show which products have been consumed, and in which quantities. In the cases where the customer wants all product usage information to be visible so that they can utilize the reporting functionality of the system for all of their product usage, they may need to provide the manufacturer with a list of UPC codes and corresponding product descriptions so that these items can be easily identified in the customer's usage reports.

¹¹ Some customers have traditionally made use of a paper tagging system, where the user of a product would record his particular usage on a paper tag. At the end of a specified period of time, these tags would be accumulated manually and entered into the customer's appropriate inventory system.

¹² The term 'cradle' is used to represent the process of a customer attaching the scanning device to a PC and downloading the information on the scanner to the PC.

After the data is uploaded to the server, it may be used to calculate usage and order information. The database can keep track of usage since the last shipment to the customer, and create a proposed order based on actual usage. The customer would also have access to this usage information, and could potentially change the amount of product on the proposed order in the event that changes in base inventory levels are anticipated. The system would act in some senses like the Compact Disc clubs that many of us have been exposed to through companies such as Columbia House, or BMG. An order is generated for you every month (i.e. Selection of the month), and if you do nothing, the selection is sent to you. If you choose, you have the ability to have nothing sent, or change the “order” to better reflect your needs. In this quick response environment, a similar system would be in place with the key difference being that product usage must occur before an “order” is generated – i.e. product would not be sent to the customer if it did not use any product since the last shipment. Once usage is observed, and a shipment date is reached, the order will be created and product replenished automatically in the exact quantities as were used unless the customer intervenes and changes the proposed order on the website containing his product usage information before the next scheduled shipment date.

Chapter 4: Quick Response Pilot

After analyzing the potential benefits and current infrastructure, it was determined that a quick response implementation would be supported from both the color film manufacturing unit as well as the Kodak Professional Business unit. These were only two of many functional units at Kodak, and more importantly, only two of several functional units that would be affected by a large scale quick response implementation.

Figure 4.1 demonstrates the relevant pieces of the Kodak organization, and the level of involvement at this stage of the process. The business units are represented as vertical silos, while some of the functional groups span across each. I have highlighted each to indicate their current level of involvement, and to show which groups would eventually be necessary to have on board in order for the program to be successful, but were deemed to be too risky at the early stages given their likelihood to “kill” the project since a larger scale implementation would require significant resource commitment in order to proceed.

It is interesting to note that of all the different functional groups listed in the figure, Color Film Manufacturing was perhaps one of the least important groups to have on board in order to make the program work, and it was one of the two units to begin the work. The reason for this is that the manufacturing groups (particularly Color Film Manufacturing given their volume compared to the other manufacturing units) stood to gain considerably through demand variability reductions in the, only after a large scale implementation had occurred. The problem was that the other groups (Information Technology, Customer Order Services, and Distribution) did not have any sound benefits to gain from the project, but instead would have to change their processes considerably, or dedicate significant resources in order to make the program work. Given their lack of potential benefits, and the inevitable requirement to provide the necessary resources, it is easy for me to look back and see why the two divisions initiating the project were so insistent on keeping the project low key. It would have been way too easy for these other functional groups to blow holes through our proposition, and without any data to defend our stance, we could have been easily defeated. We needed to be prepared for the imminent struggle that lay ahead in convincing the rest of the organization to help scale-up the quick response program, and to do this, we needed data.

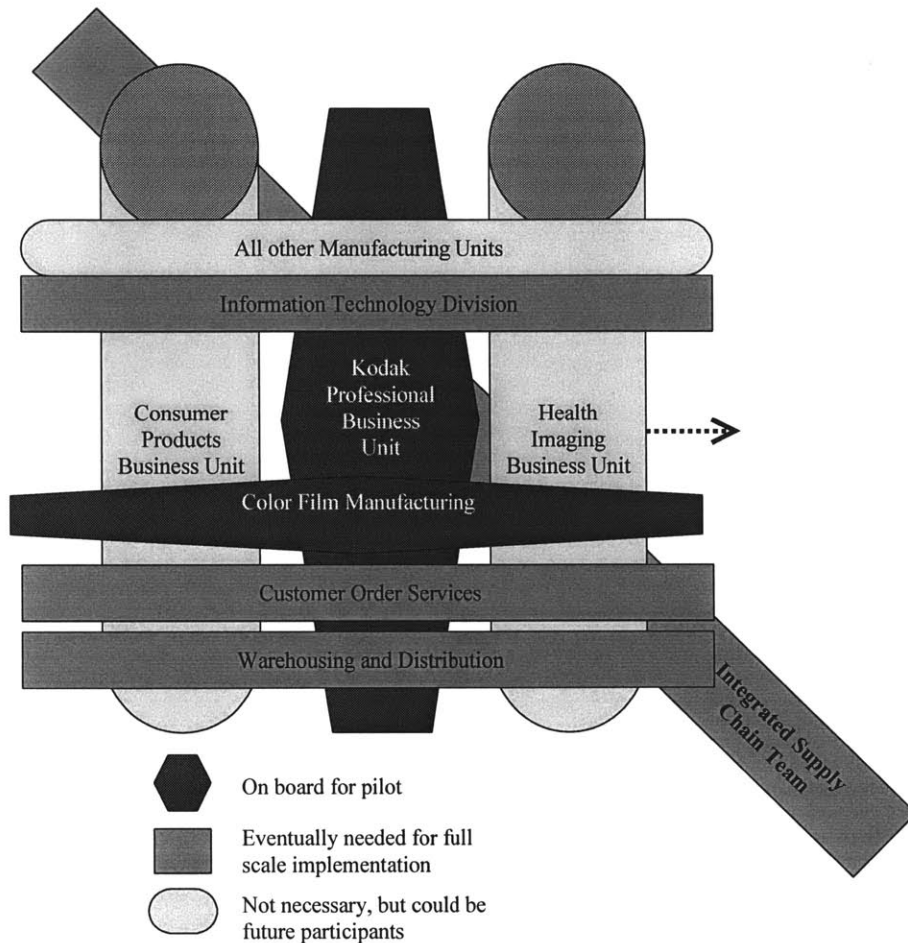


Figure 4.1: Functional overview of the Kodak organization with level of involvement in the quick response pilot during the early stages of development.

It was in this organizational context that the quick response pilot program began. We knew that we would need to eventually get the support of the Information Technology group in order to put any IT related program in the hands of customers, and also that Customer Order Services would need to be heavily involved in ensuring frequent entry of orders into SAP, and finally that Warehousing and Distribution would need to pick product in much smaller quantities than they ever had in the past (for the customers that we were looking at involving). But, we also knew that for those reasons they might show a great deal of resistance to the program, so we proceeded without them for the early stages of pilot development by developing a software package and searching for potential customers.

4.1 General considerations

The next step in the process was to actually design, develop, and implement a quick response pilot program. This section will discuss the different components of making this pilot functional, including choosing customers, developing the application, and starting up the program.

Customer selection

Choosing the customers to participate in the pilot program turned out to be one of the most important steps in beginning the process. First and foremost, we thought it necessary to work with “Kodak Friendly” customers at the beginning stages of the program. The business environment at the time of this project was one that had seen stalled growth in the traditional photographic industry as the use of digital technology was becoming more popular. It is clearly never good to lose the sales of a customer due to irritation with a new program, but at this time of market consolidation, it was particularly important.

Secondly, it was necessary to choose a customer whose annual sales volume was relatively large. We needed data which would demonstrate the proposed benefits to Kodak and the customers, and obviously the more the better. Economics also came into play. Traditionally, Kodak Professional customers received free shipping of their orders if they totaled \$1000 or more. Using this constraint as a guideline, we set a rough threshold for minimum annual sales volume such that average order size under the automatic replenishment policy of quick response would be \$1000 or greater. In order to determine how this requirement would translate to quick response, however, we needed to factor in delivery frequency as this determines the amount by which to divide the annual sales volume in order to find an average order size. In an ideal implementation, the order frequency could be whatever the customer was most comfortable with – the product usage quantities could accumulate throughout the cycle between orders, at which point that amount of product would be shipped to the customer. Because we had no experience in choosing order frequency, it was decided that we should choose an order frequency that was consistent with the customer’s historical tendencies. Given these requirements, customer selection began with the

equation $\$1,000 \leq \frac{\$AnnualVolume}{\# AnnualOrders}$, and proposed order frequency (POF) would be determined as:

$$POF / week = \frac{\# AnnualOrders}{52weeks}.$$

Using the previous year's worth of historical sales data (see the next section – Historical Data - for more detail), an initial list of potential customers was created. The next step – assessing whether a customer fit the “Kodak Friendly” criteria – was left to sales and marketing representatives from the business unit.

From this initial list, a potential customer (hereafter to be referred to as Customer X) was identified. Customer X was privately owned by a group of four people, the most active of which had a good relationship with key management of the Kodak Professional business unit. By now several managers had become aware of, and supportive of, the quick response program, and it was expected that he would be used as an influential figure in developing customer and internal Kodak confidence in the program. Customer X also was extremely Kodak friendly, according to the sales representative responsible for their account, as their percentage of Kodak products in relation to their total purchases of photographic products was estimated to be around 80%. Although it was still too early to reveal to Customer X the details of the quick response program, as we had nothing in place to demonstrate the concept at this point, we were able to make inquiries as to their IT infrastructure, and what we would need to develop in order to make the process work in their environment.

We found that Customer X was quite varied in their level of IT capability. As a commercial laboratory, they employed an onsite graphical arts staff that made use of high-end PC's. Additionally, they connected these PC's, and those of management, to a local area network and had their own email server. The one glaring exception, however, to this system of advanced PCs was the computer used by the stockroom manager. In his area was one stand-alone PC running on Windows 95. The oldest system in the entire company, it still was connected to the LAN, and the email server.

Equipment Selection

In preparing for the implementation of a quick response system, I found that there are several key components to be considered when determining the type of hardware to be used. Ideally, there is already a POS system in place that would allow a usage signal to be intercepted, and used as a signal for the quick response system. Unfortunately, many businesses do not have this type of system in place as we found out when looking at some of Kodak's customers. Scanning devices range considerably in price depending on the functionality included, so it is important to determine which needs are important for an implementation and then to choose a device accordingly.

- The device must be capable of reading all types of barcodes that the relevant manufacturers use on their products

- Depending on the data transfer timing requirements, the device can transmit information real-time via a radio frequency signal or through a tethered connection to a PC, or store information in memory and transfer later. In either case, there must be capability to store all scanned data in some retrievable location.
- The device may or may not have data entry capability
- Multiple devices may be needed depending on who will be scanning products, and where the scans may take place

Depending on the needs of a particular quick response implementation, there is a wide variety of scanning devices on the market to choose from. Cost restrictions need to be weighed against functionality to determine the best possible fit. In our case, we chose a CS2000 device from Symbol Technologies that was handheld, wireless, capable only of reading or erasing barcodes, and needed to be cradled for data transfer. For the pilot program, Kodak purchased the necessary units and distributed them to Customer X.

Historical data

For this project, we had one year's worth of historical customer ordering data. The relevant information for analysis in our case were the following fields:

- Customer
- Order Number
- Product Ordered
- Quantity Ordered
- Date Ordered

Not available with any accuracy was data that supported Kodak's inventory positions, and transportation costs for each of the orders.

4.2 Application Development

Data transfer became the key challenge in developing the quick response pilot. We needed something not only to transfer data from the scanning devices to a PC, but we also needed to transfer that data from the customer site to Kodak. We opted to develop a Visual Basic program that could then be turned into an executable program and be installed on any PC. Used in conjunction with a communications port, this VB program permitted scanned data to be downloaded from the scanner to a PC. The problem with this approach, however, is that the logic for the program needs to reside on the client's computer, and maintenance needed to be applied to all existing systems should any need to be done. In a more advanced

implementation, the more ideal approach would have been to develop logic that would allow the program to reside on a Kodak server, and for the client device to read that program when downloading the scanner.

The minimum features required for this Visual Basic program were:

- 1) Be compatible on any Windows Operating system
- 2) Download data from a Symbol Technologies CS2000 scanner
- 3) Clear the memory of the scanner after data has been downloaded

Additionally, we hoped to add the functionality to the program that would transfer the data to Kodak with no extra user interaction. At a minimum, the quick response program could function with the user transferring a text file to Kodak via an email that they compose, but that obviously was not a desirable situation since the additional user interaction introduces more opportunity for error, and the possibility of increased user frustration given the lack of automation. The final version included a function that automatically generated and sent an email with an attached text file to a Kodak recipient each time the scanner gets cradled (once daily in the pilot program) with no interaction needed by the customer.

4.3 Business rules

A successful quick response implementation requires collaboration from all of the parties involved. The whole system can quickly fall apart if someone does not fulfill their responsibilities on a regular basis. The participating customers need to take responsibility for ensuring that all relevant products are scanned, inventory levels are adjusted properly, and products are added to or removed from the automatic replenishment list as needs change. Kodak must take responsibility for providing timely and complete deliveries, in addition to timely processing and posting of customer usage data over the web. As Lawson, King and Hunter point out¹³, the most important feature of quick response is communication between the vendor and customer. This communication must not only happen while the quick response program is in operation, but also before the implementation actually begins in order for there to be a common understanding of how the process will work. In this section, I will address the areas that we found to be most important in terms of communication between the active parties, and those most important for agreement as ‘business rules.’

¹³ Lawson, B., King, R., Hunter, A. *Quick Response – Managing the Supply Chain to Meet Consumer Demand*. John Wiley & Sons, 1999.

Transportation Costs

One of the biggest concerns that people had every time we discussed the quick response concept was that transportation costs would rise significantly. In the Kodak Professional business unit in which we were working for the pilot program, all shipping charges are waived if the dollar value of an order exceeds \$1,000. Thus, since the quick response program advertises much smaller delivery quantities for a particular item more frequently, customers immediately assume that shipment sizes will not reach the \$1,000 threshold and they will subsequently not receive free shipping. To eliminate this fear, the decision was made to ship all products replenished through the quick response program for free. As explained in Section 4.1, we strategically chose customers for the quick response pilot program such that their average orders with a given shipping frequency would be over \$1,000 anyway. Thus, by setting a shipping frequency equal to the customer's historical average time between orders, we expect the total shipment sizes to be approximately the same as they have been historically, but with more items constituting each order.

Shipment frequency

Our goal in establishing shipping frequency is tied in part to the transportation costs discussed above. Obviously, if each product is shipped individually, the transportation costs to Kodak would be excessive to the point that the program would not be economical. Additionally, it would be quite inconvenient for the customer to receive such a large number of packages separately. We strove to agree with the customer for a shipment frequency similar to that of their historical tendencies. In Customer X's case, that frequency was on average twice per week. This number is one that could vary by customer depending on their ability to receive shipments, and also on Kodak's willingness to provide free shipping. Customers demanding a shipment frequency that led to orders significantly less than \$1,000 on average are probably not ideal customers for Kodak to bring onto the quick response program.

Figure 4.3.1 shows the ordering pattern of Customer X, who in 1999 ordered 111 unique products from Kodak, placed 100 orders, and never ordered the same product more than 15 times during the year. Clearly, this customer orders quite frequently, but does not order many different products at once, and does not order the same product very often.

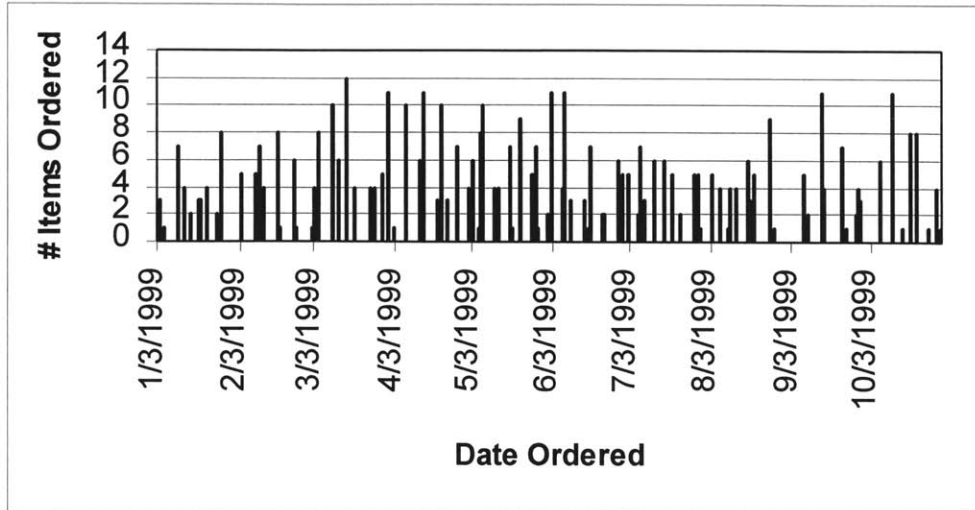


Figure 4.3.1: Actual orders for Customer X. Each bar represents a distinct order to Kodak (111 in total), and is measured by the number of items in that particular order. This customer averaged under 5 items per order.

Now that a shipping frequency has been established, it is possible to further refine this frequency to establish the exact day(s) of the week when shipments would be made. In the case of Customer X, they were interested in receiving replenishment orders on Mondays and Thursdays, so we established pre-set order creation and shipment dates to conform to this request.

Replenishable Items

In many of today's production environments, and in particular in professional photographic laboratories, the purchasers of products rely on a combination of on-hand inventory and on-demand order placement. We consider these two situations to be very different, and necessarily distinguishable for a quick response environment. For those products that the customer uses on a regular basis, or keeps on-hand in the event that some of that product is needed with no lead time, there is often inventory. These are the products that we targeted for inclusion in the quick response program. The process that we followed to establish such a list involved close collaboration with the customer. All we knew from a supplier perspective was what the customer had ordered, not what they kept in inventory. Often, special jobs will arise, and the product is ordered in the exact quantity needed and used as soon as the shipment arrives. In all cases where we attempted to involve a customer in a pilot implementation, we asked the customer to provide us with a list of currently inventoried Kodak items if available. In all cases, customers were willing to provide us with at least this information – some were even willing to provide a complete picture of their inventory holdings, including competitive products. Ideally, this is the level of information that we were shooting for, as it would allow us to measure product conversions from competitors during the time of the pilot program and distinguish them from new product additions in general to the customer's portfolio.

With the exception of cases where the customer asked us to replenish a product that had been replaced by a newer generation product, we left the product replenishment decisions in the customer's hands. In the end, it was the customer that would be receiving product based on usage, so we felt that they should have the final say in what would be replenished.

Order Quantities

One of the most important factors that comes into play when establishing policies about order quantities in a quick response implementation is any supplier minimum order quantity policy. Many companies have limitations that force customers to buy a minimum quantity of a product, and possibly even buy the product in certain multiples. This can be a problem area with automatic replenishment, and it must be addressed at the beginning of the quick response program. For example, there are certain film and paper products at Kodak that are sold in case (or pallet) quantities only. The customers may keep the case or pallet in inventory, and remove individual product packages (that are not sold individually) when needed. If this happens, and the individual product packages are scanned at the time of use, the supplier must commit to replenishing the items individually, which may be a significant deviation in the distribution system, or wait until the usage is equivalent to a case worth of product, and replenish a case. If one case is all that a customer needs to keep in inventory, the trigger for a new case replenishment may need to be set at some level of usage before the entire case is empty. Standard reorder point analysis as discussed in Chapter 6 applies here as well.

For the quick response program at Kodak, we established from the beginning of any implementation that we would replenish only the minimum order quantities as Kodak has always defined them to customers in any of the traditional purchasing channels. Where order multiple requirements applied, we would stick to existing policy as well. Figure 4.3.2 depicts the fields a customer might see on his website in regards to order quantities.

Figure 4.3.2: Fields contained in a customer's Order Report

Customer X					
Next Replenishment Trigger: Monday, MM/DD/YY, 5:00PM					
Catalog #	Description	Unreplenished Quantity	Minimum Order Quantity	Multiple	Next Replenishment Quantity
The Kodak catalog number of the item to be replenished	Product description	(Quantity scanned – Quantity shipped)	Kodak minimum order quantity	Order quantity multiples	Quantity set to be sent to the customer on the next delivery

This information is based upon the next scheduled shipment to a customer in the automatic replenishment program. Again, the trigger date/time is displayed at the top of the table and the product catalog numbers and descriptions are also included in the table. The Unreplenished quantity shown in the table is the amount of product that has not been replenished to the customer, based on the quantity of product the customer has scanned. This quantity is equal to the amount of product used, determined based on the number of scans for an item, minus the quantity of units that had previously been sent to the customer. The minimum order quantity for a product is shown, along with an order quantity multiple. The order quantity multiple may be defined in an enterprise resource planning, or product ordering program such as SAP. The Next Replenishment Quantity was calculated based on the following business rule:

Next Replenishment Quantity = INT((Unreplenished Quantity – MOQ)/MULT)*MOQ+MOQ, where INT rounds a fractional amount down to the next closest integer, MOQ = Minimum Order Quantity, and MULT = Order quantity multiple. This equation insures that the order quantity sent to the ordering system is sent in legal quantities based on minimum order quantities and order multiple rules.

The database that we used to track this usage and replenishment stored all scanned items, and maintained a separate tally for products shipped. The main reason for doing this, and not marking a scanned record as shipped, was that the customer may on occasion decide to have a product sent early, have a case sent before it is fully used, or order extra product because of a special job, etc. If the system marked scanned items as sent, and was capable only of basing the next order on any unmarked scans, there would be no records to mark in the database when these instances of advanced shipments, etc. occurred since there were no items scanned to populate the database. Additionally, this also helped us prevent situations where the customer ends up with more product in the long term than they want. Take the situation where

they order extra product for a special job. The customer does not want to increase his standard inventory level, but does need extra product for the special order. With our ordering policy, we recorded this special order as product sent, and the Unreplenished Order Quantity would initially fall to a negative amount (since extra units were shipped for product that was not scanned: Quantity scanned – Quantity shipped <0). This negative amount would be equal to the extra units of product that the customer requested. Then, as the customer scans this product as it is used, the Unreplenished Quantity returns to a positive amount, and the replenishment cycle continues as before.

If the system were not to record the shipments separately, it would likely continue replenishing all of the product that the customer asked for in the special shipment, and the customer would then end up with excess inventory. This is a key issue to consider when implementing the automatic replenishment portion of the quick response program since customers will often need to bring in excess product without wanting to increase their base inventory levels for the long term.

Data transfer

With the technology choice that we made regarding the barcode scanning device, the quick response system was dependent on a manual transaction by the customer. Clearly, for Kodak to provide replenishment of consumed products, we needed to know what was being used. The software package was designed to automatically send an email to a recipient at Kodak with an attached text file which contained the barcodes of all scanned products, an identifier of the scanning device used, and a date/time stamp indicating the time at which the scanner was cradled. The responsibility of actually cradling the device fell to the customer. With the date/time stamp, we were able to identify the time at which the scanning device was cradled, and this indicator could be used to resolve any potential conflicts that may have arisen due to timing in the shipping frequency cycle.

This method of data transfer required a manual transaction at Kodak's end. Someone needed to receive the email, detach the text file, and import it into the database that was used to process the consumption and ordering information. Ideally, this manual step would be eliminated, and the data would be automatically received into the database without human interaction. We determined that for the pilot implementation, the email system would be manageable for the limited number of customers that would potentially be involved. For our implementation, the recipient was in the Customer Order Services department, and was ultimately the group responsible for triggering the automatic replenishment orders at the pre-established cut-off time. Once the data was imported into the database, consumption and tentative order reports were automatically generated and posted on the customer's website.

Penalties for non-compliance

We viewed our pilot implementations as a test of the quick response system, and wanted to work with customers that also viewed it as such. We were trying to work out the kinks in the system, and not knowing what these would be, we did not establish any penalties for non-compliance. Essentially, it was understood that the customer needed to scan all products that were being used, and Kodak needed to process the data and provide timely shipments of all the products that were part of the automatic replenishment agreement. We knew that any mistakes would probably be attributed to Kodak, and we therefore kept a close eye on all of the transactions from our end, as well as monitoring as closely as possible the necessary activities at the customers' end. For instance, if we did not receive an email on any given night with the customer's consumption information, we would contact the customer and make sure that there were no issues causing them not to be able to send the data. Communication between the two parties was essential in the pilot implementation to make sure that all aspects of the system were working smoothly, and we tried to avoid any conflict or frustration by monitoring potential problems (namely that the customer doesn't receive product that they are expecting because they forgot to send us the information).

Chapter 5: Findings

As of February, 2001, the pilot quick response program had been implemented at Customer X for approximately 8 months. The pilot customer was subjected to the full rigors of the program, and the data and learnings can be used as a base from which to extrapolate and estimate the benefits if the program were to be expanded. In this section, I will discuss our findings with the implementation at Customer X, and with that implementation, the associated findings both at their site, and at Kodak.

5.1 Inventory Analysis

Inventory has been a central point of discussion as a potential benefit for both the customers and for Kodak from quick response. For the customer, the inventory savings were due to more closely matching their product ordering (or replenishment) to their actual usage of those products. For Kodak, the inventory savings were to come at a finished goods level in the Regional Distribution Centers by reducing the demand variability and hence reducing the safety stock required to meet customer service targets.

Actual changes in inventory levels at pilot sites

Because we did not have access to Customer X's inventory management system, I was unable to do a thorough analysis on the changes in actual customer inventory during the pilot implementation. Nevertheless, I can make some inferences based on order frequency and on customer testimonial.

The premise of the automatic replenishment portion of the quick response program is that the customer will receive more frequent replenishment of each individual item that they use on a regular basis. Traditional customer behavior was to order a relatively large quantity of an individual item, store it in inventory, and work the inventory off until a critical reorder point was reached, at which point the stockroom manager would order a new batch of the product. In the new environment, the product is reordered based on usage between shipping frequency cycles, not on a reorder point. In the year prior to the pilot program, the maximum number of times that Customer X ordered a single product was 15 times (once every 3.5 weeks on average), with products being ordered 4.2 times per year on average. During the 8 months of the pilot program, the maximum number of times that a product was replenished was 53 (once every 0.6 weeks), with individual products being ordered 14.4 times per year on average.

Because the customer was receiving more frequent shipments of product, it seems logical that their inventory would never fall down to their reorder point levels given usage patterns similar to their historical tendencies. Although I do not have data from the customer to examine in detail what exactly

happened to their inventory, I do have a quote from the customer that indicates behavior similar to what I expected:

“My only complaint with the program so far is that we seem to be carrying more inventory than we did before the program began. This confuses me since you guys said that we would be reducing our inventory with this program.”¹⁴

As can be seen in the Figure 5.1.1, more frequent replenishment of base stock without a corresponding adjustment in the base stock of that item, will result in a higher average inventory level over a period of time.

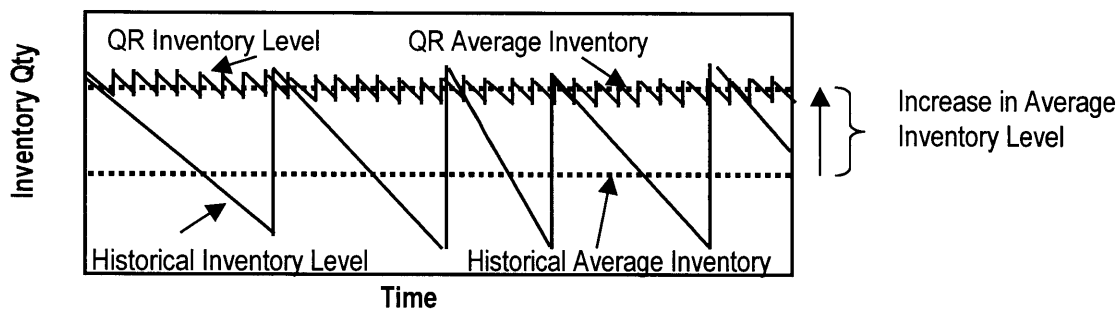


Figure 5.1.1: Depiction of inventory increases with no changes in base stocking models under the quick response program

Clearly, this inventory management policy is suboptimal, and the customer needs to “bleed off” some of its inventory, or consume some of its inventory without replenishing it. In essence, I would expect the following to happen once the customer and Kodak have enough evidence that the quick response program works, as depicted in Figure 5.1.2:

¹⁴ Quote by the stockroom manager of Customer X, August 3, 2000. Quote was in response to general customer satisfaction questioning after 3 months of the quick response implementation.

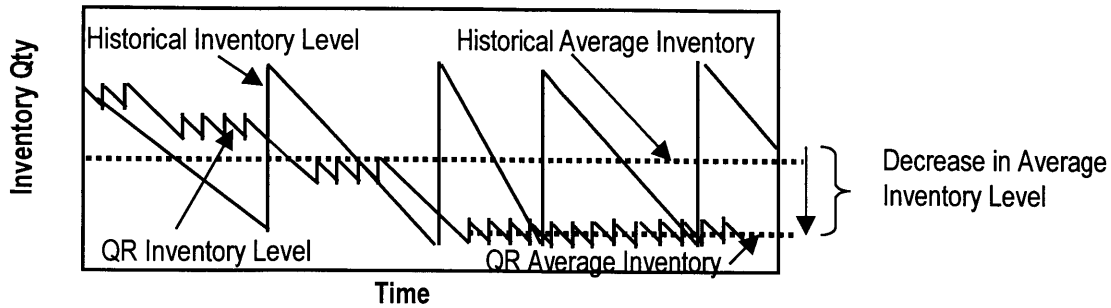


Figure 5.1.2: Depiction of inventory decreases when base stock policy is changed to reflect more frequent product replenishment under the quick response program

This situation is what we would push the customers toward in the longer term as participants in the quick response program. Nearer term, the reason for not seeing this pattern was that we were trying to build the customer's confidence in Kodak's ability to reliably deliver on the promises of automatic replenishment twice per week. So, even though we received a complaint in the customer satisfaction survey by the stockroom manager, we took it as a positive since the system was acting as we expected it to – the average inventory levels increased with more frequent product replenishment and no change in base stock policy.

Changes in Kodak finished goods inventory

There were no noticeable changes in the finished goods inventory levels for the Kodak Regional Distribution Center serving Customer X. Since Customer X is a small fraction of the business generated in the Kodak Professional business unit, we could not realistically expect to see any inventory reductions with just this one implementation. Instead, I will estimate in Chapter 6 the benefits that Kodak might expect to see should similar results be seen at customers participating in a larger scale implementation.

5.2 Demand Variability

Customer X agreed to have 97 Kodak items in automatic replenishment mode for the pilot program. Using the historical data for the year prior to the quick response implementation at Customer X, I was able to determine the average daily usage of each product in the automatic replenishment program, as well as the daily standard deviation of the orders as placed on Kodak. It is important to note that when analyzing the standard deviation of orders placed on Kodak, I am including all work days¹⁵, including those on which no orders were placed. So, for most products, the order stream consists of a number of zeros, followed by an order quantity, etc. and the standard deviation was computed on this order stream,

¹⁵ I excluded weekends from the analysis since Customer X does not place orders on the weekends, and I did not want the values for each metric to be skewed downward as a result.

not just the days on which orders were placed. I was then able to compare these historical results to those accomplished through the quick response implementation.

In looking at the demand during the quick response program, there are two different data sets of interest. The first is the signal received from the customer on a daily basis. This is the true demand stream of our end customer (their on-site daily usage). Since we were placing orders only twice per week for Customer X, however, there is a second signal that is more relevant to the Kodak distribution system. This order signal can be zero or positive in quantity twice per week, and zero on the other three days. It is this dataset that I use for comparison to historical daily orders since this is the only information that the Kodak distribution system could actually see.

Because there was a shift in the mean usage of almost every product analyzed between the historical usage and that during the pilot program, I computed a Coefficient of Variation (COV) in each case, and determined a reduction in variability based on a comparison of the old and new COV's.

$$COV = \frac{\sigma}{\mu}$$

and

$$\Delta Variability = \frac{COV_{New} - COV_{historical}}{COV_{historical}}$$

where

σ =Standard Deviation of daily demand on Kodak for the product

μ =Daily average usage of the product.

Figure 5.2.1 shows a histogram of the variability reduction over historical levels based on actual usage, and based on orders to the RDC by item, and Appendix I shows the reductions at a detailed level for each item involved in the pilot (Note: while there were 97 items in automatic replenish mode, only 79 were actually used during the pilot implementation).

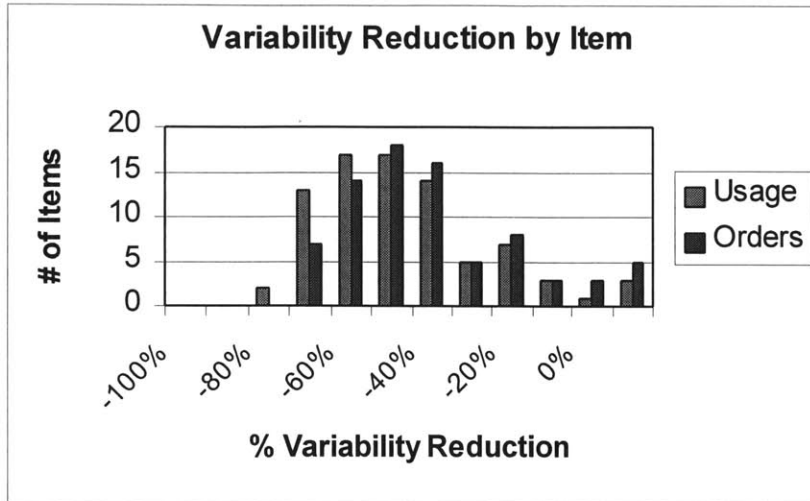


Figure 5.2.1: Variability Reductions by item based on usage signals to Kodak, and based on orders to the distribution network.

As can be seen in Figure 5.2.1, the quick response program achieved substantial benefits from a demand variability reduction perspective for a majority of the products that were part of the automatic replenishment program. Also of note is the slight shift downward in variability reduction when the data is analyzed from the perspective of the orders placed on the RDC instead of the actual consumption signal being captured by the system. These benefits could, in theory, be achieved by making the signal visible to the RDC's, but because of the significant information systems and process modifications that would be necessary to make this information useful, we opted to allow the data to trickle through the system based on actual orders to the RDC's as-is. The systems in the RDC's would need to be changed so that they take into account product "on order", or product that has been consumed as known by the quick response signal, but not to release it as an order to the customer until the next scheduled shipment date.

In summary, the demand variability reductions as seen in the pilot implementation with Customer X were significant. Because this was just with one customer, however, we need to look at how the program, if implemented on a larger scale, would affect the overall Kodak finished goods inventory. This will be discussed in Chapter 6.1.

5.3 Business Process Changes

As a result of implementing the quick response pilot program, several business processes were changed slightly, or were expected to possibly change over traditional processes. We needed to determine to what

extent these changes positively or negatively affected Kodak and Customer X in order to determine the larger scale viability of the program.

Customer Order Services

Customer Order Services played a vital role in our pilot implementation. On one hand, we saw as a goal of a large scale implementation of quick response at Kodak a significant reduction in the need for the Customer Order Services department to take and process orders. This was obviously noticed by the department when quick response was proposed since they saw the program as a threat to their jobs. On the other hand, since we lacked the automation in our pilot program to feed the product consumption signals directly into the SAP ordering system as orders for the customer, we still needed active participation from the department to facilitate the pilot. With the support of the Kodak Professional business unit, we were able to acquire the support we needed from Customer Order Services during the pilot program.

As described earlier, a customer would traditionally have two options for placing an order to Kodak – via a phone call, or through Kodak’s Biznet system. In either case, a Customer Order Services representative would receive the order (either electronically, or over the phone), and manually key it into the SAP ordering system. In our pilot implementation of quick response, an email would come directly to a designated Customer Order Services representative (as well as a backup in case the main contact was absent). The email was generated by the software on the customer’s PC, and was sent each time the customer cradled their scanning device, in the case of our pilot, once per day. Upon receipt of the email, the representative then needed to detach the text file containing Customer X’s daily consumption information and import it into the Quick Response database. The database contained a graphical user interface that allowed this import to happen with one click of the mouse. A tentative order form was created in the database, and at the pre-determined shipping frequency deadline (twice per week), the representative would place the order by entering the data into the SAP ordering system.

This process was not significantly different from the traditional process that the Customer Order Services representative employed prior to quick response, with the exception of receiving emails instead of a phone call or printed order form that came via Biznet, and importing this data into the database. In actuality, the representative was happy with the process due to the elimination of phone orders, which took significantly longer to process. Cooperation during the pilot did not turn out to be an issue due to the high visibility that the pilot was receiving throughout the Kodak Professional business unit, and also the ease of processing the orders. On a daily basis, the representative needed to set aside less than 5 minutes

every afternoon to process the email and update the quick response database. The graphical user interface used by the Customer Order Services representative is shown in Figure 5.3.1:

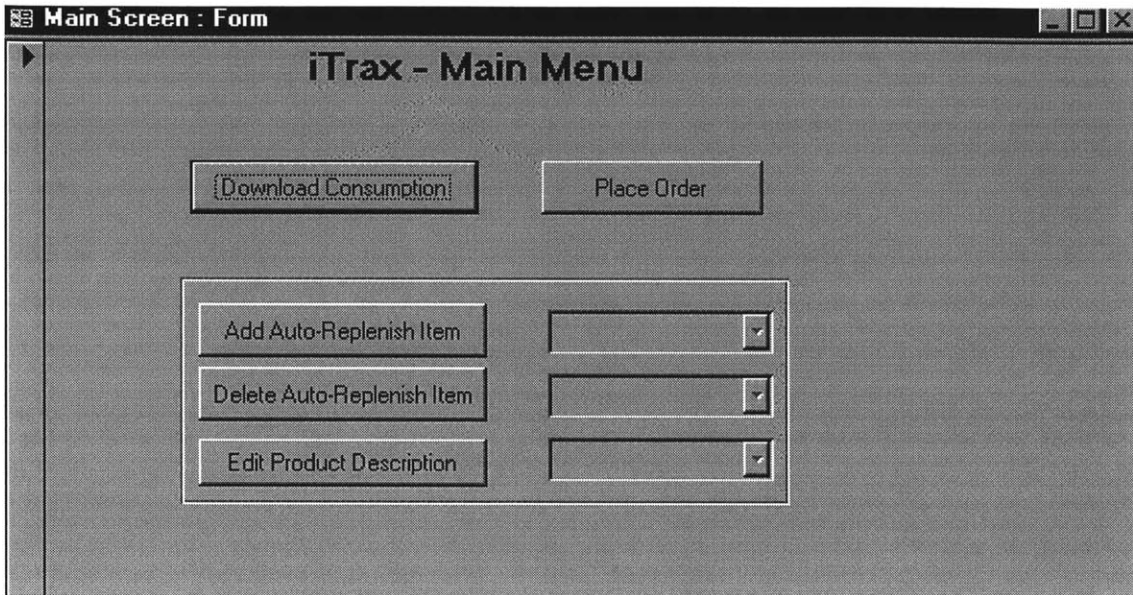


Figure 5.3.1: Graphical User Interface used by Customer Order Services to process data for the quick response pilot

The representative was also the point of contact for the customer in the event that they wanted to add or remove a product from the automatic replenishment portion of the quick response program. This function was also accomplished on the graphical user interface that the representative used to update the consumption data in the database.

Distribution

On a high level, the distribution system was not affected by the quick response program. The orders for Customer X were entered into the SAP system exactly as they always have been by a Customer Order Services representative, and then transferred through to the Regional Distribution center for product picking and shipment. Looking at the process more closely, however, it can be seen that more items needed to be picked per order, in smaller quantities, than they traditionally have been. Because we stuck to Kodak's established minimum order quantities and order multiples, there were no base process changes that needed to be implemented, but there were still smaller quantities of products, and more products per order. A stylized example of the changes in order composition is shown in Figure 5.3.2:

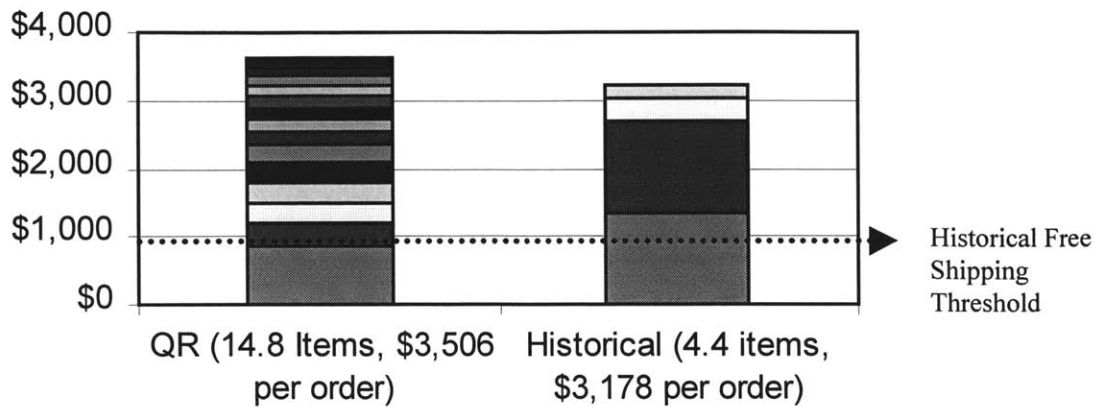


Figure 5.3.2: Historical product mix per order vs. product mix per order in the quick response pilot for Customer X

Again, with the volume associated with just one customer, this change did not result in any noticeable difference to the distribution network, but it should be noted that this could be an issue in a larger scale implementation and some of the labor savings associated with automatic order entry may be offset by a slight increase in distribution personnel needed for order picking.

Transportation Costs

Because one of the criteria we used in choosing Customer X for the pilot was that their average order be valued at over the Kodak Professional threshold for free shipping, we did not see any noticeable changes in the transportation costs of shipments during the pilot program. On only one occasion during the 8 months of implementation did the value of an order generated through automatic replenishment fall under the \$1000 threshold. In this case, the shipment cost, which normally would have been billed to the customer, was paid by Kodak because of the business rule to include free shipping with all orders coming through quick response. The results of this portion of the pilot program do, however, help to support our decision to set an order frequency equal to that of a customer's historical average order frequency given that their average order size is also greater than \$1,000.

Customer's process changes

From the customer's perspective, there were several changes to their business processes. The most obvious is their need to scan products as they are used, or consumed from inventory. In the past, Customer X employed a paper tag system in which any person taking product from inventory would fill out a paper tag indicating the product used, and the quantity taken. This tag would then be left in a folder for the stockroom manager who would manually key this information into his inventory management

system on a daily basis. In the pilot environment, any person taking product from inventory would scan the barcode of each product package with the scanning device located in whichever product stocking location they were taking inventory from. This saved them the time required to fill out a tag and place it in the stockroom manager's folder. At the end of each day, the stockroom manager would then cradle the scanning devices and log onto the website provided by Kodak to get a summary of the consumption by day. Because the software we developed did not have the capability of linking directly into the customer's inventory management system, the stockroom manager still needed to key the data on his consumption report into his inventory management system, but instead of reading a folder full of handwritten (and often illegible) tags, he simply needed to read the consumption report. We also worked with the customer to identify the barcodes of non-Kodak products and include their usage of all products in their consumption reports.

The consumption report was divided into two sections: one for items in automatic replenishment mode, and one for items that were not. Now, instead of worrying about ordering any of the auto-replenishment items, he could look at the consumption report and see exactly what he could expect in his next order. Should he need more, or less of an item, he had the option of calling the Customer Order Services representative and change the quantity of a product that was due to be ordered automatically. For all other, non-replenishment items (some Kodak and all non-Kodak items), the stockroom manager would still need to create orders through whichever of the traditional ordering means he desired.

The final piece of the process as far as the customer was concerned is shipment receipt and invoicing. There were no changes to either of these processes as the shipments arrived exactly as they did before with an invoice enclosed. Because the customer had visibility of all orders generated through automatic replenishment, and also had the ability to modify these orders as needed before they were shipped, the responsibility for paying for all products shipped fell to the customer exactly as before.

Implementing the Pilot at additional customers

One of the biggest disappointments with the pilot program was our inability to implement the program at more than one customer in the Kodak Professional business unit. This left us with data from Customer X only, and makes it somewhat more difficult to make a case for a larger scale implementation. There were a number of reasons for there not being more implementations – most of them stemming from the fact that most of Kodak Professional's larger customers have more advanced information systems than Customer X, and the solution we were proposing would often add work to their daily processes. For

instance, if a customer already has an automated inventory control system that they are comfortable with, the incorporation of our scanning devices and the need to scan each product in addition to whatever they already do for inventory control was seen as a nuisance. For these and other less automated customers, many people saw our quick response system as an “inventory control” system. Through the consumption reports, we were providing a means to monitor product usage, but we were not looking at being in the business of monitoring product inventory levels and guaranteeing their accuracy. We were guaranteeing shipment of product based on a signal that the customer provides. With the inherent human error risk of products not being scanned, we were hesitant to assume that the consumption signal that we received was 100% accurate in terms of actual product usage. On this same note, the entire quick response program will fail if anyone consuming product forgets to scan products as they use them. This made many customers nervous if they did not already have a system in place to insure that this happened. Some customers also ran a retail shop in addition to their laboratory. In these cases, they normally would use a different system (connected to the cash registers) to monitor retail product outflow as compared to laboratory product usage. Our pilot solution relied on the signal generated by a specific scanning device, and we were not able to scale the solution during the pilot phase to receive signals from different sources.

Chapter 6: Analysis and Recommendations for Larger Scale Implementation

To this point, much of the discussion has been about the pilot implementation of quick response at Customer X. Being a small portion of Kodak's overall business, we could not reasonably expect to see noticeable results on the business with just the one implementation. In this chapter, I will consider a larger scale implementation of the quick response program with an emphasis on the Kodak Professional business unit, and explore how such an implementation might affect different components of the organization.

6.1 Potential inventory savings for Kodak

I have already discussed the demand variability reductions achieved on an item level during the Customer X pilot implementation. These reductions would hopefully translate into the most significant monetary benefit that Kodak would hope to achieve through a larger scale implementation – reduction in finished goods inventory. As was covered in Chapter 2, Kodak uses a reorder point methodology for its distribution center network where manufacturing replenishes inventory in the distribution centers based on actual sales consumption. The distribution centers follow the following formula to calculate reorder points:

$$ROP = \mu_D T + Z_\alpha \sigma_D \sqrt{T}$$

Where, μ_D = Average Demand

T = Lead Time, or the time from when an order triggers until the inventory is replenished

Z_α = Z-value at specified service level

σ_D = Standard deviation of demand

Again here, I will focus on the safety stock portion of the reorder point, since this is the component affected by demand variability ($SS = Z_\alpha \sigma_D \sqrt{T}$). With this, we can take the actual results from the Customer X implementation, along with the past year's historical data to estimate what might happen to the safety stock levels in the distribution centers.

To perform this analysis, we need to consider that the results obtained at Customer X were at the item level, and for Customer X only. In a larger scale implementation, the demand of all of the customers would pool together to create the end demand variance that contributes to the reorder point value. Part of the consideration that must be made when thinking about a larger scale implementation is how many

customers should be involved. The table below shows the FY2000 segmentation of customers based on contribution to total Kodak Professional revenues¹⁶.

Revenue Percentage	Percent of Customers
10%	0.1%
20%	0.2%
30%	0.4%
40%	0.7%
50%	1.3%
60%	2.1%
70%	3.6%
80%	6.7%
90%	13.3%
100%	100.0%

Table 6.1.1: Kodak Professional Customer/Revenue segmentation

As can be seen from this table, a relatively small number of Kodak Professional customers represent a majority of the business. With this being the case, a larger scale implementation can be considered for a small percentage of Kodak Professional's overall customer base, while still covering a majority of the business. At a maximum, my analysis will be limited to the customers representing approximately 70% of the yearly revenue.

Additionally, as we saw with Customer X, not every product is used on a regular basis, and correspondingly would likely not be good candidates for automatic replenishment. Instead of considering each and every product that these top customers order, I will limit the analysis to just the items making up 80% of each of these customers' revenue contribution to Kodak Professional. This assumption is made to err on the conservative side in terms of the benefit that the quick response program would likely be able to achieve for Kodak since some products are not maintained in stock and instead are ordered on special use basis.

Finally, I need to make assumptions about the demand variability reductions that I will assign to each customer's item level demand. To accomplish this, I will aim to assign a demand variability reduction based on mean product usage, variance of usage, and frequency of orders. I will make the assumption that customers operate under a periodic review policy, where at the end of each period (n days), they would order an amount of product equal to their demand in the previous cycle. In reality, most customers are likely operating under more of a reorder point methodology, where there is some degree of variation

¹⁶ At the time of this analysis, Customer X was in the top segment of customers by revenue contribution.

in the time between orders. For simplification, I am assuming that this time between orders is constant. I next assume that the daily demand for an item at a store is independent and identically distributed with a daily mean μ and demand variance σ_d^2 . If the store places an order for the item to Kodak once every n days, the variance of the daily order process (σ_o) on Kodak can be shown to be¹⁷:

$$\sigma_o^2 = \sigma_d^2 + \mu^2(n-1)$$

Equation 6.1: Variance of the daily order process on Kodak for a product ordered by a single customer

Using the year's worth of historical customer order data, I was able to obtain customer order frequencies (n), mean usage (μ), and order variance (σ_o^2) on Kodak for each customer/product combination fitting the original screening criteria. I then used the above Equation 6.1 to invert the actual daily demand variance (σ_d^2) at the customer site. I subsequently estimated a new order variance (σ_o^2) that we might expect to see under the quick response program with a new ordering frequency of 3 days, mean usage equal to historical tendencies, and a demand variance equal to the value solved for with Equation 6.1.

To verify the validity of this approach, I used the data collected at Customer X and compared the actual variability reductions to those estimated using Equation 6.1. Figure 6.1.1 demonstrates the linear fit between the actual reductions in variability for each product used in the quick response program at Customer X against the estimated reductions in variability.

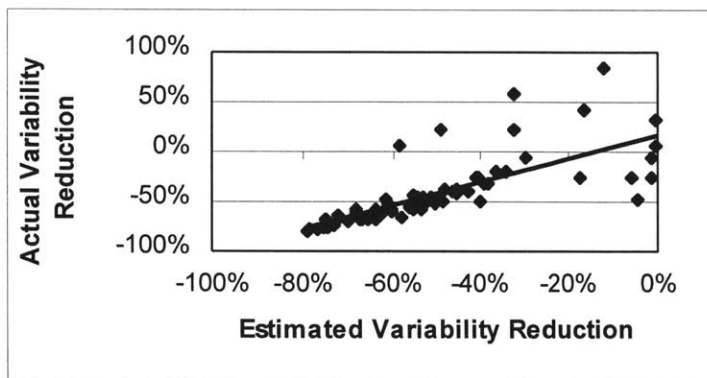


Figure 6.1.1: Relationship of estimated reductions in variability against actual reductions in variability by item at Customer X during the quick response pilot program

¹⁷ Lee, H, Padmanabhan, V, Whang, S. *Information Distortion in a Supply Chain: The Bullwhip Effect*. Management Science, V43, No. 4, April 1997.

The datasets match with a correlation coefficient of 0.74. It should be noted that many of the outliers are products that were used significantly more in 1999 than they were in the pilot (some discontinued products, some obsolete products, etc.). Given this high degree of correlation, I consider the method of analysis to be feasible for estimation of demand variability on a larger scale and will utilize it accordingly.

The process to estimate demand variability reductions on a large scale is as follows:

1. Identify the customers contributing to the top 4% of Kodak Professional revenue
2. Identify the items for each customer that make up 80% of that customer's revenue contribution to Kodak Professional
3. Calculate the mean daily usage (μ) and standard deviation of daily orders on Kodak (σ_o^2) for each product at each customer based on 1999 historical data
4. Estimate the actual daily demand variance (σ_d^2) at the customer site by substituting n , μ , and σ_o^2 into Equation 6.1
5. Estimate a new daily variance based on a proposed quick response shipment frequency of once every 3 days
6. Sum the variances for each product (over all of Kodak Professional's customers), the square root of which is the overall standard deviation of demand for each product
7. Substitute the new standard deviations of demand into the safety stock formula and calculate a new estimated distribution center safety stock level for each product
8. Convert the safety stock quantities into dollar values and compare to baseline amounts

The results of this analysis are quite encouraging in regards to a large scale implementation of quick response in the Kodak Professional Business Unit. Of the products analyzed, over half of them were not affected by any adjustments to standard deviation of demand. These products were either not used by the top customers, or were not significant enough in value to contribute to the top 80% of revenue contribution from any of these customers.

After substituting the new standard deviations of demand into the reorder point formula where appropriate, keeping the mean usage constant, assuming an 11 day lead time, a 98% service level requirement, and the average product selling price across customers, I was able to compare the total safety stock value of all Kodak Professional products based on new estimates of demand variability where appropriate, and compare to estimations calculated with historical standard deviations of demand. This analysis estimates that Kodak Professional would be able to realize a 22% reduction in finished goods

inventory by implementing the quick response methodology with its top customers. The following table summarizes the results:

	\$ Value of SS Levels (Scaled Values)
Historical	33
Adjusted	26
Difference	7
% Reduction	22%

Table 6.1.1: Summary of estimated savings based on individual product safety stock levels as calculated using Kodak's reorder point policy with historical standard deviations of demand and those estimated with Equation 6.1.

In summary, I decided that the best way to analyze potential inventory savings for Kodak Professional was to use their current distribution center reorder point calculation policy to estimate safety stock levels based on the historical daily demand averages and corresponding standard deviations of demand, and compare these to the safety stocks calculated based on adjusted standard deviations of demand as per increases in shipping frequency. The potential benefits associated with implementing the quick response system at even a small fraction of Kodak Professional's total customer base can be substantial, and much more cost effective than pursuing an implementation strategy that involved all Kodak Professional customers.

6.2 Potential inventory savings for customers

In contrast to Kodak, where the safety stock portion of the reorder point formula would be most affected by the quick response program, for the customer, it would be the usage over a given leadtime, or cycle stock, that would be most affected. Since I am assuming that the quick response program will have no effect on the customer's mean daily usage and standard deviation of demand for product usage, their safety stock requirements should change only slightly to reflect a shorter review cycle. With more frequent shipments, their cycle stock should be able to decrease since they would need less product on hand to cover their usage until the next shipment. Hence, I will look at Customer X's historical inventory needs based on their mean usage of product, and their historical time between shipments for a given product and compare the results to the corresponding requirements given a shipment frequency of twice per week.

$$\text{Average Cycle Stock} = (0.5)\mu_d * n$$

Where: μ_d = mean daily usage

n = Days between orders

I also added a condition that there be at least one item in stock, even if the average usage during the time between orders was determined to be less than one. The results of the analysis show that Customer X could see a significant decrease in average inventory on hand:

	\$ Value of Average Inventory (Scaled Values)
Historical ¹⁸	46
Adjusted	11
Difference	35
% Reduction	76%

Table 6.1.2: Summary of estimated savings at Customer X based on 1999 average product usage, and 1999 average time between shipments. The adjusted frequency is twice per week as was seen during quick response.

These savings are supported by the fact that Customer X's ordering patterns shifted from ordering each item 4.2 times per year on average (once every 57 business days), to ordering individual items 14.4 times per year on average (once every 17 days - each product is not always used during each 3 day shipping frequency cycle). The estimated savings shown for Customer X are likely much larger than the savings that might be feasible at most other customers. On average, the historical tendencies of the remaining top customers show that they order products 10.4 times per year (once every 23 days) on average (compared to once every 57 days at Customer X). Making the assumption that they would also average an order every 17 days in the quick response environment, we can estimate that they would see a reduction in

cycle stock inventory of: $\frac{23days - 17days}{23days} = 26\%$, since a reduction in cycle stock inventory is

directly proportional to the days between orders. Although much smaller in magnitude than the potential savings for Customer X, a 26% reduction in cycle stock represents a significant savings for any of Kodak's top customers.

6.3 Quick Response as a signal to Manufacturing

Implementing quick response on a larger scale offers the opportunity to provide a much more accurate signal of demand to manufacturing than has traditionally been received via a pull signal from the Regional Distribution Centers. The nature of Kodak's manufacturing processes, however do not facilitate such a real-time production signal, and pooling will be required anyway. Long changeover times, and in

some instances, long upstream processing times do not make the manufacturing environment as flexible as some other product families. By pooling demand at the RDC level, Kodak is able to stagger their manufacturing schedule appropriately to accommodate stocking their diverse product portfolio. By reducing the variability in the RDC's, as the quick response system does, the demand on manufacturing will inherently see a smoother signal and consequently less spikes.

6.4 Customer satisfaction impacts

The quick response pilot demonstrated success in one of the original cited problem areas: Customers that deal directly with Kodak are much less satisfied than those that deal with an intermediary. During the pilot, Customer X did not have to place an order for any of the products traditionally used on a regular basis. Additionally, they could expect, and in fact received shipments twice per week on the days that they asked for. While we only have the testimonials of one customer, their response was quite favorable and encouraging for further implementation.

6.5 Other impacted areas

While there were many functional groups aware of, and to some extent participants in, the quick response pilot, a larger scale implementation would require additional support in order for the program to be a success.

Distribution & Transportation

As demonstrated in Table 6.1.1, a larger scale implementation of quick response would likely only impact the top customers in the Kodak Professional business unit. Although the individual item quantities for shipment would be smaller in the new quick response environment, picking these smaller quantities would not be a total shock to the system. Already, orders are being picked for the remainder of Kodak Professional's customers that receive much smaller item quantities than the customers being proposed for quick response. Hence, there would be no need for new business processes from a distribution perspective, but instead there may be a need for some additional labor if the added effort for picking more items per order on the larger customers became an issue.

Similarly, transportation costs should also not be affected. As demonstrated with the Customer X implementation, average shipment sizes should stay about the same as long as shipment frequencies are set appropriately. Since the largest customers order large enough quantities, frequently enough to deal

¹⁸ According to Customer X's inventory records, the actual inventory level of the products affected by the quick response implementation was within 2% of this calculation on one day during the week prior to the implementation. We were unable to obtain any additional snapshots of inventory levels for comparison to this number.

with the shipping costs, expanding the program beyond the top customers would require some approach for dealing with the shipping cost aspects of smaller orders.

Information Technology

Different options for the information technology behind the quick response system have been discussed, but should Kodak move to a larger scale implementation, the current software package in place at Customer X will not be suitable for scaling up. As currently designed, the software is stand-alone at the customer site. Any maintenance to the program requires installation of a new version by the customer. Additionally, the current method of data transfer requires a recipient on Kodak's end to download an email attachment, update a database, and enter the order at the appropriate time based on the customer's desired shipment frequency. This process would quickly get out of hand with more than a few customers. A system would need to be developed, preferably web based, that would allow real-time updates of the database as the customer downloads his usage information, and for orders to be automatically sent through to the order system without the intervention of a customer services representative. This would also give the customer the ability to see their usage real time, instead of needing to wait for the information to be processed by Kodak, and subsequently posted to their database. A web based solution is easily scalable to multiple customers as long as they have internet access (which would presumably be a requirement for participation in the program), and could be maintained at Kodak instead of at each individual customer site.

Chapter 7: Summary and Conclusions

7.1 Summary

The quick response pilot was a success. We were able to implement the system at one of Kodak Professional's key customers and in doing so, we saw evidence of addressing the original concerns of the two initiating entities within Kodak: customers dealing directly with Kodak are generally less satisfied than those that deal with an intermediary on the Professional business unit side, and demand variability on the Color Film Manufacturing side. Unfortunately, the magnitude of a single pilot implementation was not such that we were able to see noticeable differences to either of these factors as measured across the entire company. However, the fact that this single customer continues to be happy enough with the program to still be an active participant after almost a year, and that we saw demonstrated reductions in demand variability for nearly every active product in the quick response program, demonstrates success. One must keep in mind too, that this analysis was performed only on the Kodak Professional business unit – a small portion of Kodak's overall business. Applying the methodology elsewhere could potentially lead to much higher savings.

7.2 Lessons Learned

Perhaps the biggest takeaway from this project is that quick response is not for everyone. We had originally hoped to have closer to five pilot implementations instead of just the one. Without a system flexible enough to accommodate all potential inventory and material tracking systems that customers may use, there is a good chance that the quick response program might add a step or two to the customer's existing business processes. For instance, if a customer is already scanning product as it comes out of inventory and the system we propose is not capable of picking up this signal, the customer would need to scan again for quick response. Added steps such as this are time consuming and unwanted by most customers. Given this, to implement at a wide variety of customers may require a great deal of customization for each particular application. Trying to implement on a larger scale then becomes much more of a challenge.

Another key learning was that a lack of quantified customer satisfaction gains can be very detrimental in the quest to offset quantifiable losses that come as a result. It was extremely difficult to build a compelling business case when the lost sales implications of improved responsiveness were so real and quantifiable, yet the sales implications of improved customer satisfaction were so subjective.

7.3 Conclusions

A business case has been made for a larger scale implementation of quick response in the Kodak Professional business unit. The results of this analysis indicate that there is potential for significant benefits to both Kodak, and many of their key customers, should the program be expanded. We have also found that there are implementation issues, and to implement in each of the top customers as has been proposed will require a great deal more flexibility than that achieved with the pilot. Further, we have a satisfied customer that can provide testimonial in favor of the program for any in doubt. Perhaps we chose the wrong customer base, in that we focused on laboratories where there was a wide variety of technological capability, and a wide variety of business processes. The application might better serve the retail environment where point-of-sale applications are in common use to electronically register usage by the end customer.

In either case, Kodak will need to somehow value the potential gains in customer satisfaction, and use that factor in conjunction with the potential inventory savings as demonstrated in this thesis and weigh them against the effects of a one-time loss in sales from its key customers to determine whether the program should be implemented on a large scale.

Appendix I – Item level summary of quick response gains at Customer X

Item #	Item Price Relative to Average Price	QR Mean Usage	QR Std Dev on Orders	Historical Mean Usage	Historical Std Dev on Orders	QR COV	Historical COV	% Variability Reduction	1999 Times Ordered	Pilot Times Ordered
1	0.5	0.13	0.41	0.05	0.68	3.06	14.73	-79.2%	1	13
2	2.5	0.10	0.33	0.05	0.68	3.28	14.73	-77.7%	1	11
3	0.7	0.14	0.47	0.02	0.27	3.34	14.73	-77.3%	1	14
4	1.2	0.14	0.47	0.02	0.27	3.34	14.73	-77.3%	1	14
5	0.3	0.08	0.26	0.02	0.27	3.53	14.73	-76.1%	1	9
6	0.2	0.18	0.47	0.09	0.96	2.55	10.39	-75.5%	2	18
7	0.6	0.08	0.29	0.02	0.27	3.93	14.73	-73.3%	1	8
8	0.1	0.48	1.07	0.18	1.35	2.21	7.31	-69.8%	4	28
9	0.3	0.22	0.61	0.18	1.66	2.82	8.99	-68.6%	3	18
10	0.2	0.24	0.59	0.28	2.13	2.46	7.72	-68.1%	4	23
11	0.2	0.13	0.47	0.14	1.52	3.50	10.96	-68.1%	2	11
12	0.7	0.28	0.54	0.28	1.64	1.90	5.94	-68.1%	6	29
13	0.8	0.08	0.40	0.04	0.54	4.82	14.73	-67.3%	1	5
14	0.1	1.02	1.59	0.74	3.39	1.56	4.60	-66.0%	11	52
15	0.7	0.12	0.41	0.09	0.96	3.55	10.39	-65.9%	2	10
16	0.2	0.07	0.34	0.09	1.36	5.05	14.73	-65.7%	1	6
17	0.6	0.07	0.25	0.07	0.76	3.76	10.96	-65.7%	2	8
18	0.8	0.13	0.50	0.07	0.79	3.76	10.71	-64.9%	2	8
19	0.5	0.09	0.29	0.14	1.17	3.16	8.47	-62.7%	3	11
20	1.4	0.70	1.71	0.11	0.70	2.44	6.37	-61.7%	6	36
21	0.4	0.06	0.24	0.04	0.38	4.03	10.39	-61.2%	2	7
22	0.4	0.05	0.22	0.04	0.40	4.38	10.71	-59.1%	2	6
23	0.1	0.05	0.22	0.05	0.48	4.38	10.39	-57.9%	2	6
24	0.6	0.05	0.22	0.04	0.38	4.38	10.39	-57.9%	2	6
25	0.6	0.03	0.18	0.06	0.83	5.41	12.79	-57.7%	2	4
26	0.2	0.77	1.66	0.60	3.06	2.17	5.11	-57.5%	9	22
27	0.8	0.05	0.31	0.02	0.27	6.27	14.73	-57.4%	1	3
28	0.4	0.06	0.24	0.08	0.78	4.03	9.44	-57.3%	3	7
29	0.6	0.15	0.51	0.07	0.54	3.42	7.87	-56.6%	4	13
30	0.4	0.15	0.59	0.09	0.76	3.93	8.63	-54.5%	3	12
31	0.8	0.58	1.41	0.29	1.56	2.41	5.29	-54.4%	8	23
32	1.1	0.35	0.96	0.18	1.07	2.74	5.96	-54.1%	7	25
33	1.1	0.13	0.40	0.11	0.72	3.21	6.81	-52.9%	5	13
34	0.4	0.11	0.34	0.10	0.66	3.12	6.50	-52.0%	6	12
35	0.8	0.34	0.98	0.18	1.07	2.88	5.96	-51.7%	7	23
36	0.3	0.35	1.01	0.18	1.07	2.88	5.96	-51.6%	7	24
37	1.1	0.29	0.85	0.15	0.91	2.93	6.00	-51.2%	6	25
38	0.9	0.10	0.33	0.11	0.71	3.28	6.69	-51.0%	6	11
39	0.6	0.39	1.15	0.28	1.64	2.93	5.94	-50.7%	6	21

Item #	Item Price Relative to Average Price	QR Mean Usage	QR Std Dev on Orders	Historical Mean Usage	Historical Std Dev on Orders	QR COV	Historical COV	% Variability Reduction	1999 Times Ordered	Pilot Times Ordered
40	1.0	0.03	0.16	0.03	0.35	6.27	12.51	-49.9%	3	3
41	0.6	0.17	0.51	0.28	1.64	3.05	5.94	-48.8%	6	13
42	0.7	0.04	0.20	0.04	0.39	4.82	9.37	-48.6%	3	5
43	4.1	0.02	0.13	0.01	0.14	7.71	14.73	-47.6%	1	2
44	2.3	0.02	0.13	0.05	0.68	7.71	14.73	-47.6%	1	2
45	0.7	0.02	0.13	0.02	0.34	7.71	14.73	-47.6%	1	2
46	1.8	0.27	0.90	0.18	1.15	3.36	6.38	-47.4%	6	18
47	1.8	0.13	0.48	0.07	0.53	3.82	7.20	-46.9%	5	11
48	0.1	0.23	0.87	0.18	1.35	3.88	7.31	-46.9%	4	14
49	0.2	0.04	0.20	0.18	1.66	4.82	8.99	-46.4%	3	5
50	0.7	0.08	0.40	0.09	0.83	4.82	8.99	-46.4%	3	5
51	1.7	0.04	0.24	0.09	0.98	5.73	10.60	-45.9%	2	4
52	0.4	8.84	22.09	6.69	29.49	2.50	4.41	-43.3%	12	18
53	0.8	0.43	1.38	0.41	2.21	3.18	5.44	-41.6%	8	16
54	0.4	0.13	0.54	0.17	1.22	4.35	7.36	-40.9%	5	10
55	0.7	0.17	0.65	0.23	1.50	3.92	6.53	-40.0%	5	9
56	1.4	0.08	0.50	0.04	0.36	5.94	9.71	-38.8%	4	6
57	0.5	0.03	0.18	0.12	1.01	5.41	8.80	-38.6%	3	4
58	0.8	0.08	0.35	0.06	0.42	4.63	7.52	-38.5%	4	7
59	0.5	0.63	1.63	0.46	1.75	2.58	3.83	-32.6%	15	20
60	0.2	0.63	1.66	0.46	1.76	2.63	3.83	-31.3%	15	19
61	1.5	0.02	0.13	0.02	0.19	7.71	10.39	-25.8%	2	2
62	0.4	0.02	0.18	0.02	0.34	10.95	14.73	-25.6%	1	1
63	0.2	0.01	0.09	0.02	0.27	10.95	14.73	-25.6%	1	1
64	5.4	0.01	0.09	0.00	0.07	10.95	14.73	-25.6%	1	1
65	0.9	0.02	0.18	0.02	0.34	10.95	14.73	-25.6%	1	1
66	2.4	0.01	0.09	0.02	0.34	10.95	14.73	-25.6%	1	1
67	0.5	0.01	0.09	0.03	0.41	10.95	14.73	-25.6%	1	1
68	2.3	0.08	0.37	0.07	0.46	4.94	6.18	-20.1%	8	6
69	1.5	0.12	0.65	0.07	0.48	5.58	6.96	-19.9%	5	6
70	0.8	0.01	0.09	0.02	0.21	10.95	11.63	-5.8%	2	1
71	2.3	0.30	1.03	0.65	2.37	3.45	3.65	-5.6%	17	15
72	0.1	0.01	0.09	0.04	0.38	10.95	10.39	5.4%	2	1
73	1.0	0.80	6.17	0.88	6.47	7.71	7.31	5.5%	4	2
74	0.3	0.20	2.19	0.18	1.66	10.95	8.99	21.9%	3	1
75	0.9	0.02	0.18	0.11	0.99	10.95	8.99	21.9%	3	1
76	0.2	0.01	0.09	0.06	0.46	10.95	8.28	32.2%	5	1
77	1.1	0.03	0.20	0.05	0.29	8.14	5.76	41.2%	7	2
78	0.1	0.16	1.41	0.22	1.26	8.93	5.68	57.2%	8	2
79	10.9	0.01	0.09	0.03	0.16	10.95	5.94	84.3%	6	1

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