Collaboration Software to Reduce Inventory and Increase Response

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Some recent trends in business and manufacturing hold the promise of greater profits, yet, due to profit robbing inventory increases, this promise has not been fully realized.[Reeve [2002]] The major trends influencing this are:

- Globally and organizationally distributed suppliers (trading partners).[Hewitt [2001], Economist [2002]]
- Globally and organizationally distributed sales channels (trading partners).[Economist [2002], Cargille et al. [2001], Elliott [2002]]
- Increasing product variety and customization.[Hewitt [2001], Cargille et al. [2001], Elliott [2002], Budhwani [2001], Shah [2001]]

In addition, due to increased business process complexity, original equipment manufacturers (OEMs) are finding the frequency of on-time fulfillment of a customer order is decreasing.[Hewitt [2001]] We describe software that maps to business models and instantly communicates information and business intelligence among trading partners. Serus software improves collaboration enabling inventory reduction, improved customer fulfillment and therefore increased profit.

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1. INTRODUCTION

A value chain is the complete process of making and selling a product. We think of this as a network divided into two parts as illustrated in Fig. 1. The first part, called the supply chain, is the process from raw materials to completion of manufacturing. The second part, that we call the demand chain, is the process from finished goods (completion of manufacturing) to sales. Some people refer to demand chain management as reverse logistics.

We consider an original equipment manufacturer (OEM) to be the business entity responsible for the design and sale of commodity products. Serus software was sold to Quantum, a disk drive maker selling to computer manufacturers, and VINA, a telecom equipment company selling to the end consumer. Serus software applies to both scenarios and thus we consider both to be OEMs.

Historically all manufacturing, sales and distribution was performed from a single location or region and was wholly owned by the OEM. Figure 1 also illustrates the current state of manufacturing. Expanding markets and cost pressures have resulted in today's OEMs having global demand and supply chains.[Hewitt [2001], Economist [2002], Cargille et al. [2001], Elliott [2002] ,Conlon [2000]] For the same reasons OEMs have also entered into manufacturing, sales and distribution agreements with partner companies.[Taylor [2001]] Competitive pressure requires OEMs to offer more products and customizable products.[Hewitt [2001], Cargille et al. [2001], Elliott [2002], Budhwani [2001], Shah [2001], Reeve [2002]] The net result is that to solve these new problems the OEMs carry more inventory thus generating profit-robbing inventory carrying costs.[a, Reeve [2002], Hewitt [2001], Cargille et al. [2001], Shah [2001], Oliver [2002]] In addition, despite higher inventory levels, OEMs find that on-time fulfillment of customer orders has decreased.[Hewitt [2001]] This unreliability causes an OEM's customers to defect to other OEMs[Graff [2002]] thus robbing an OEM of potential revenue, that is, lost opportunity costs.

Recognizing these influences, Serus software maps to business models and

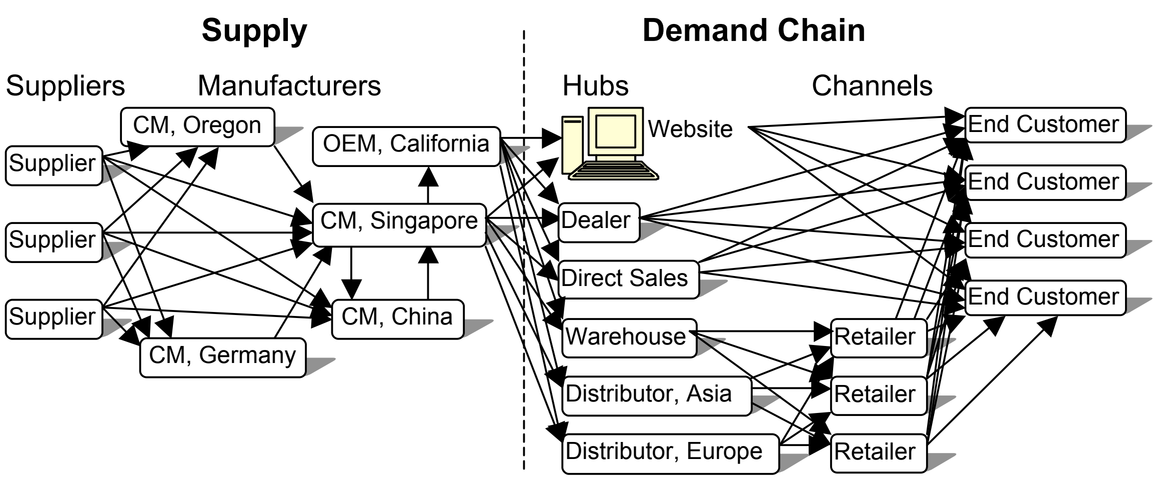

Figure 1 – Simplified illustration showing the complexity of the value chain comprised of the supply and demand chain.

communicates business information from the disparate, globally distributed partners virtually instantaneously and transparently. This enables OEMs to manage their manufacturing, sales and distribution as if it were under one roof.[Arntzen et al. [2002]] We enable inventory reduction by increasing the velocity of a product through the value chain, and managing stock levels more tightly, reliably, frequently and automatically.[Reeve [2002], Hewitt [2001], Oliver [2002], Arntzen et al. [2002]] Since inventory is more closely tuned to demand, we have also observed improvements in customer response.

2. SUPPLY CHAIN ISSUES

With some exceptions, contract manufacturers (CMs) produce goods at a lower cost than captive manufacturers. This is due to locating in cost advantageous locations and supplying to several OEMs thus enjoying the benefits of economy of scale.[b,Conlon [2000]] However movement of goods across organizational and political boundaries has increased the time required to produce a product (cycle time) and thus, to fill the supply chain, requires larger inventory. Even captive manufacturers must employ some of these cost cutting measures that increase inventory. These inventory-carrying costs have cut into the expected benefits.[Reeve [2002], Hewitt [2001]]

On the surface, it appears that just-in-time (JIT) inventory management solves this problem.[Hewitt [2001], Shah [2001]] When an order is placed they build-to-order (BTO),[Arntzen et al. [2002]] that is, initiate manufacture after receipt of order. Suppliers then must rapidly deliver the parts required. While the OEM minimizes its inventory, the costs are pushed to the supplier who must pass along these costs to the OEM in the form of higher prices. The OEM has only transferred and hidden the problem.[Hewitt [2001]] What is needed is a way for the OEM's suppliers to have some, even a few days, forewarning about what is needed.[Hewitt [2001], Economist [2002], Taylor [2001], Oliver [2002], Arntzen et al. [2002]] They would not need to know who the OEM's customers are, etc. If, however, they had real-time information regarding how many parts the OEM has committed to sell they could manage their inventory levels much closer to expected demand. This is part of the function of collaboration software. It enables an OEM's suppliers to manage inventory levels much more precisely and reduce costs that can result in lower prices for the OEM. Both parties win as examples show.[Shah [2001], Oliver [2002], Arntzen et al. [2002]]

The second issue to face OEMs is the increasing number of product models and customization required. One strategy employed is to make parts that become the final product as common as possible, i.e., the parts can be used in many different product models or product configurations. For example, HP converted its PC power supplies from many parts (110, 220 VAC and variations) to one (a configurable power supply), changed to a generic printer and localizes at the distribution center.[Hewitt [2001], Cargille et al. [2001], Elliott [2002]]

A hypothetical example is if 200,000 units per week of either part A and B are required, the mix of A and B is 50% each and 10,000 of each type are needed for contingency

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[a] Inventory carrying cost is the cost per week of maintaining inventory prior to a sale. It is typically 35% to 100% of the price of a unit per year. A typical example is a $100M company holding inventory 6 weeks at a cost rate of 52% per year. The carrying cost is $6M. Typically inventory-carrying costs are due to product obsolescence (write-offs), price erosion, lost sales and lost opportunities. The cost of money (lending rate) and warehousing costs are usually much less.[Reeve [2002], Hewitt [2001], Shah [2001], Oliver [2002]]

[b] Economy of scale is the reduced cost of manufacture per unit by increasing the number of units produced.

(safety stock). At first glance converting to one part would still require 220,000 units. The fact is that 6,000 fewer are required. The reason is that the probability that the safety stock of BOTH A and B is consumed is much smaller than either one individually. This influence is known as risk pooling.[Cargille et al. [2001], Billington [2002]] HP reported reducing inventory from 7 to 5 weeks of inventory and a $72 million savings.[www.hp.com]

Another strategy is to delay configuration until the last possible moment in a manufacturing process. It is referred to as postponement[Hewitt [2001], Cargille et al. [2001], Elliott [2002]] and we refer to this point in the process as the *decouple point*. It is the point where product variability is introduced. Prior to the decouple point OEMs can use risk pooling to reduce inventory prior to or staged at the decouple point.

However, to benefit from risk pooling requires implementation during design. Collaboration enabling software assists in this process by measuring and reporting the financial impact of design decisions. Thus by exposing the net financial impact of a decision the communication between the engineering, finance, operations, purchasing or other groups improves resulting in better decisions. This illustrates that collaboration software improves communication within an organization as well as outside.[Hewitt [2001], Cargille et al. [2001]]

3. DEMAND CHAIN ISSUES

Similar changes influence the demand chain. Global distribution has required more hubs. The increased number of product models and customization also influences the demand chain. The number of ways a product can be sold has increased. Products can now be sold through web sites, outsourced sales (dealers) and their web sites, outsourced distributors, etc. All of these influences tend to increase inventory required. Simultaneously, the right product is often not in the right place at the right time to fulfill a customer's order.[Hewitt [2001]] Thus, despite higher inventory levels, it is increasingly difficult to fulfill orders.

The demand chain is also impacted by price protection, and other agreements resembling consignment.[Taylor [2001]] In these agreements an OEM does not realize the income from a sale until *their customer* sells the product. Thus financial exposure of the OEM increases.

4. SOLUTION REQUIREMENTS

The previous sections discuss the enormous financial benefit of a responsive, yet lean, value chain. A solution should accomplish responsive, lean value chains by:

- Inventory reduction through increased velocity, improved communication and automated replenishment.
- Increase ability to meet customer requests thus increasing revenue and market share by instant access to availability information.

Ideally, the software solution will also improve productivity and require fewer staff hours, resulting in better and faster information. This approach will leverage the expertise of decision makers since their time is freed from repetitive, data processing tasks.

We believe the software should be installed on a web server at the OEM and provide all trading partners (CMs, suppliers, hubs, warehouses, dealers, retailers, etc.) access. The features of such software should include:

- Simple, friendly, easy-to-use user interface, i.e., a web site interface.[www.w3c.org [1998]]

- Trading partners only need an Internet connection and web browser. An OEM installs our software, but trading partners use it without cost or new software.
- A security system to prevent trading partners from getting information about another trading partner.
- Data is gathered from disparate sources including ERP systems and, the most common form of business data communication, Excel files.
- Business intelligence software transforms this data into meaningful business information.
- Some processes can be completely automated. For example, we have an algorithm to automatically replenish stock and learn the appropriate stock target levels.
- Our software has a user interface enabling users to create their own calculations, make decisions (if-then statements) and write SQL scripts.
- An alerting engine to send an email or pager message to responsible parties on a time schedule. The responsible party can then correct situations by ordering more parts, assigning engineers to fix a cycle-time problem, etc.

5. ARCHITECTURE

Serus has developed a collaboration system that satisfies requirements in the previous section. Serus has implemented this system using 100% Java/JSP/EJB running on an n-tier web server, implementing model-view-controller architecture,[java.sun.com [2002]] and connected to an relational (SQL) database. The data access objects interface with the database and send XML documents to the presentation layer. This flexible and modular architecture enables us to rapidly implement new business functions and business intelligence including customer requested modifications. Our previous deployments average 8 weeks.

Figure 2 shows the architecture and implementation of our system. We prefer to install the system at the OEM site on a JSP enabled web server in their IT network. We have deployed the software on Linux and NT.

Since our data access layer is separated from presentation and we use XML, we have the ability to rapidly customize code to exchange XML documents, interface to other business system's APIs, interface to databases or read Excel files. Our current modules are:

MODULES WITH SUPPLY AND DEMAND CHAIN APPLICABILITY

- Financial Exposure Management – Gathers key data from many business systems, both internal and external, and shows exact, up-to-date demand and supply side inventory value.
- Value Chain Planning – Plans and schedules manufacturing to a combination of predetermined, forecasted, or algorithmically determined (based on history) levels thus keeping inventory at a minimum required to meet demand.
- Simulation and Modeling – Predicts, compares and contrasts potential interventions in the value chain.
- Portal – Enables suppliers and customers to collaborate with OEM.
- Custom Columns and Calculations – Excel like flexibility to customize environment including calculations, decisions (if-then) and embedded SQL statements.
- Alerting and Exception Automation – User defined event or time based customized alerts based on business data with escalation hierarchy.

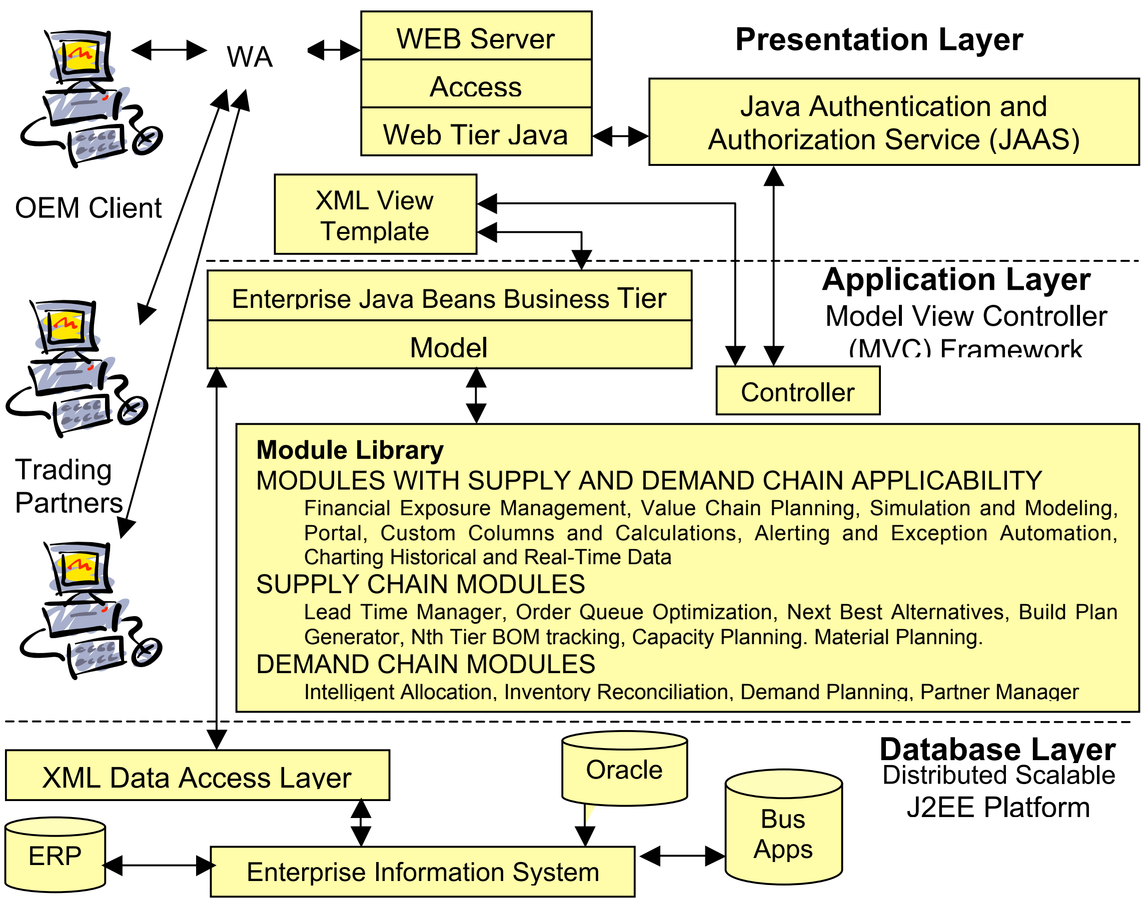

Figure 2 – Software architecture of Serus enterprise application software.

- Charting Historical and Real-Time Data – Customized visualizations of information enabling a user to "see" information that may be hidden in rows of numbers.

SUPPLY CHAIN MODULES

- Lead Time Manager – Analyzes parts inventory to determine what and when a product can be built enabling accurate and optimal response to customers.
- Order Queue Optimization – Assessing the total financial impact on a business of prioritizing a particular customer accounting for order value, lifetime value and impact on other customers.
- Next Best Alternatives / Best Cost Substitutions – Real-time ability to evaluate if a substitution can profitably satisfy a customer's request if unable to meet the quantity or time frame of a customer's original request.
- Build Plan Generator – Combines historical and forecasted, including product mix, to create a build plan at all level of a multi-level bill-of-materials (BOM).
- Nth Tier BOM tracking – Tracks inventory at a high level, the most granular level or any level in between of a multi-level BOM.
- Capacity Planning – Analyzes capacity and cycle time in a complex multi-path and product dependent parameter scenario.
- Material Planning – Forecasts probability of parts at higher levels of BOM and predicts expected demand at all lower levels of BOM given high level demand.

DEMAND CHAIN MODULES

- Intelligent Allocation – Determination and reward of the most profitable channels to move product.
- Inventory Reconciliation – Identifies and reconciles inventory discrepancies between trading partners.
- Demand Planning – Central repository, consolidation, analysis and distribution of forecasts from business systems, marketing and sales.
- Partner Manager – Aggregates and monitors contract driven relationships with trading partners.

6. TELECOM INDUSTRY SUPPLY CHAIN SOLUTION CASE STUDY

VINA Technologies designs and sells highly configurable broadband telecommunications equipment to companies such as Lucent, AOL TimeWarner, and WorldCom. VINA contracts with CMs who drop-ship finished goods directly to the end customer. VINA was seeking a way to have visibility and identify the financial liability in their manufacturing network, the revenue potential from their customer base and speeding the velocity of product through their value chain. Within six weeks Serus deployed our repertoire of supply side solutions. VINA executives and operations staff now had the ability to instantly aggregate data from disparate sources and view inventory information. The VINA team began to see tangible return-on-investment (ROI) benefits during the first week of "go live" use and tune inventory much closer to customer demand. After the first quarter of full deployment, Serus' software resulted in:

- Over 20% reduction in inventory exposure at the CM. This reduction includes enabling the complete elimination of safety stocks loaded in the manufacturing plan.
- 90% reduction in time requirements for aggregation and analysis of the quarter's shipments and planning ratios.
- Faster response to customer orders.

- Faster response to a soft market enabled VINA to quickly adjust the manufacturing plan and minimize financial risk.
- Improved team productivity.
- Improved leverage of human expertise.

Diane Pewitt, executive vice president of operation for VINA Technologies, said, “The Serus software has been a valuable solution that helped us improve our materials management and inventory portfolio to consistently and more effectively meet out customers demands for world class services. Serus delivered us the most advanced functionality that we have not seen in any other products, and allows *our* team to more intelligently manage our product manufacturing.”

Chris Vincent, manager of materials management, said, “The Serus software combined data from our sales, manufacturing and finance departments into a single system to allow me to more accurately forecast business rather than re-entering data from the past. Unlike other applications that forced me to adapt to the way that they programmed the system, Serus gave me the flexibility to quickly and easily change the way I view the data to fit my preferences and set the modular rules to my specific needs.”

7. DISK DRIVE INDUSTRY DEMAND CHAIN SOLUTION CASE STUDY

Quantum Corporation chose Serus’ demand side solutions to improve collaboration with their channel partners and reduce financial exposure caused by price erosion. Quantum sought a way to improve customer satisfaction by improving availability of product, but at the same time wanted the ability to react quickly as market conditions changed based on real-time demand. “The Serus application allowed us to implement inventory-reducing initiatives through a web-based application that was easy for our trading partners to use,” said Mike Wais, Director, eSupply Chain group. In less than six weeks, Serus Corporation deployed its demand fulfillment solution, providing the following capabilities:

- Intelligent Replenishment
- Demand Based SKU Allocation
- Mitigating the effects of price protection
- Monitoring and Alerts
- Historical Data Capture, Charting and Reporting

Similar to the VINA case, Quantum staff now had the ability to instantly aggregate information from disparate source and view their inventory position in the reseller network. This enabled Quantum to better manage their business, reduce inventory and react very quickly to changes in demand.

Quantum also found that Serus’ software improved their working relationships with their trading partners. “The tool Serus built for us created a level of visibility for our trading partners that they had never had before. Serus is very slick with a user friendly look and feel and we can now automatically execute on key decisions, which saves us time,” said Mike Wais

8. SEMICONDUCTOR INDUSTRY SUPPLY CHAIN SOLUTION CASE STUDY

Wafer manufacturing from starting silicon to finished wafers requires a long time and is done in a build-to-forecast mode. Many semiconductor manufacturers will inventory finished die in a “die bank” consisting of wafers containing die (or chips). To customize, they decide which package the die is assembled into. They also have the option of “down binning,” i.e., a higher quality part is substituted in an order for a lower quality parts. Semiconductor manufacturers desire the scenario where the mix of high quality parts exceeds the demand since they can always be sold. The inverse scenario, where they produce an excess of low quality parts results in lost sales opportunities or excess inventory of low quality parts that they are unable to sell. Inappropriate “down binning” may also result in a shortage of high quality parts, which Serus’ business intelligence algorithms prevent.

Typically the wafers in die bank have been tested and thus can be assigned properties, such as probable yield, bin distribution, and test times, from which the probable output can be predicted. Theoretically the demand can be input and the die bank wafers to be assembled determined, however the data processing to accomplish this determination is usually beyond the capability of most semiconductor manufacturers.

Serus has developed an algorithm to “cherry pick” wafers in order to most precisely match demand to product in die bank inventory. The problem is a variation of the knapsack problem which is NP-complete.[Baase [1988]] While we started with a standard algorithm, business problems are rarely amenable to solution by a standard algorithm. However a standard algorithm, suitably modified, often solves the problem.

Serus began by defining a “profit” equal to yield/residuals (residual is the difference between required and predicted quantity). The algorithm picks wafers with the largest quantity (yield) of die (chips) that meet demand requirements. While residuals might be sold, since there is no demand the algorithm tends to minimize residuals. This profit metric thus quantifies best fit to demand.

A greedy knapsack algorithm is run once. The profit metric can result in an excess of residuals. This illustrates the need, as asserted previously, to modify standard algorithms to meet business requirements. We take the list generated and use the knapsack algorithm again to minimize residuals. We privately showed this module to a top 10 semiconductor company and the feedback was enthusiastic.

Convinced of Serus’ capability, ISSI, a $500 million fabless semiconductor company, chose the Serus solution and it is currently in implementation. Within the highly competitive semiconductor industry, ISSI searched for a way to respond faster to sales opportunities while balancing long manufacturing lead times and minimize overall financial exposure. Serus software answered their need for a state of the art system that could be rapidly deployed and work with technologies already in place. Analysis and decisions that used to take days will now execute within minutes.

9. FUTURE

We have built web server software that solves business problems in supply and demand chains. We analyze market requirements for collaboration and business intelligence software and improve and add modules to our software solution to meet these requirements. While this broadens the applicability of Serus software, we balance this with strategic planning to deepen to applicability to selected vertical markets. These markets have included commodity high-tech component suppliers, electronic product manufacturers selling to end customers and the semiconductor industry.

We do not have a magic algorithm intended to work for all needs. Instead when evaluating requirement we review existing public domain and internally developed algorithms and artificial intelligence and determine if, with suitable modification, they can be used to fulfill the requirement. We continue to improve existing modules and add new modules this way. We also believe in offering the user choices and overrides to leverage the abilities of human experts. For example, in intelligent replenishment we offer the user a sliding scale that implements a weighted average between a forecasting algorithm and a short-term historical demand algorithm. In this way the human users always control the business decisions with computing assistance and faster data processing.

10. CONCLUSION

The financial rewards of a lean, yet responsive, value chain and customer fulfillment are enormous, yet elusive.[Reeve [2002],Hewitt [2001],Cargille et al. [2001],Elliott [2002],Budhwani [2001],Shah [2001],Oliver [2002],Arntzen et al. [2002],www.hp.com] In this article, we have shown our software serves as a collaboration enabler to squeeze excess inventory out of the value chain and improve the ability to satisfy customer orders.

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