CUSTOMER FOCUSED SUPPLY MANAGEMENT

by

Galya Racine

B.Sc., Industrial Engineering, Tel Aviv University, 1997

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Signature of Author_____
Sloan School of Management
Department of Civil and Environmental Engineering

Certified by_____
Professor Charles H. Fine, Thesis Advisor
Sloan School of Management

Certified by_____
Professor David Simchi-Levi, Thesis Advisor
Department of Civil and Environmental Engineering

Accepted by_____
Oral Buyukozturk, Chairman, Departmental Committee on Graduate Studies
Department of Civil and Environmental Engineering

Accepted by_____
Margaret C. Andrews, Executive Director of Masters Program
Sloan School of Management

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ABSTRACT

Much thought and resources have been invested in identifying how companies can create and capture value for their customers. Results are presented in literature and industry in various forms and approaches from organizational structures through business processes to information systems methodologies. However, the contribution of operational tasks and supply chain design to this effort has been somewhat neglected. One possible reason for this is that any such contribution is mostly indirect and difficult to quantify. Yet, with trends of globalization, enhanced customer expectations and increasing need for agility, the role of Supply Chain in customer satisfaction is becoming more and more important.

This research attempts to answer the question of how to align a company's supply chain around customers. A framework, Customer Focused Supply Management (CFSM), is introduced, by means of a seven-step implementation guideline. CFSM is a cultural way of thinking and a way for managing processes that any company in a competitive market, and especially in a fast clockspeed industry, should adopt in order to transform its supply chain to a core competence. The method is implemented mainly through managers' awareness of their impact on customers and around inter- and intra-organizational two-way communication flow.

The concept is illustrated through examples learned during a six-month internship at Nortel Networks, in the Intelligent Internet group. As part of the internship, improvement opportunities specifically relevant to Nortel are presented. Process documentation and analysis include demand forecasting, customer satisfaction survey and end-of-life management.

Thesis Advisors:
Charles H. Fine,
Chrysler Leaders For Manufacturing Professor

David Simchi-Levi,
Professor of Civil and Environmental Engineering

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To that extent, I would like to acknowledge Nortel Networks for hosting my internship, especially during these difficult times. Specifically, I would like to thank Jeff Townley and Justin O'Connor, my company supervisors, for their guidance and support throughout the internship. Their commitment to the internship under difficult conditions demonstrated true ethical leadership, which I will never forget.

Next, I wish to thank my thesis advisors, Professor Charlie Fine and Professor David Simchi-Levi. If it were not for that little extra push towards the end, much of this thesis would have stayed in my head. Thank you for helping me make this a more meaningful thesis.

For my husband, Dan – thank you for being there. The support I received from you is more than I could explain in words in this context.

Finally, I wish to dedicate this thesis to the memory of my father, Daniel Racine, who in just eighteen years gave me more than I could ask for in a lifetime.

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I. Introduction

1. Project Setting

This thesis was written based on a six-month Leaders For Manufacturing (LFM) internship at Nortel Networks, that took place from June 2001 to December 2001. The timing of this project is especially important for the understanding of the described processes, due to the economic downturn in this period.

The focus of this thesis is a new concept or way of thinking about Supply Chain Management as described in the abstract. The initial goal of the internship was to further develop this concept and implement portions of Customer Focused Supply Management (CFSM). However, the timing was not right for the company. The stock reached an all time low (from above $80 in late July 2000 to single digits in one year) and the work force was reduced from close to 100,000 employees to 48,000 employees. As a result, the changes the organization went through were immense and all resources were directed to matters of survival. Unfortunately, yet understandably, CFSM was not one of them.

Therefore, this thesis describes the concept in general, and a few relevant processes at Nortel. Then, these processes are critiqued, and generalization of the gaps Nortel needs to overcome in order to become more CFSM are summarized. Naturally, throughout the thesis, examples are disguised due to company confidentiality concerns.

2. Company Background[1]

Nortel Networks has been in the telecommunication industry from its very beginning. The company's roots go back to Alexander Graham Bell, and the very first telephone in 1874. Since that time, the company has grown from a small manufacturer of telephone equipment into a global Internet and communications powerhouse. In 2001,

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[1] Based on company web site www.nortelnetworks.com

Nortel Networks ascended to the No. 1 position in global telecommunications equipment, showing year-over-year growth of 41.6 percent, according to Gartner Dataquest. The company that leapfrogged into global leadership is now in its fourth incarnation.

As Northern Electric and Manufacturing Company Limited, the name under which it was incorporated in 1895, the company made telephones, wind-up gramophones, and street call boxes for police and fire departments.

As Northern Telecom Limited, the title it assumed in 1976, the company shook the telecommunications world by boldly declaring it would bet its future on digital technology, and then was first to produce a full line of digital communications equipment that set new standards for the industry.

As Nortel, the streamlined identity it adopted for its 100-year anniversary in 1995, the company set out to dominate the burgeoning global market for public and private networks for communication, information, education, and commerce.

As Nortel Networks, the name that evolved after the 1998 acquisition of Bay Networks, the company reengineered itself into an Internet powerhouse, offering complete solutions for multiprotocol, multiservice, global networking.

3. Intelligent Internet Group and Value Chain

a. Global Operations

Nortel's global organization, being as large and as complex as one would expect it to be with dozens of thousands of employees is aligned around many dimensions, including product portfolio, functions and customer segments. The hierarchy of organization is first by function and then, the front-end is mainly aligned by customer segments while the back-end is typically aligned by product portfolio. Front-end being the organization directly interfacing with customers, back-end being the core and support systems of the organization that do not directly interact with customers.

The pre-restructuring operations organization had mainly two groups with hundreds of employees in each group and two Vice Presidents leading them. The first was Global Operations and the second was Supply Management. The Operations group was traditionally composed of System Houses and was responsible for manufacturing, operations and logistics. The second group, Supply Management, was responsible for supply chain design, supplier relationships, and commodity management.

Systems Houses were the cornerstones of Nortel's manufacturing strategy. They focused on systems integration, test, delivery, new product introduction, and product cost. They linked customers, design houses, other Nortel regional manufacturing sites, component houses, and CMs (contract manufacturers) and OEMs (original equipment manufacturers). The company had seven System Houses in US (Boston, Raleigh, North Carolina), Canada (Calgary, Montreal, Quebec), Europe (France, Ireland, Northern Ireland), China and Brazil.

As mentioned above (on page 8), during the internship period and the year preceding it, the company had gone through major changes and restructuring. For detailed financial information see Appendix 1: Nortel's Recent Income Statements. One of the major changes in the company's strategy was related to its manufacturing strategy. Nortel decided to shift to an outsourced model, selling most of its manufacturing facilities to its contract manufacturers. As a result, the System House structure was abandoned and the two major operations groups (Supply Management and Operations) merged into one.

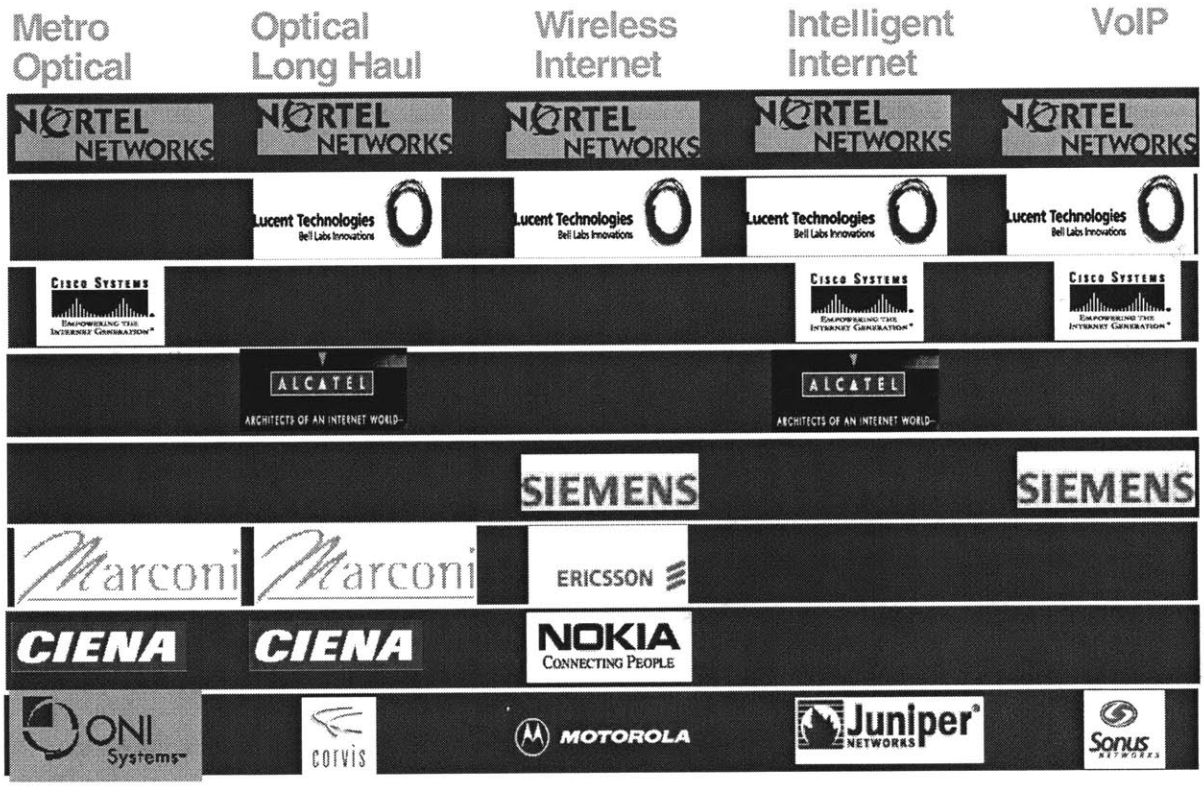
b. Intelligent Internet

(1) Product Portfolios

Due to the many changes briefly described above, the internship sponsoring group, supervisor and scope changed several times throughout the course of the internship. Nevertheless, the sampled products and processes were always related to the Intelligent Internet product portfolio. Initially, the organization was aligned around five portfolios (see Figure 1: Product Portfolios and Main Competitors): Metro Optical, Optical Long Haul, Wireless Internet, Intelligent Internet and VoIP (Voice over IP).

The Intelligent Internet portfolio includes: Alteon web switches and software for application and content delivery; Shasta 5000 Broadband Service Node for IP-based service delivery; Passport products for IP, ATM, or MPLS infrastructures; BayStack products for Ethernet solutions on IP infrastructures; and Contivity VPN services for routing, firewall, bandwidth management, encryption, authentication, and data integrity for secure tunneling across managed IP networks.

Figure 1: Product Portfolios and Main Competitors



Source: Nortel's marketing materials

(2) Intelligent Internet Customers

Nortel's Intelligent Internet solutions help customers maximize their profit from the high-performance Internet through a range of advanced IP, optical, and content management solutions that add a new layer of intelligence and content awareness to the network - expanding customers' ability to generate new revenues through personalized, value-added services delivered at lower costs with high performance.

Nortel's Intelligent Internet strategy consist three key layers - infrastructure, service, and content, and includes best-in-class solutions like the Passport for Multiservice Switching and Optical Ethernet. Intelligent Internet customers face increased competition and are looking to differentiate themselves through added- value services while maintaining low costs/prices.

The Intelligent Internet end customers include Service Providers, Carriers, and Enterprises and their expectations are for: a reliable, scalable performance for optimized service delivery; security that goes beyond firewalls; agility to turn up services and applications on demand; and efficiency to reduce costs and make the most of resources.

The Intelligent Internet allows Service Providers and Carriers to offer differentiated services, provide end-to-end security, respond to market changes, migrate enterprise functionality onto the network, and leverage existing investments. Intelligent Internet offering is built on optical networking that enables solutions such as Data Services, Managed Hosting Services, Content Delivery Networks, Packet Delivery and 3G Wireless, Virtual Private Ethernet Services, and Virtual Private Networks.

The Enterprise can use the Intelligent Internet to access more, better, cheaper bandwidth, secure the network, ensure network performance and services, use the Internet as a strategic tool, and reduce operating costs. The solutions deliver business applications like High Availability Intranet / Extranet, Web Optimization, Secure Connectivity, Ethernet LAN/MAN, and Network Consolidation.

(3) Intelligent Internet's New Place in the Organization

Toward the end of the internship period the company reorganized the portfolio definitions and realigned itself around three main network layers:

1. Optical Long Haul Networks – incorporate next-generation long haul line systems, optical switches, and intelligence throughout the network - making the networks smarter, faster and more reliable. These solutions drive down networking costs by providing low cost per connected bit, allowing for lower total network management costs.
2. Wireless Networks – bring the high-performance Internet to mobile users throughout the world, delivering the information and services they need.
3. Metro & Enterprise Networks – includes:
    - Metro Optical – solutions to eliminate the congested and complex metropolitan networking bottleneck, redefining the performance and economics for enterprise networking while enabling new and profitable services for carriers.
    - Intelligent Internet – a set of innovative technology capabilities that powers networks and the Internet to operate with an exceptional level of security, performance, agility, and efficiency.
    - VoIP – is Voice over IP. The products increase the profit potential of the Internet, enabling carriers and enterprises to expand communications with new services and applications, drive cost savings through simplification, and speed time to profitability.

(4) Intelligent Internet Business

Following is a slide from a company's public presentation illustrating Nortel's leadership in the industry. Furthermore, below is a chart of predicted future growth of internet traffic, indicating a promising future for the industry.

Figure 2: Nortel's Leadership in Intelligent Internet (II)

- **Nortel gained largest market share and is**
  - #1 Global ATM Core Switch for 1Q01 Nortel (Infonetics)
  - #1 Overall ATM WAN Switch for 1Q01 (SRG 01)
- **Shasta #1 Market Share for IP Services**
- **Alteon #1 Market Share for Gigabit Ethernet Web Switching**
- **Passport 8600 continues to take market share**
- **Contivity #1 Market Share for Carrier Managed VPNs**

Intelligent Internet Presence

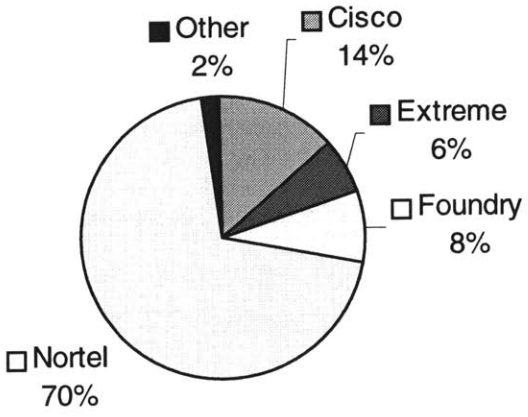
II products are present in every industry-leading Service Provider networks

Passport

750+ Customers

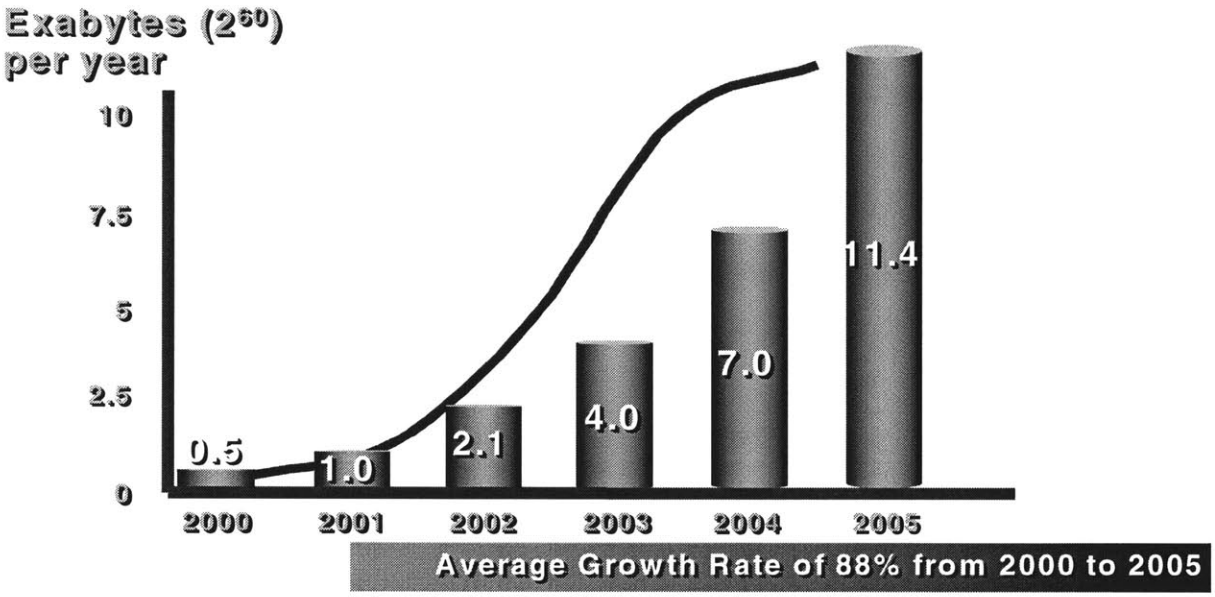
32,000+ Systems deployed

Gigabit Ethernet Web Switching
Year 2000



Source: Nortel's marketing materials

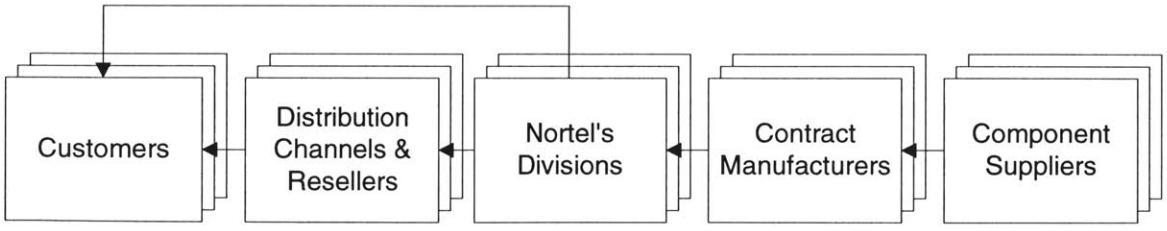
Figure 3: IP Traffic Growth



Source: McKinsey & Company and JPMorgan IP!, May 2001

(5) Intelligent Internet Value Chain

Figure 4: Intelligent Internet Value Chain Map



Customers

Service Providers, Carriers, and Enterprises are the three customer segments Nortel is targeting for its Intelligent Internet products. For additional information see I.3.b(2)Intelligent Internet Customers.

Distribution Channels

Partners and distribution channels help Nortel to effectively sell to small and medium size customers (about 40% of Intelligent Internet sales are indirect sales). Examples of big distribution channels include Ingram Micro, Tech Data, Westcon and Gates/Arrow.

Contract Manufacturers

There are two main types of contract manufacturers that Nortel outsource to, electromechanical and circuit packs manufacturers. Examples of electromechanical manufacturers are CMAC and Sanmina. Examples of circuit packs manufacturers include Solectron, SCI, Celestica and Jabil. Until very recently, Nortel was responsible for the final assembly and integration of electromechanics with the circuit packs. However, the value is changing as Nortel and its competitors are shifting away from the vertical integration model. Currently, the final assembly is also outsourced and the two types of contract manufacturers are merging (e.g. SCI – Sanmina merger). Needless to say this creates tension in some of the products' supply chain where SCI is asked to work with CMAC, now its competitor.

Component Suppliers

There are many components that go into Intelligent Internet products and the supply chain includes a multi-tier supplier chain. Most of the component may be perceived as commodities, but the parts that are key to the product from a strategic and a manufacturing perspectives are software and ASICs. Networking software is tied specifically to the hardware "guts" of a router. That is, the software runs on specific processors made for those systems, whether it is a general-purpose chip or one that is specifically tailored, called ASIC (Application Specific Integrated Circuit). Currently the

software is kept in house, and the main ASIC suppliers include Intel, IBM, TI, Fujitsu and Toshiba. It is important to note some of Nortel's competitors kept ASIC manufacturing in house as well (Lucent).

4. Glossary

Table 1: List of Acronyms and Glossary

Acronym/ Term	Description	
ASIC	Application Specific Integrated Circuit	Circuit chips that are used to assist in the routing process and have architecture that can handle millions of packets per second. These circuits are customized per product/ application.
ATM	Asynchronous Transfer Mode	ATM is a packet-switching technology in which information is organized into cells. It was developed in mid-1980s for eventual use as a carrier backbone technology capable of integrating multiple types of traffic, including voice, video, and data.
ATP	Available to Promise	A date at which the company can commit to fulfill an order considering inventory levels, lead times and other orders.
Back-end		The core and support systems of the organization that do not directly interact with customers (e.g. operations, manufacturing, packaging).

Acronym/ Term	Description	
BSH	Boston System House	Systems Houses were the cornerstones of Nortel's manufacturing strategy. They focused on systems integration, test, delivery, new product introduction, and product cost. They linked customers, design houses, other Nortel regional manufacturing sites, component houses, and CMs and OEMs. BSH was one of seven System Houses in US, Canada, Europe, China and Brazil.
Bullwhip Effect		The bullwhip effect occurs when the demand order variabilities in the supply chain are amplified as they moved up the supply chain. Distorted information from one end of a supply chain to the other can lead to tremendous inefficiencies.
CFSM		Customer Focused Supply Management
Clockspeed		The rate of changes/ evolution in an industry
CM		Contract Manufacturer
Consumption Chain		Customers' entire experience with a product or a service
DOA	Dead on Arrival	When a customer receives a defected product that they can not operate.
End of Service		A product status after 5 years from Last Ship Date where no service or best effort is available.
EOL	End of Life	Is a phase of a product in the product life cycle, where the product is being phased out and discontinued.

Acronym/ Term	Description	
Front-end		The organization directly interfacing with customers driving sales and providing service (facing the customers - e.g. sales, marketing, service and support)
In-flow		Information coming from the customers and the front-end of the organization flowing to the back-end.
IP		Internet Protocol
Last Order Date		A product status after which no external orders will be accepted or processed by Order Administration. This date is set as the Discontinued date plus 120 days unless overridden by the Product Manager.
Last Ship Date		A product status after which all externally ordered products must be shipped by. This date is set as the Last Order Date plus 6 months unless overridden by the Product Manager.
LTB	Last Time Buy	The last order of a product that is being discontinued.
MPLS	Multi Protocol Label Switching	An IETF initiative that integrates Layer 2 information about network links (bandwidth, latency, utilization) into Layer 3 (IP) within a particular autonomous system in order to simplify and improve IP -packet exchange. MPLS gives network operators a great deal of flexibility to divert and route traffic around link failures, congestion, and bottlenecks.
MPS		Master Production Schedule

Acronym/ Term	Description	
NPI	New Product Introduction	Is the very first phase of a product in the product life cycle, during which a new product is introduced to the market.
OSP		Order Sales & Production Planning. A high-level dollar forecast.
Out-flow		Information originating at suppliers and the back-end of the organization flowing to the front-end and to customers.
PLM / PM		Product Line Manager / Product Manager
SKU	Stock Keeping Unit	A number associated with a product for inventory purposes. There is a one to one relationship between products and SKUs (each SKU is unique).
SUCCESS		A quantitative target defined by Nortel's senior management that sets the basis for employee bonuses.
Supply Chain		The process in which a product is manufactured and distributed.
Sustaining		A mature phase of a product in the product life cycle.
Value Chain		The entire supply chain from the smallest component supplier to the end customer.
VoIP	Voice over Internet Protocol	Internet telephony uses VoIP technology over internet or intranet to carry voice calls, bypassing the public switched telephone network.

II. Customer Focused Supply Management

1. The need for Customer Focused Supply Management

a. Acknowledgment of 'Customer Focus' Importance Over Time

In the 90's it became apparent to companies and business analysts that customers and customer relationship management are key for any company's success. But, the question of how to listen to your customers and to what extent you should satisfy their wishes is still under debate, and, in many cases, the answers are still unclear. Nevertheless, we have come a long way since the late 20's, when Henry Ford, CEO of Ford Corporation and forefather of manufacturing strategy, said "to hell with the customer," offering Ford customers "Model T" cars in any color – as long as it's black. He refused to diversify until the Model A in '27, and by then GM had gained considerable market share.

There is no doubt that with globalization and thus increased supply chain complexity combined with intensified competition and thus higher customer expectations, supply chain's role in strategic management and company's positioning is becoming key. There have been many approaches and buzz words thrown around in recent years trying to predict the next evolution of supply chain from collaboration through virtual integration to mass customization.

However, each of these approaches looks at the supply chain from a somewhat narrow perspective. Virtual integration looks at the value chain from an information-systems point of view. Mass customization looks at the issue from a strictly marketing and manufacturing perspective. Furthermore, the question of balance remains valid. Who are our important customers? Do they really know what they want? To what extent can we impact their demand and needs? Scholars and managers alike have extensively considered the role of customers' needs and preferences in product design, sales and marketing and even company strategy. In these fields, the importance of listening to the

voice of the customer is relatively clear. But the question of how the company's supply chain, logistics and manufacturing managers should relate to customers' needs and preferences has not been sufficiently addressed.

Customer Focused Supply Management is a framework I developed to help companies answer some of these questions and generalize the steps needed to take in order to enhance its supply chain to the next generation. This framework can be used as a guideline in parallel to other methods or strategies adopted, whether it is mass customization, integrated manufacturing-services or other.

b. Why Customer Focused Supply Management?

The ultimate goal of most companies is to increase profits and shareholder equity. The ultimate goal of supply chain managers in that capacity is to match supply and demand. Customer Focused Supply Management can help achieve these goals by:

- Changing supply based on demand input. By getting supply managers closer to customers and helping them know and understand the true demand for their products, they can properly adjust supply levels.
- Changing demand based on supply (frequently referred to as 'demand shaping'). By educating sales and marketing to follow and care about supply levels, they can react in real time and affect demand through promotions (e.g. by changing lead-time commitments, price discounts, bundling).
- Identifying synergies between customer preferences and supply/fulfillment capabilities. We all know customers want everything, delivered yesterday, and for free. But understanding the importance of each attribute and the tradeoffs can help identify opportunity for improvements and prioritize back-end efforts.

  An example of this can be found in the recent revolution of the supply chain for video rentals. Prior to this change, the buying and replenishment processes were fine-tuned, but with the high price of each copy, Blockbuster, a retail

video rental chain, could not afford to stock the number of tapes needed to serve every customer on time, yet they could not increase the price to consumers. In 1998, Blockbuster solved the problem by changing the way it paid its suppliers. Instead of paying a high price up front, they paid a much lower price per copy in return for sharing rental fee profits with the studios. This changed Blockbuster's breakeven point per copy from 20 rentals to 6, allowing them to purchase more copies of any given release. As a result, both Blockbuster and the studios increased their profits.

Furthermore, a requirement for both the organization's front-end and its back-end to align around a common goal, strongly tied to customers, can result in improved internal communication, quality, customer satisfaction and balance between supply and demand and therefore decreased lead times, cost, variability, and bullwhip effect. In addition, identifying synergies between the front-end of the organization and its back-end may result in new ways to create value to the customers. Thus, in the next decade, especially when globalization or fast clockspeed industries are involved, supply chain optimization and such synergies may become a core competency and a competitive advantage.

In the past, companies have struggled to become global and develop tools to capture and analyze the customers' voice. With globalization, the importance of flexibility designed into the supply chain is magnified. At the same time, the increase in deployment of the Internet has in many cases increased competition and therefore customers' expectations. One of the reactions to these developments of the information age is 'mass customization'. Therefore, there are potential synergies between sales and marketing and supply chain design and fulfillment. A company that will leverage such synergies will in essence have a core competency and competitive advantage over its competitors.

2. How to Achieve CFSM

The following chapter describes a suggested framework to implementing CFSM, as well as key challenges faced by organizations in that respect. The different steps may be conducted in parallel and different methods may be used to achieve each step's goals. Finally, it is imperative that these steps are conducted and decisions are agreed upon in cross-functional teams with the support of senior management.

a. Define Your Customers

Although this may seem trivial, it is important to take the time to define "Who are your customers?". The next steps are aimed at realigning the organization and its value chain around your customers, as well as providing guidelines for future decisions. As such, this definition of your customers will set the stage for the rest of this process.

In identifying your customers, the following questions should be considered:

- Are distribution channels suppliers or customers?
- What are our customer segments?
- Who are our more important customers?
- Which of our existing customers would we be better off without?

b. Define Customers' Needs and Priorities

As much as 70% to 80% of a product's costs are effectively immutable after it leaves the designers' hands. To that extent, an approach called Cost Targeting (see HBR article by Cooper & Chew) was developed to better control product costs and profit margins. This approach attempts to align every cost element in product design and features with the perceived value of that element by customers. Before launching a product, senior managers determine its ideal selling price, establish the feasibility of meeting that price, and then control costs to ensure that price is met.

The concept of CFSM is similar, in the sense that it tries to design the company's supply chain based on customer needs and priorities. While Cost Targeting focuses on quality, functionality and price targets, CFSM deals with operations and fulfillment related targets. However, similar to Cost Targeting, major aspects of the supply chain design are determined during the product design phase, thus reemphasizing the importance of supply chain involvement in the design phase.

One of the challenges in implementing CFSM, and probably one of the reasons it has not yet been fully explored, is that the link between customer satisfaction and supply chain is indirect and difficult to quantify. It is easier to ask customers what they expect the product to do and design it accordingly, than to ask them how they expect the purchasing and usage of the product to be and design the supply chain accordingly. The 'Kano model of needs' differentiates between Delighters, Satisfiers and Must Haves/Dissatisfiers. Most of the supply chain needs are in the Dissatisfier category, meaning that their potential contribution to positive customer experience, when done well, is less than their potential negative impact when done poorly.

For example, an on-time delivery might pass unnoticed by the customer, in which case it has little contribution to the purchasing experience. However, a late delivery can belittle other factors and ruin the entire purchasing experience. To address this challenge of identifying customer needs that are beyond the traditional scope of functionality, an analysis of the consumption chain is recommended. "Discovering New Points of Differentiation" is an article describing a method for companies to learn more about customer needs for the sake of creative positioning and differentiation. Nevertheless, because this approach looks at the entire consumption chain it can be used to identify operations related needs as well.

The two main steps of this method are:

- Mapping the Consumption Chain – this includes answering questions such as: "How do customers find your offering?"; "How do customers make their final selections?"; "How do customers order and purchase your product?"; "How is your product or service delivered?"; "What happens when your product or

service is delivered?"; "How is your product installed?"; "What about returns or exchanges?"; and so on. When answering these questions, try to understand customers' needs, expectations and priorities (a benchmark against competitors could help establish expectations).

- Analyzing Your Customer's Experience – this step involves considering how a series of questions – what, where, who, when, and how – apply at each link in the consumption chain.

In addition, when surveying customers, additional issues concerning operations and information flow should be considered (for next steps). These issues vary from one company to another, but may typically include:

- Information customers need and/or want before ordering (e.g. product availability, promise dates).
- Information needed and captured during order entry.
- Customers' certainty and decisiveness at ordering point. This affects chances of later changes and therefore variability as well as sales representatives' capability to shape demand.
- Customers' expectations during the period between order and fulfillment (e.g. order tracking).
- As part of the consumption chain include aspects of shipment receipts, unpacking, and packaging material disposal.
- Potential differences between market segments.
- Interdependencies between products.
- Customers' certainty and decisiveness at ordering point. This affects chances of later changes and therefore variability as well as sales representatives' capability to shape demand.

- Customers' expectations during the period between order and fulfillment (e.g. order tracking).
- As part of the consumption chain include aspects of shipment receipts, unpacking, and packaging material disposal.
- Potential differences between market segments.
- Interdependencies between products.

c. Map the End-to-end Value Chain

In order to set a framework for systematically aligning the back-end and the front-end of the organization, the company's end-to-end value chain should be mapped. During this process, it may be useful to start thinking of how supply chain can contribute to customer experience and what some of the current demand-supply issues are. Similar to the previous step, where the consumption map may vary between customers and products, value chain structure may vary as well. It is up to the implementers to define the borders and scope of the project and level of detail required.

There are many approaches to mapping value chains. One is to break down the value chain by high level "activities" such as plan, buy, make, move, store, sell, service, then breaking it down further to an operational level of detail. Another approach is to have the first level of break down by companies and functions involved, such as component suppliers, contract manufacturers, integrators, distributors, service providers. A fellow student of mine documented developed and documented a seven-step methodology to map supply chain. For additional information, see thesis "Impact of Performance Measurement and Goal Setting on Supply Chain Responsiveness: an Experiment" by David H. Campos, MIT 2001.

d. Identify Synergies Between the Customers' Consumption Chain And the Company's Value Chain

Once the consumption chain and the value chain are mapped and understood, it is easier to methodically look for synergy opportunities on the strategic level as well as improvement opportunities on the tactical and operational levels. To do so, review both chains in a cross-functional team and brainstorm to identify all the direct and indirect touch points between the two.

Identified strategic synergies usually require major changes in the business model or redesigning of the supply chain, but may result in high returns and new strategic core competence. It can vary from changing market positioning to reflect company's supply chain strength that is valued by customers to redefining the push-pull balance of the supply chain (see "Tactical Planning for Reinventing the Supply Chain", by Prof. Simchi-Levi).

Good examples of companies that identified such synergies and designed their supply chain accordingly, are Blockbuster (as described in II.1.b Why Customer Focused Supply Management?) and Dell Computers. Dell has identified such synergies, determining that not all customers need a retailer to purchase a PC (that in addition to the fact distribution channels were an obstacle in their way to penetrating the market). While the old players in the industry were struggling to predict demand and manage inventory much because of the distributors, Dell bypassed them all together. The direct model enabled them to balance supply and demand, shorten lead times, maintain low costs and therefore offer customization capabilities for lower prices. Dell has successfully combined the two worlds of front-end and back-end.

The tactical and operational improvement opportunities are easier to identify and implement. To manage and prioritize changes, these opportunities can be sorted based on return per investment (in terms of change effort). Following are a couple examples of such opportunities.

Many of Nortel's Intelligent Internet products are shipped to the customer 'á la carte'. Meaning, the customer receives several cardboard boxes, one for the chassis and one for each board that needs to be inserted into the chassis. It is important to note, for some products the product configuration may vary, i.e. boards that go into the chassis may vary between orders. For low-end, simple products, customers do the installation. For some of the high-end products, it is done by Nortel technicians.

From a logistics point of view, this system simplifies manufacturing, packaging and warehousing. Rather than doing final assembly to order, and maintaining many more items and part numbers of finished goods, additional flexibility is maintained.

However, how does this system impact customers? Customers prefer having a 'turn key' product as well as less packaging material to dispose of. Furthermore, in cases where a technician is not necessary, customers might "do something wrong", resulting either in damaged product or in a false assumption that it was defected, and a 'Dead on Arrival (DOA)' return. In cases where a technician is involved, there is also the hassle (and cost) of scheduling the visit.

Raising this question at Nortel showed it would be relatively easy to change the default preference of á la carte shipping for new products. The contract manufacturer already had the 'build to order' capability, design teams could design the robustness needed to ship the boards in the chassis and there was the added benefit of saved shipping costs. Yet, the logistic challenge this will create for the channels is greater than for Nortel, since they frequently order products and bundles for their inventory. Shipping configured products per order will make it difficult for them to manage their inventory and will force them to order from Nortel per actual order from customers.

Shipping configured products and perhaps combined with shipping directly from contract manufacturers to the end-customer may prove not only to positively contribute to customer experience, but also to reduce inventory levels in the channels and reduce internal costs. However, channel relationships need to be carefully considered. Making a final decision on such an example ties back to the first step of CFSM – defining your customers. 40% of Intelligent Internet's sales are through the distribution channels, but

are these channels considered a Nortel customer? Or perhaps suppliers? Defining customers and priorities are strategic decisions that should be answered by senior management.

Another example of an operational improvement opportunity relates to product packaging materials. Customers may prefer materials that are recyclable, easier to unpack, and when disposed are collapsible to save space. In the example of electronic boards, there are a variety of options. Some require more steps than others, having anti-static bag in addition to shock-absorbent frame (foam or plastic). Some shock absorbents are recyclable as opposed to others and some take more space than do others. Choosing a packaging method is a relatively easy decision to make and change if needed.

Finally, CFSM is not about making all decisions based on customer satisfaction considerations, rather changing the decision making process to incorporate customer preferences as another argument in the economic equation. To that extent, in the packaging material example, the best solution for the customer is not necessarily the best solution for the company from a cost perspective. However, customer benefits should be taken into account. Thus, in this step of the implementation, in addition to driving changes in the supply chain, relevant information about customer preferences per each element of the value chain should be made available to managers on a daily basis as guidelines for their decision-making processes.

e. Map Necessary Information Flow

In order to enjoy CFSM benefits as described above (adjusting supply, shaping demand, and identifying synergies), information has to flow between functions as well as between organizations in the value chain in cases of a multi-tier supply chain. The information flow can roughly be divided into two groups: "in-flow" and "out-flow". In-flow is defined as information coming from the customers and the front-end of the organization flowing to the back-end. Out-flow is defined as information originating at suppliers and the back-end of the organization flowing to the front-end. Finally, the level

of detail of information and frequency of information flow varies based on company and industry.

In this step, both in-flow and out-flow is defined based on previous steps. Examples of in-flow most basic elements might include long term and short term demand forecasting (what, when and how many), customer requirements and priorities, and routine feedback from customers and field sales/support. Example of out-flow most basic elements might include information regarding product lifecycle (NPI, sustaining, and EOL, launch & discontinuation dates, estimated cost for pricing), inventory levels (flagging shortages and excess), and fulfillment information (e.g. available to promise dates, lead times, etc.). Determination of information flow components should be guided by customer needs and improvement opportunities as previously identified.

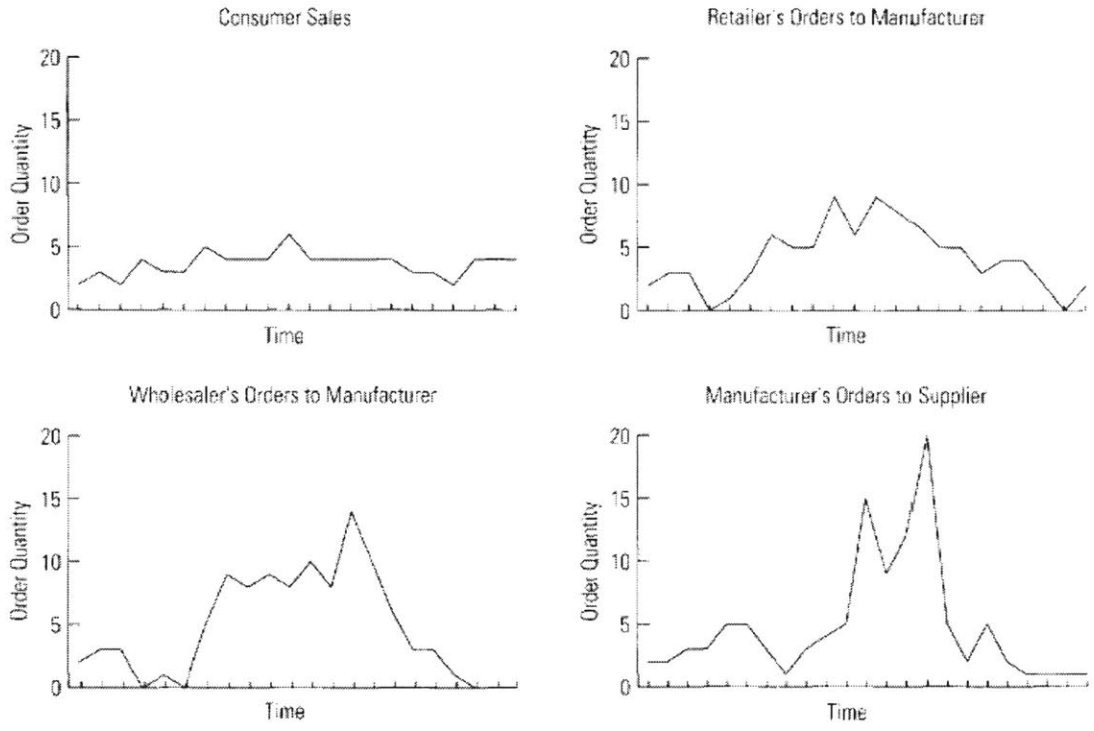
This may seem trivial and easy to implement, however it becomes very challenging in some environments. For example, in large corporations this information becomes of large volume and is not only difficult to track but also may not always be available at the source. Furthermore, this becomes even more complex in a multi-tier supply chain, where this information may have to cross inter-organizational barriers and may be considered confidential to some companies.

In addition, the potential benefits of this step are beyond the scope of CFSM as illustrated in the Beer Game exercise such decreased bullwhip effect due to global view of the supply chain. The bullwhip effect is a term coined by Proctor & Gamble when they observed that order variability increased upstream in the supply chain, even for a product that had stable demand, such as diapers (see Figure 5). The Beer Game, as developed by MIT's Prof. Sterman in 1989, is a simulation game where participants play the role of different players in the supply chain. Each player only sees the order from the player downstream and has no information about true inventory levels or orders received by other players in the supply chain. After a certain number of periods, each player is rewarded for orders supplied and penalized for backlogs as well as excess inventory after each round.

At the end of the game, orders and production levels are graphed per each player in the supply chain and compared. The results are typically identical to the bullwhip effect seen in reality. Even when consumers' demand is constant, there is a great amount of volatility upstream, as every small change in order level downstream is amplified by the time it gets upstream. There are many articles and reviews in the literature analyzing this phenomenon. Some explain it in supply chain terms and some through system dynamics, but either way it is proven that demand and inventory visibility improve supply chain overall performance.

Finally, in order to take the next step of shaping demand, as part of this step, the relevant strategies to do so should be identified so the relevant information can be transferred at the relevant frequency and the appropriate level of detail. A few of demand shaping techniques include promotions (e.g. price discounts, bundling, cross-selling and up-selling), dynamic pricing, and improved delivery time or service offering. Once these are defined it is easier to define sources and targets of information flow as well as the required frequency and detail level for the reports.

Figure 5: Increasing Variability of Orders Up the Supply Chain



Source: "The Bullwhip Effects in Supply Chains", Sloan Management Review, 1997

f. Define Customer Satisfaction Metrics

Most companies measure and follow customer satisfaction metrics very carefully. In order to maintain future benefits of CFSM, operational measures should be integrated into the regular periodic surveys. Traditional metrics include quality and on time delivery, but additional questions that are aligned with the touch points identified between the consumption chain and the supply chain should be added.

For example, if when mapping the consumption chain it is found that keeping customers informed about the status of their orders will enhance their experience. A

question to measure their satisfaction during waiting time may be in place. It could furthermore be broken down into elements asking about 'response time to requests', 'frequency of change in promise dates', credibility of promise dates' and so on.

The important thing to remember is to measure customer value in a level of detail that can be used by managers to improve upon. If one number is provided for a group of products that cross organizational departments, managers might not feel ownership towards the results. Such differentiation can be done either at the survey level (e.g. different surveys per product line) or, when possible, at the analysis level.

g. Align Front-end and Back-end Incentive Structures

The key for successfully implementing Customer Focused Supply Management is in aligning incentives within the organization. Once these are aligned, internal integration is improved, virtual integration with partners can take place so relevant information can flow at the required frequency, accuracy and level of detail.

Traditionally, companies' front-end and back-end functions were organized as separate "silos". The goal of the front-end was to increase revenue, drive growth, capture customer requirements, and manage customer satisfaction, while the back-end focused on decreasing cost, shortening lead times and maintaining "proper" production capacity and flexibility. Some may claim that it is best having each function in a company focus on a local goal and be rewarded based on their achievements toward that local goal. Company optimization then occurs by a balanced solution of conflicts between these local goals. In such a case, the front-end is incentivized to provide low long-term forecasts, since these set the standard for sales goals – The higher they are above the goal, the higher the bonus will be. Once goals are set, and it is time to provide the back-end with short-term forecasts, these become overly optimistic, in order to guaranty fulfillment and avoid lost sales.

In such a scenario, the back-end would not care about customer satisfaction but rather focus on cost and inventory levels, striving to decrease production levels even at the cost of lost sales. By the same token, the front-end would not care about inventory

levels at all, pushing for increased volumes of production. Too many companies follow this philosophy, leaving the balance in their organization up to political gaming and managers' personalities. Furthermore, this has a major impact on the bullwhip effect. Such a set of local measurement system may work in small organizations, but not in large ones. To gain the benefits of CFSM, a company needs to align its incentive plan to create the balance earlier in the process and in a more controlled way. Only global thinking can set the stage for constructive corporation between the front-end and the back-end and discovery of new creative synergies.

The definition of alignment of incentives depends on the definitions and goals in the previous steps. For example, holding product managers share responsibility for inventory will encourage them to provide as accurate forecast and as early as possible. It will also incentives them to promote sales of items that have higher inventory levels. In addition, holding manufacturing or contract manufacturers responsible to some extent for customer satisfaction or to specific fulfillment measures may also encourage CMs to alert backlogs further in advance, and identify improvement opportunities that may increase customer satisfaction.

3. CFSM Potential Benefits and Challenges Across Industries

a. Industry Characteristics

The potential benefit from CFSM varies by industry and company. This section describes an approach to predict the extent a company can benefit from CFSM, as well as estimate the magnitude of complexity and challenges faced during implementation. The approach is mainly based on positioning of the company on a two-by-two industry characteristic matrix (see Figure 6).

The first industry characteristic is industry clockspeed. Clockspeed indicates the rate of evolution of an industry, and as indicated in Prof. Fine's book Clockspeed, depends on product clockspeed, process clockspeed, and organization clockspeed. The second chapter of the book elaborates on how to measure these three clockspeeds.

Generally speaking, good indications of industry clockspeed would be product life cycle or rate of new product introduction, manufacturing capital equipment obsolescence rates, and frequency of organizational restructuring.

The second characteristic is 'need for differentiation'. Every company wants and needs to differentiate its products, but this characteristic differs between a need for differentiation that comes from or is valued by customers and a need that comes from a company due to commoditization. For the sake of this section, when thinking about a product's need for differentiation, exclude commodities and branding considerations.

The first quadrant (marked 'I' in Figure 6), represents industries with slower Clockspeed yet high need for differentiation, such as the automotive industry. Companies in such a position are ideal for CFSM since they can greatly benefit from the implementation, while encountering fewer challenges than would those companies characterized by faster clockspeeds. The outcome and learnings from the process of implementation and mapping of consumption and value chains are valid for a longer period of time, providing stability needed to instill the information flows and customer focused culture. Furthermore, typically, products that have high need for differentiation are such due to increased competition and frequently a mature market. By implementing CFSM, the company is adding customer value; and by sustaining CFSM – acquiring a strategic core competence.

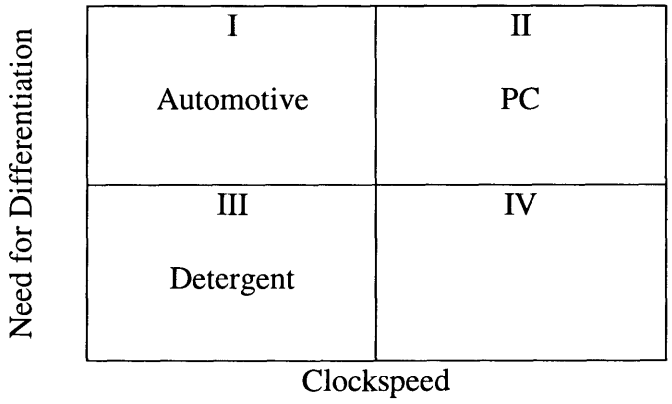
The second quadrant (marked II), represents companies in fast clockspeed industries that have products with high need for differentiation, such as the personal computer industry. This quadrant somewhat suffers from a "catch 22" predicament. On the one hand, fast clockspeed industries typically suffer from high demand uncertainty and variability, amplifying the issue of bullwhip effect. However, as mentioned above, CFSM decreases this effect through demand visibility. Thus, companies in this category stand to benefit more from improved supply chain performance in addition to enhanced customer satisfaction, meaning that these companies have the most to gain from implementing CFSM. On the other hand, fast changing customer expectations, supply chain design and organizational structure make the implementation of CFSM more

difficult. In these cases, companies should emphasize putting in place continuous improvement processes and progressive information systems to facilitate fast and reliable information flow.

The third quadrant (marked III) represents slow clockspeed industries with little need for differentiation, such as laundry detergent. Although I believe most companies (perhaps excluding monopolies) can benefit from CFSM, companies in this category stand to gain the least. Low need for differentiation indicates low potential for improvement of customer experience through the supply chain. Generally, companies in this category will try to differentiate themselves through customer perception via branding, positioning or additional services. Thus, commodities, even if they are in high need for differentiation and in a fast clockspeed industry (e.g. Central Processing Units in the computer industry), are similar in relation to CFSM to products in this quadrant.

Finally, the fourth quadrant (marked IV) represents fast clockspeed industries with little need for differentiation. Since a need for differentiation is one of the main motivations for companies to keep changing, investing and introducing new products, by definition these create a fast clockspeed industry. Thus, actual industries and companies in this quadrant probably do not exist.

Figure 6: CFSM by Industry Characteristics



b. Company-specific Characteristics

In addition to the above-mentioned challenges due to an ever-changing environment, there are additional indications of a company's readiness for CFSM and potential implementation barriers. For example, large corporations tend to have challenges coping with large quantities of internally generated data. Managing efficient flow of information from customers to suppliers while maintaining data integrity can pose the main barrier in achieving CFSM. Following are a few more characteristics to help companies think through the challenges from an earlier phase of implementation:

- Size of company – the larger the company is, the more difficult it is to manage information, and to drive change.
- Market power – the company implementing CFSM must consider the cooperation needed from value chain partners and their ability to influence them into adopting the concept.
- Supply chain architecture - as defined in chapter 8 of the book Clockspeed, integral supply chain architecture, as opposed to a modular one, features close proximity among its elements, measured along geographic, organizational, cultural and electronic dimensions. The more integral the supply chain is, the easier it is to implement CFSM. This is equivalent to considering internal integration and virtual integration across the value chain. Either way, as the company becomes more CFSM-oriented, the better integrated the value chain becomes.
- Synchronization of internal clockspeed with industry clockspeed – when internal clockspeed is slower than the industry's clockspeed, information may not flow fast enough within the organization, creating situations where decisions are made based on information that is no longer accurate. Furthermore, in order to be able to shape demand, not only does the decision to promote an item need to be made based on reliable information, but it must be communicated to customers in a timely manner.

III. Nortel's Internal Processes

In order to assess the gap Nortel needs to overcome in order to become more CFSM oriented, I chose several key processes across the Intelligent Internet supply chain. For the in-flow and how it could be implemented at Nortel, I chose a couple of processes/ tools to analyze. One was demand forecasting and the other was customer satisfaction surveys.

Please note that as mentioned in the introduction, most of these processes have changed since the internship due to company restructuring during the downturn. Therefore, you will find portions written in past tense yet you will not find descriptions of the new processes, as the restructuring continued until after the internship period was over, as well as due to company confidentiality concerns.

1. Demand Forecasting

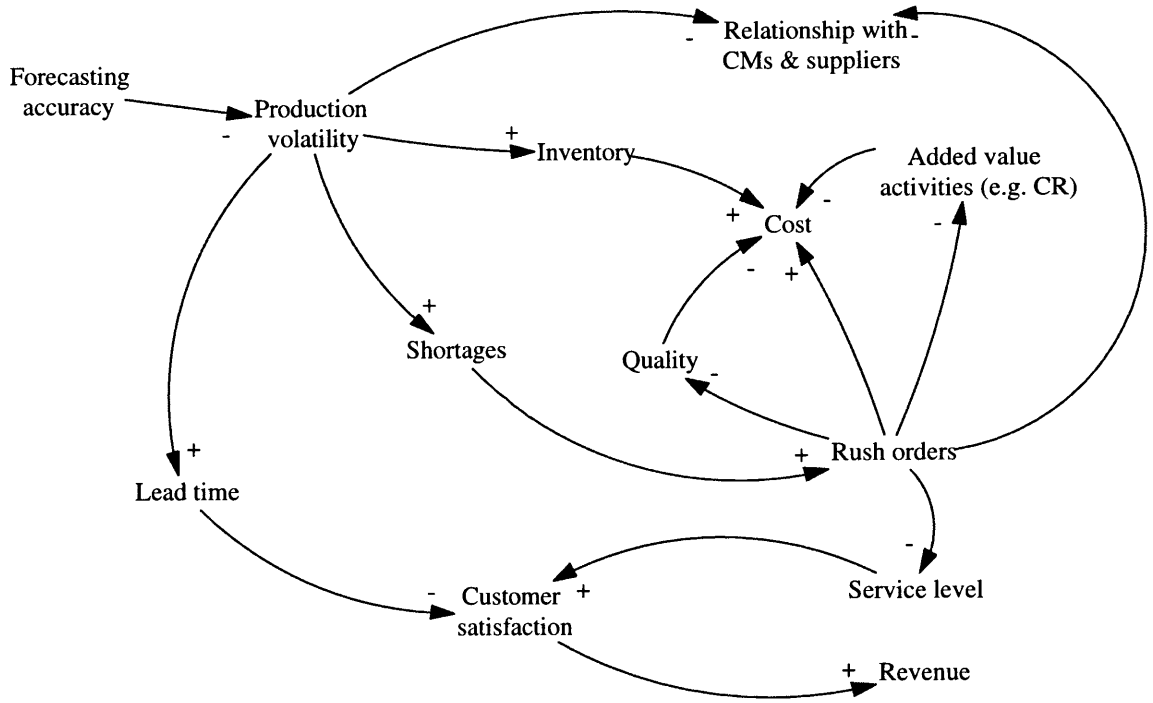
Forecasting is the most common tool for companies to share customers' demand and priority information. Based on the forecast, company budgets are set, predictions to Wall Street are published, manufacturing capacity planning decisions are made, and raw material purchased. However, naturally, since we are trying to predict the future this tool is rarely accurate. Furthermore, ironically sometimes the sequence of planning is shifted and companies lay out their forecast based on Wall Street's revenue expectations and growth (or cut back) desires rather on real signals or trends in the market. This is probably one of the reasons so many companies failed to foresee this recent downturn.

a. The importance of Forecasting and impact of inaccuracies

There are many studies that prove the importance of forecasting and quantify the cost of forecast inaccuracies. One of these studies as described in Chris Schechter's thesis from 1994, list five main cost drivers due to inaccuracies: added lead time, lower service level, added capacity, added inventory and opportunity cost due to misallocation of resources.

Sine this is beyond the scope of this thesis, further elaboration and quantified impact of inaccuracies on these five cost drivers can be found in Mr. Schechter's MIT thesis "Characterization of the Cost of Forecast Error in a Complex Supply Chain". Nevertheless, to graphically illustrate the chain of cause and effect especially with respect to customer satisfaction, Figure 7 describes the relations through a simplistic system dynamics model. The arrows represent cause and effect relationship. When a plus is at the end o an arrow it indicates a positive contribution and a minus represents a negative impact. For example, the more shortages in the system, the more rush orders are processed, which create higher costs (e.g. due to expedited delivery). In addition, the more rush orders in the system the lower the quality will most likely be, which again increases costs.

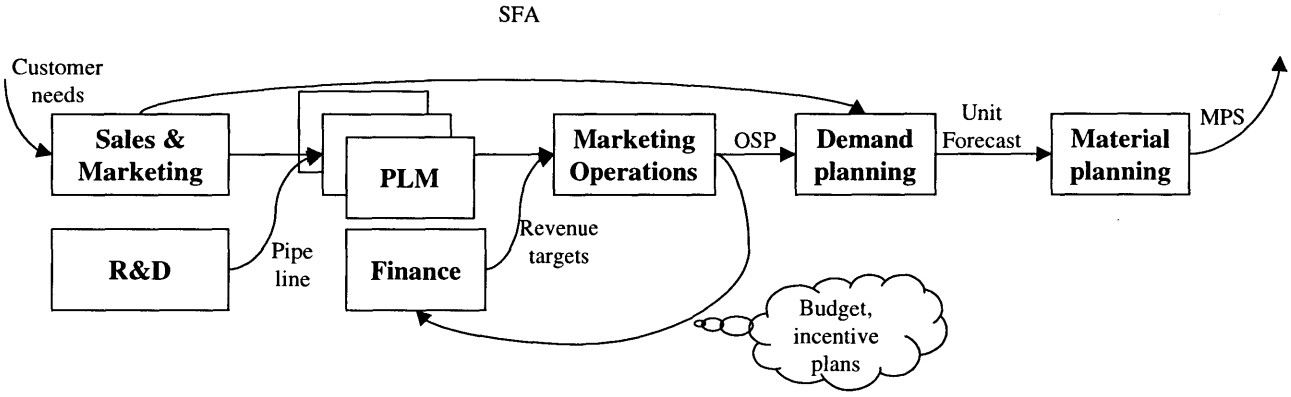
Figure 7: Implications of Forecast Inaccuracies



b. Forecasting Process

Currently at Nortel, there are three levels or types of forecasts prepared by three different functions/groups. First is a high-level dollar forecast called Order Sales & Production Planning (OSP) is prepared by a Marketing Operations group. Second is an item/ SKU level forecast prepared by a Demand Planning group, converting the dollar forecast to a unit count forecast. Third is a Master Production Schedule (MPS) prepared by a Material Planning group and is sent to Contract Manufacturers. It is important to note that these three groups only converge from a hierarchical management perspective at a very high level of the organization (president and VPs). Furthermore, there are two more levels of organizational structure and that is geographical regions and company divisions (e.g. North America versus World wide and Optical versus Intelligent Internet). Nevertheless, for the most part, I will not address these differences.

Figure 8: Forecast Process



Complexity elements:

- Geographical Regions – when historically more than one system house was manufacturing a product, forecasting and actual reporting may be separate for each system house. Therefore, in some of the reports and analysis below the scope includes global perspective and in some it only refers to a certain system house perspective. Main difficulty today when the manufacturing is

outsourced, is consolidation of planning, reporting and performance measurement operations. This general issue was addressed in recent restructuring and consolidation is currently in process.

- Different levels of detail and aggregation definitions – in trying to compare OSP to Unit Forecast to check consistency and compare accuracy performance, I encountered a troubling challenge. Since the OSP is associated with the front-end of the organization it aggregates products into product families and groups that are associated with company's positioning to the customer. While, the Unit Forecast is more associated with the back-end of the organization and is more detailed. Therefore, even an aggregated row that may be named the same in both forecasts, may actually include different items. Comparing the two requires an extremely thorough understanding of the OSP group's definitions, taking each category and relating it to the appropriate products/items.

- Different Source IT systems – the issue described in the previous point is amplified as well as illustrated in the many IT systems involved. Appendix 2: Forecasting Related Information Flow in IT Systems, describes the forecasting information related flow in these systems. Therefore, again, to run comparisons and analysis, one needs to be very proficient not only in the product definitions in each system but also in the field definitions of each system ('actual sales numbers may differ from system to system).

- Different frequency and time horizons – Each report is published at different frequency and covers different time horizons. For example, the back-end of the organization sees an OSP with a time horizon of two quarters in advance (6 to 9 months time horizon), while the MPS time horizon is four quarters in advance (12 to 15 months time horizon). However, when I pulled out reports directly from the Marketing Operations group, I actually found reports with a year's time horizon. It could be that planning is conducted for four quarters, yet only two are communicated to parts of the organization.

- Bottom-up vs. top-down approach – the OSP is mostly top-down approach originating in growth targets with refinements based on sales predictions from the Sales Force Automation (SFA) system. The Unit Forecast is a bottom-up approach based on historical data that theoretically converges into the dollar amounts provided by the OSP.

- Gross versus net – the OSP tries to predict 'net' numbers, meaning true sales without accounting for returns. In contrast, the Unit forecast tries to predict gross numbers, which include returns. This may cause gaps between items such as the budget and operational expenses. Furthermore, it adds an obstacle in performance measurement of Unit Forecast over the long term, since historical shipments and booking are net (do not include returns). Thus, OSP compare their performance to "real" dollar sales, while the Unit Forecast is compared to shipments.

  Obtaining the returns in order to account for them in the performance measure analysis is not impossible, but is complicated since it should be puled out of a whole separate information system, in which case you run the risk again of defining products and comparing apples to apples.

- Revenue vs. non-revenue – similarly to the point above, the OSP naturally does not account for non-revenue orders (e.g. R&D orders, intra-company orders), while the Unit forecast does.

- Highly configurable products – some of Nortel's Intelligent Internet products are "off the shelf" like products. Meaning, there is one possible configuration of the product with perhaps one to three add-on options. In contrast, some of the Intelligent Internet products are highly configurable. For example, there may be a chassis of a router with different boards that fit is and comprise the router (e.g. CPU, I/O ports, etc.). However, every customer can build the router as they wish, ordering for example different number of CPU boards. This depends on the customers' requirements for speed, capacity and so on.

These products are designed with modularity to provide customers with desired scalability.

However, this also raises a challenge in forecasting demand on an orderable item. Knowing how many certain routers will be sold, still does not answer the question of how many CPU boards for that router will be sold. This variability is currently tracked, and statistical models representing an average order developed. Yet, how do you measure Unit Forecast accuracy? Do you only compare the more costly items? Do you only compare the volumes of chassis? Or do you compare each and every one of the hundreds of item lines? This point not only makes performance measurement difficult, but also poses challenges on the convergence between the item level Unit Forecast and the product level OSP.

For all the reasons above, the following analysis should be taken for what it is worth, but in some cases it is identical to the analyses used by Nortel's managers. With all that is said, one should not conclude that there is no need for a different forecast for revenue and budget purposes than for unit production purpose. Yet, there s no doubt that a project realigning these two efforts should be done. And indeed, the very last day of my internship period, such a project was kicked off.

c. Forecast Accuracy Analysis

There are different approaches to measure forecast accuracy. The one used at Nortel's Intelligent Internet group is called "waterfall." Chart. The waterfall chart compares the short and long-term forecast to the actual number forecasted for a specific item or set of items. For OSP the actual number reflects actual sales while for Units Forecast, the actual number reflects actual shipments (without returns). This chart, nicely maps the evolution of a forecast for a quarter over time, to the point that actual demand is known at the following quarter. In the following charts, the actual number forecasted is the last tab of a period, emphasized by a black bar across all forecasts per that quarter.

The goal of this section is to observe accuracy and variability of both types of forecasts, OSP and Unit Forecast. In order to do so and due to the fact most charts are lacking numbers (due to confidentiality), each analysis is presented in a below table with two measurements. The first, Mean Percent Error (MPE) measures bias and variability. The second, Mean Absolute Percent Error (MAPE) measures relative accuracy. For equation definition of each measure see Figure 9. The approach taken in this section analyzes the select examples of products or product families.

Figure 9: Forecast Performance Measures

i = Month forecast was conducted	t = Quarter forecasted
${}_iZ'_t$ = Forecast in month i for quarter t	Z_t = Actual sales in quarter t
m_t = Number of forecasts (months) for quarter t	n = Number of quarters t
$\bar{r}_t$ = Average forecast errors per quarter t	$\lvert\bar{r}_t\rvert$ = Average of absolute values of forecast errors per quarter t
MPE_t = Mean Percent Error per quarter t	$MAPE_t$ = Mean Absolute Percent Error per quarter t
MPE = Average Mean Percent Error	$MAPE$ = Average Mean Absolute Percent Error
${}_ir_t$ = Forecast error	${}_ir_t = Z_t - {}_iZ'_t$

$$\bar{r}_t = \frac{\sum_i {}_ir_t}{m_t} \qquad \lvert\bar{r}_t\rvert = \frac{\sum_i \lvert{}_ir_t\rvert}{m_t}$$

$$MPE_t = \frac{\bar{r}_t}{Z_t} * 100 \qquad MAPE_t = \frac{\lvert\bar{r}_t\rvert}{Z_t} * 100$$

$$MPE = \frac{\sum_t MPE_t}{n} \qquad MAPE = \frac{\sum_t MAPE_t}{n}$$

Figure 10: OSP Waterfall for Entire Intelligent Internet Portfolio

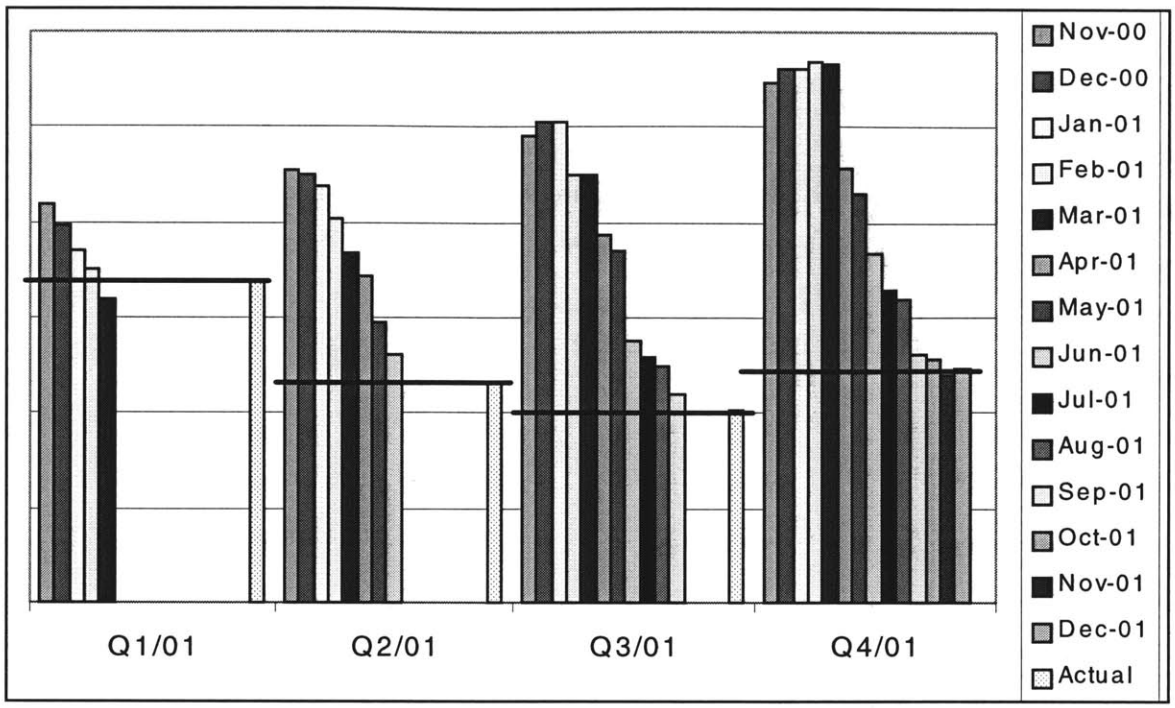


Figure 11: OSP Waterfall for Product X

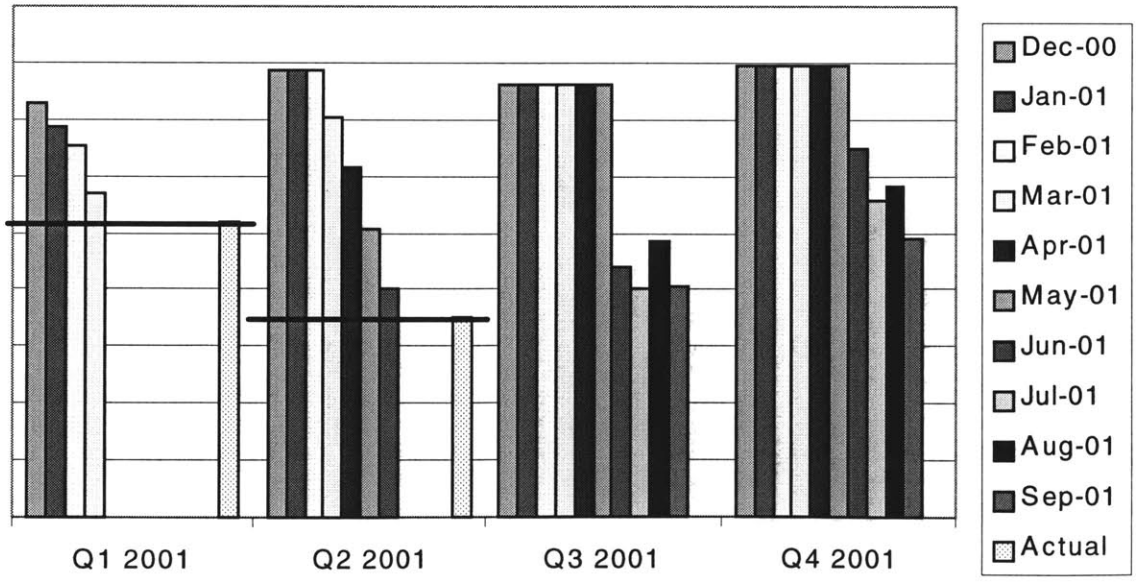


Figure 12: Unit Forecast Waterfall for Product Y

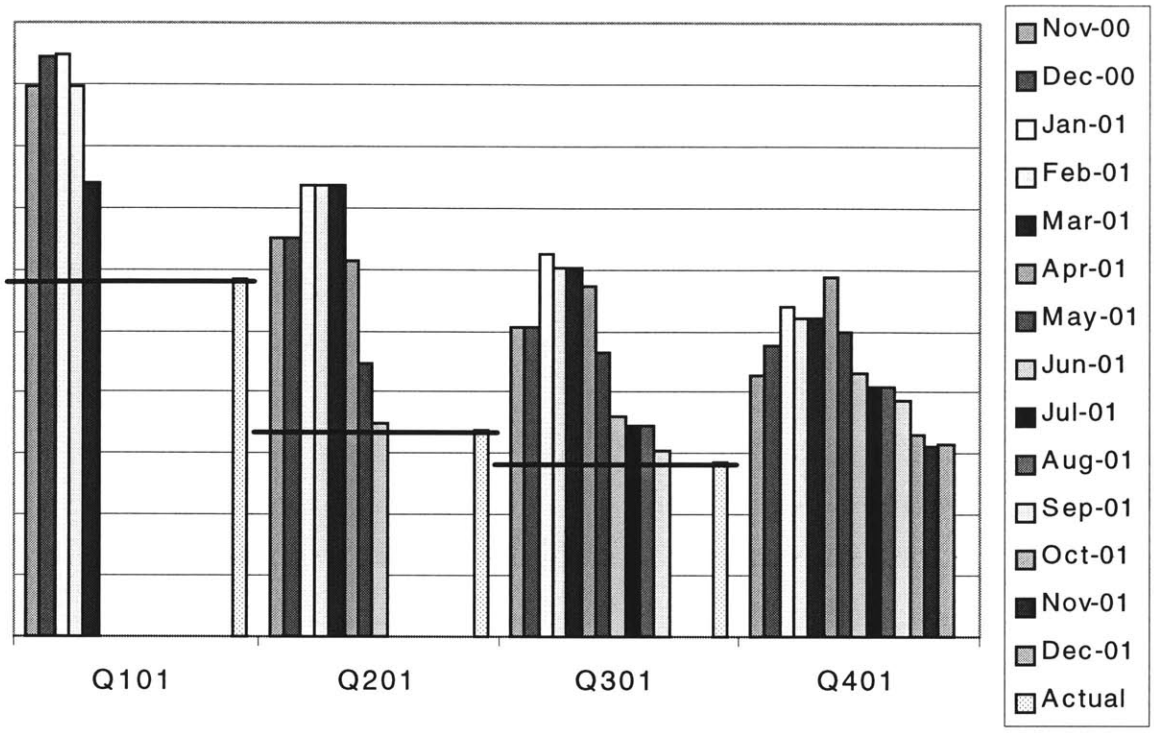


Figure 13: Unit Forecast Waterfall for Product Z

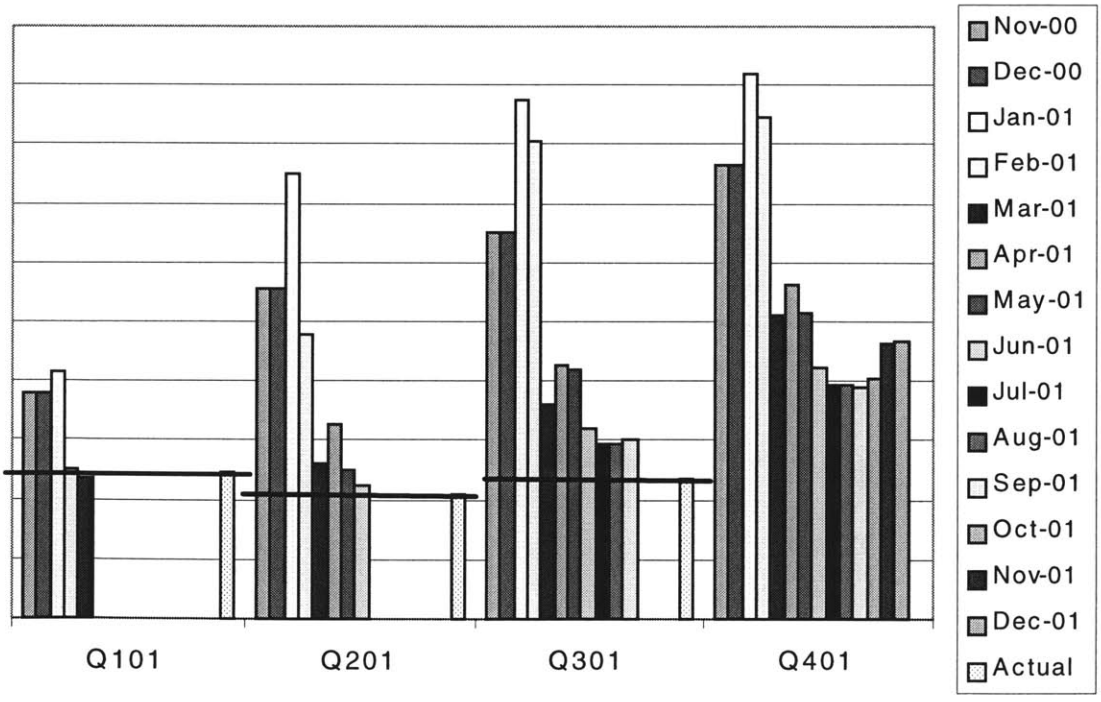


Figure 14: Unit Forecast Waterfall for product X – Chassis

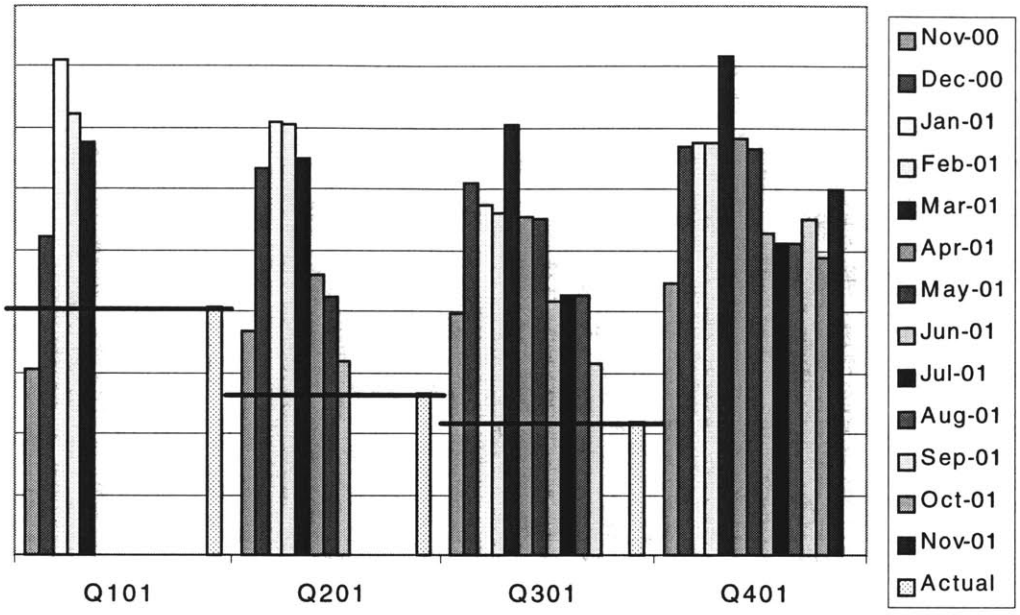
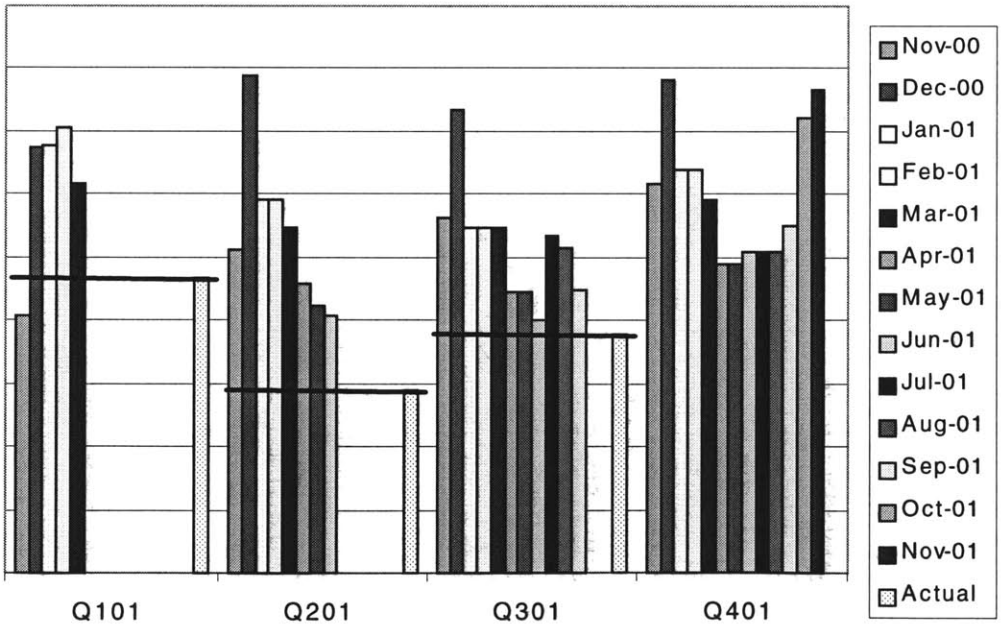


Figure 15: Unit Forecast Waterfall for product X – CPU



Note: For alternative representations of forecast variability see Appendix 3: Stock Charts for Forecasting Variability.

Table 2: Nortel's Forecast Accuracy Measurements

	Average of three quarters	Q1/01 (t=1)	Q2/01 (t=2)	Q3/01 (t=3)
OSP Intelligent Internet				
MPE	53%	10%	62%	87%
MAPE	53%	12%	62%	87%
OSP for product X				
MPE	68%	30%	92%	83%
MAPE	68%	30%	92%	83%
Unit Forecast of Product Y				
MPE	63%	66%	65%	58%
MAPE	65%	66%	66%	64%
Unit Forecast of Product Z				
MPE	90%	58%	96%	115%
MAPE	90%	59%	96%	115%
Unit Forecast of Product X – Chassis				
MPE	56%	32%	53%	82%
MAPE	58%	37%	53%	82%
Unit Forecast of Product X - CPU				
MPE	46%	32%	73%	33%
MAPE	48%	36%	73%	33%

Notes and discussion on Table 2:

- MPE & MAPE vs. Waterfall as performance measure for forecasting - The above table shows normalized accuracy and bias measurements. The advantage of these measurements (as opposed to the waterfall charts) is that they are normalized and therefore provide the ability to track and compare forecasting performance over time as well as across different levels of detail (being more forgiving to lower levels of detail). Furthermore, we can also theoretically compare two types of forecasting (e.g. OSP vs. Units) assuming we find a common base of comparison (from an aggregated items perspective).

- Q1 vs. Q2 & Q3 - As opposed to the measures for Q2 & Q3, Q1 has only two to three data points prior to the beginning of the forecasted quarter and is therefore expected to be more accurate. The longer the forecasted time horizon, the less accurate it is likely to be. Furthermore, since Q1 has less data point over all, the forecasts within the quarter (that are the most accurate) have more weight in the calculated quarter average.

- MPE vs. MAPE - As mentioned at the beginning of the section, MPE measures the forecast bias and MAPE measures the forecast accuracy. The difference between the two measures is that MAPE takes the absolute value of the forecast errors. It is therefore clear that MPE will never be greater than MAPE.

  In the examples analyzed above, the differences between these two measures are marginal. This indicates a very strong positive bias in the forecasts. Given that 2001 was a bad year, we can not conclude that this is "chronic" bias, although there is room for suspicion and future tracking of biases. It is possible that due to the increased pressure of the downturn, an opposite bias may occur. It is important to remember that an MPE should be close to zero, regardless of the MAPE.

- Different levels of detail – As we would expect the OSP accuracy of the entire Intelligent Internet portfolio is better than the OSP accuracy of product X

(statistically, the higher the level of aggregation, the more accurate the forecast is likely to be).

- Different accuracy between products – There is significant accuracy differences between Unit Forecast for the selected products. With the available date, it is very difficult to identify the cause for these differences. Furthermore, the source of difference could originate from the OSP. However, it could also be a symptom of the manual and therefore subjective method in which the Unit Forecast is populated (different individuals are responsible for different products).
- OSP vs. Unit Forecast accuracy - Comparing the OSP accuracy to the Unit Forecast accuracy is somewhat problematic, due to the different level of detail, and mainly aggregation approach. From all the examples, there is no two comparable items. The closest example, is the OSP for product X and the Unit Forecast for the chassis for the same product.

Finally, all the accuracy measures are higher than expected. Based on Prof. Masters' experience most companies are around the 40-50% while the goal is 15%. It is important to remember that these inaccuracies are amplified down the supply chain since the MPS occasionally adds buffers (on average 0- 15%) to the unit forecast. One may also assume that additional buffers may have been added by the contract manufacturer. Furthermore, any inaccuracy in the chassis forecast may be amplified in the other components' forecast since they are all tied in ratio to the chassis.

d. Forecasting Management by Product

The following analysis is trying to learn from historical trends of sales for a couple of sampled products. . Product X is a highly configurable product while Product K is a small family of "off the shelf" products. The dimensions and issues assessed are:

- The alignment of trends between demand in terms of revenue, vs. demand in terms of units on an aggregate level for both types of products.

- The alignment of trends between demand in terms of revenue, vs. demand in terms of units on a specific product level within a product family.

(1) Analysis of demand trends for Family X

There are many products related to Family X, yet some have very few similarities in their supply chain design as well as product design and functionality. For the purpose of this study, Family X is defined as a sub family of the broader scope, including two products. One is a switch and the other is a high-end routing switch. Both products are configurable and use the same chassis. However, the CPU is different.

There are several attributes of the reported data that the following figures isolate in order to identify consistencies and differences and perform the correct comparisons. One of these attributes is whether the transaction was for revenue purposes or not (e.g. in the case of intra-company transaction). Another attribute is the geographic region included in the analysis.

Figure 16, compares the historical trend of demand of Family X with the one of Product x within the family. The dollar value was calculated based on aggregation of revenues from all product parts and validated by comparison to revenue numbers drawn from the financial system. The numbers were not identical but close enough and the trends were the same. Product x was introduced at the end of the first quarter of 2000 and is the main revenue source for the family. It is important to note that the common parts between the two products of the family account in the logistics systems all in product x, however, since this does not impact the conclusion. That is that the trends are very similar and therefore forecasting a trend for the family would apply to the product. Separate management is not required for the dollar forecast.

Figure 16: Actual $ Demand Trends – Comparison of Family X with Product x

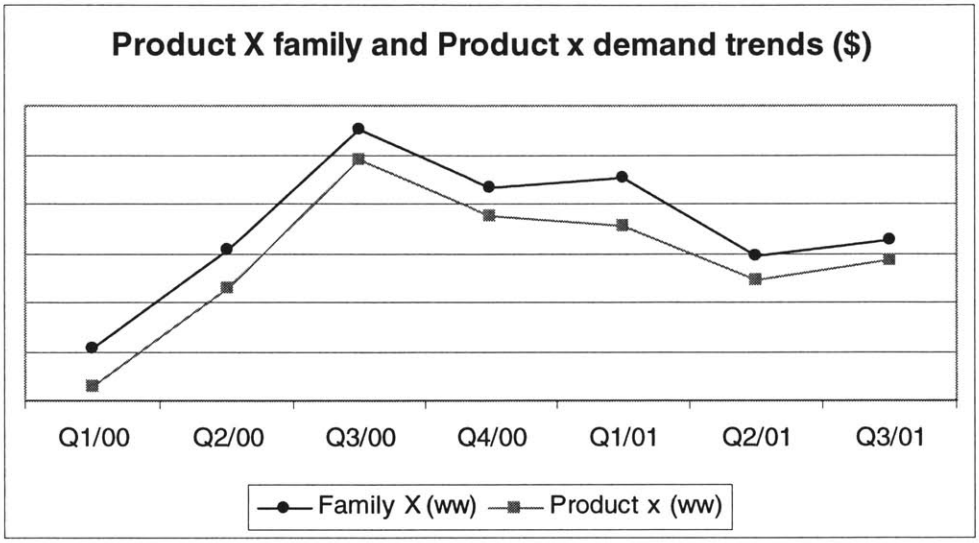


Figure 17, compares a couple of attributes. First it compares whether there is a significant difference in trend between the world wide (WW) sales and the rest of the world (ROW) sales. Second, it compares trends and volumes of CPUs and Chassis. Since a differentiation between the chassis for the two products could not be done, this chart is for the whole family and therefore includes CPUs of both as well. The numbers include all transactions, including non-revenue since it is proved it makes no difference as far as trend (see Figure 18) and all numbers in the chart are consistent. Note that a new CPU was introduced in the third quarter of 2001.

The conclusion from this figure is that for both chassis and CPUs the trend is roughly consistent around the world. Therefore, forecasting process for this family could be consolidated in the future (today planning is separate for the regions). In addition, there is a clear difference in volume and trend between the chassis and the CPU. This is very important for the forecasting process to acknowledge this difference and plan accordingly. If the model as described above is used, it assumes difference in volumes but not in trend. A possible explanation of the difference is in purchases for upgrade purposes, especially after a new CPU if launched.

Figure 17: Units Demand Trends for Family X (CPU vs. Chassis & WW vs. ROW)

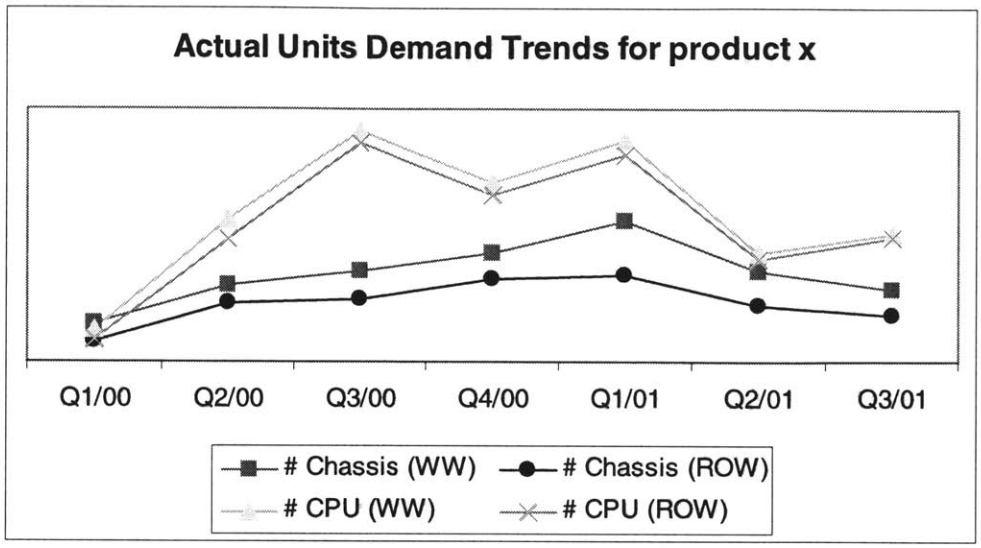


Figure 18, checks to see the impact of non-revenue items on the demand trends, for both Chassis and CPUs. As shown, the trends are the same, although the gap does raise the question of justification of so many non-revenue items – but that is out of or scope.

Figure 18: Actual Units Demand Trends for Product x (Revenue vs. Non-Revenue)

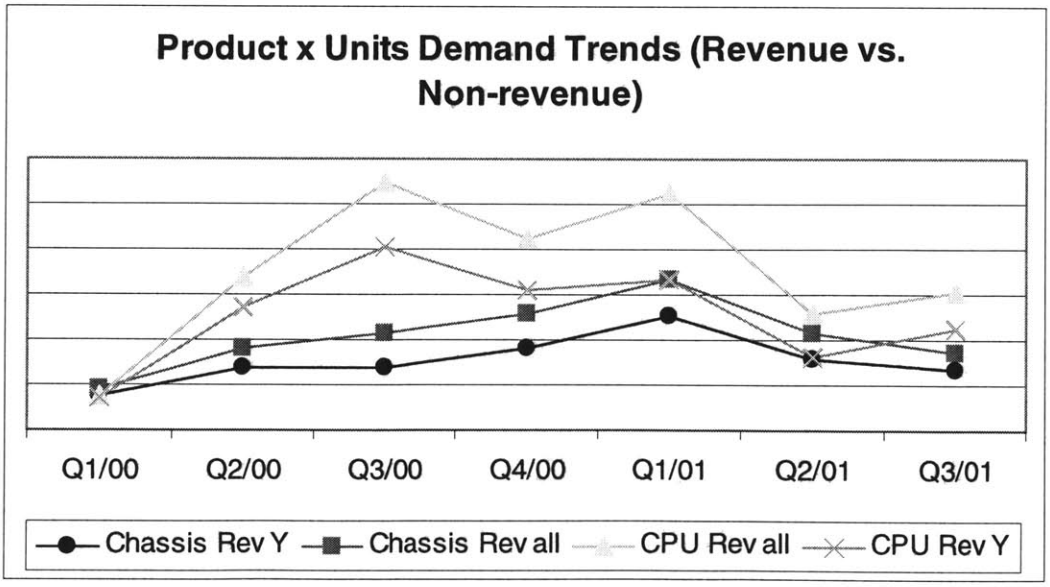
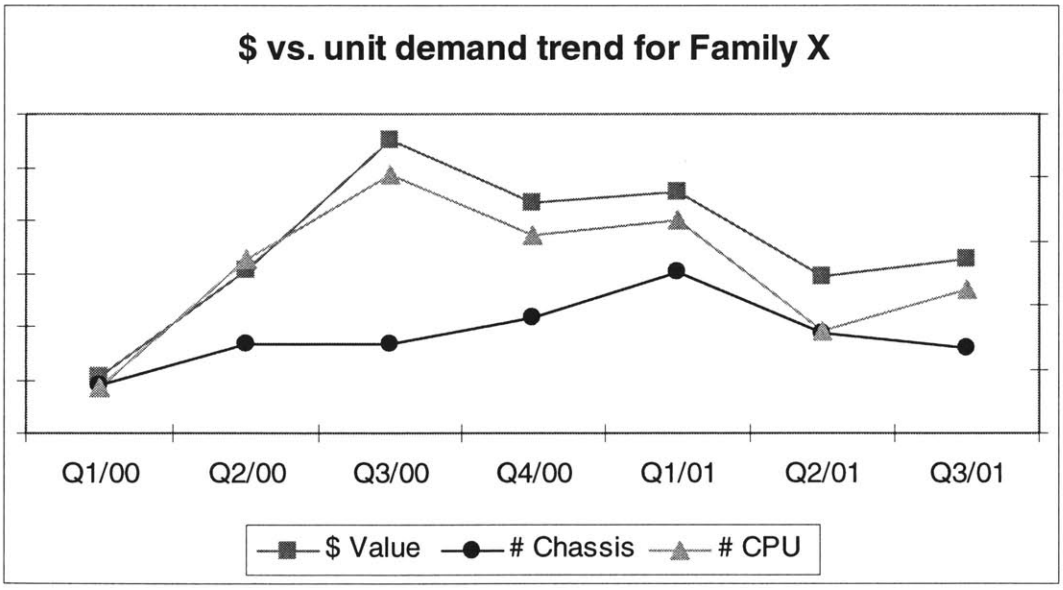


Figure 19, finally compares trends of sales in terms of dollars vs. sales in terms of units. The unit comparison is conducted against the two most basic units of the product – the chassis (the body) and the CPU (the brains). The numbers are for the entire family since a differentiation for the Chassis was not possible. In addition, the units are all revenue transaction type since naturally the dollar numbers are only from those transactions. Also these are WW numbers, although ROW shows the same results.

This graph again illustrates the difference in trends between the Chassis and the CPUs, yet it also shows that the CPU trend is identical to the dollar trend. It is expected to find higher correlation for the CPUs since it is more expensive than the Chassis, however the high correlation with the dollar trend is note worthy.

Figure 19: Units vs. $ Value Demand Trends for Family X



(2) Analysis of demand trends for Family K

Figure 20: Units vs. $ Demand Trends for Family K

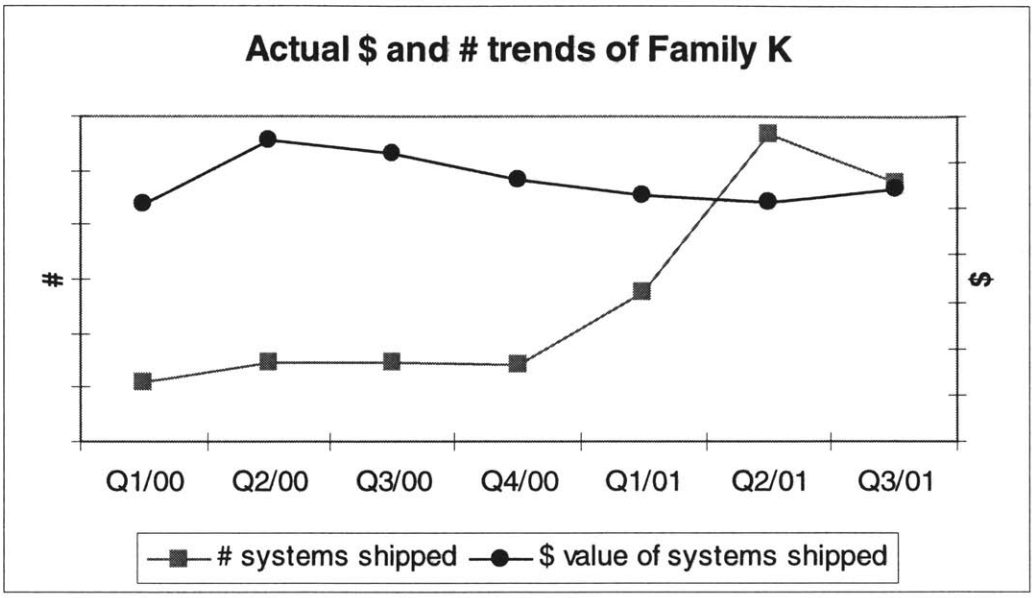
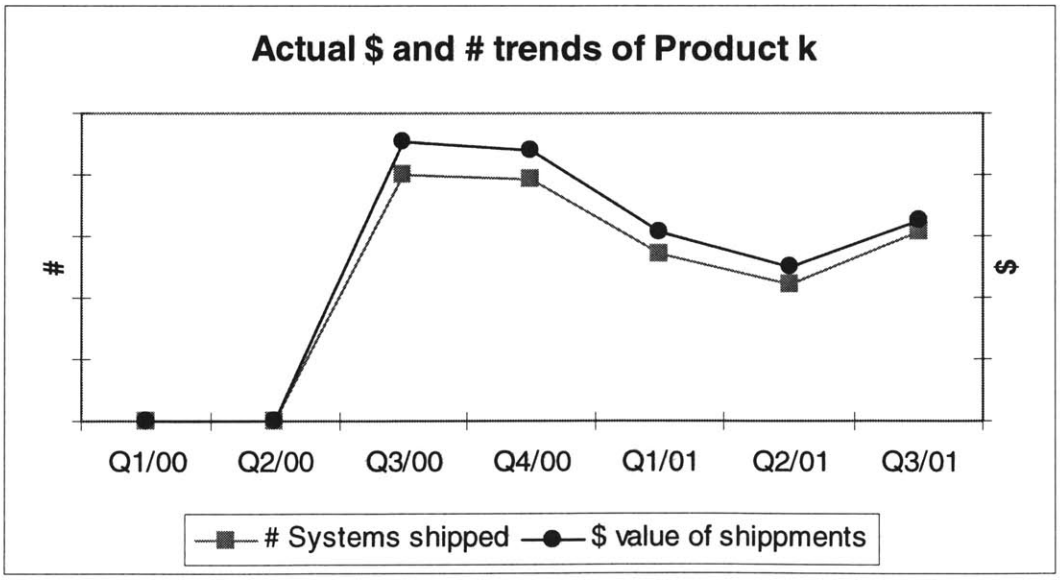


Figure 21: Units vs. $ Demand Trend for Product k



In this case (Figure 20), the selected product family is more like 'off the shelf' products. The difference between # of systems and $ value trends on the family level is thus somewhat surprising and interesting. An analogous comparison on a specific product within the family shows high correlation between the two trends (Figure 21).

A potential cause could be a shift in the portfolio structure adding new low-end cheap products. In such a case, a comparison per each product indicates high correlation, but when aggregated there is a miscorrelation where these low end products are introduced. If so, this is another argument that detailed unit level forecast can not be solely derived from an aggregate dollar forecast.

2. Customer Satisfaction Survey

Each company surveys its customer periodically and processes the information into strategic sales, marketing and product portfolio decisions. Such is the case at Nortel as well. Yet, as is the case in most companies, this information was unfamiliar to the back-end groups of the company. Analyzing this gap pointed into two main issues that needed to be addressed. First, revising the survey to include and analyze in a way that would enable the back-end to learn from the survey on an operational level. Second, stimulate interest at all levels of the back-end and put in place a model for issue resolution.

a. Old Process

There is a group at the corporate level responsible for conducting, analyzing and consolidating all customer related surveys. However, occasionally other groups in the company (such as R&D) would conduct surveys of specific interest. The main customer satisfaction survey and the only one as far as I know, is conducted twice a year by the corporate group. The process is highly automated with over 90% of responses conducted electronically. This enables automatic follow up, real time results, user specific reports and alerts of issues. In the last survey, over 80% of respondents were either decision makers or key influencers.

The survey data is then analyzed and presented on high level as well as break downs by categories/ product portfolio, product families, geographical region, key accounts and attributes as well as competitive comparison. The attributes are not rated based on average reply but rather as percentage of respondents that answer above a certain rate and below a certain rate. These reports are then posted on Nortel's Intranet and are accessible for all employees. Finally, the aggregate rate of total customer satisfaction is then compiled in the company's SUCCESS measurement, which determines whether the company achieved its semi-annual goal and if so the rate of employee bonuses.

From that point on, the survey analysis results are treated differently across the organization. Previously, within the Intelligent Internet supply chain group only senior management would review the results, struggling to conclude operational conclusions, while middle management was not even aware of the survey. As part of the internship project, we worked to identify gaps between required information and the current analysis, as well as increase awareness among middle management and staff to customer satisfaction in general and the survey results specifically.

b. Survey Improvement Opportunities

The way the survey is structured is that managers and client representatives are selected and given the questionnaire. The respondent is than asked general satisfaction questions regarding the whole account and is later asked to select one to two products within one product category he/she is most familiar with, and respond to the rest of the survey per that category. This by it self might create a situation where several high profile products get more exposure and feedback than others (for good or for bad), and some products may not be selected by any of the respondents.

So, for example in the last survey, the Intelligent Internet group had products in two categories. One of them had only 7% response ratio. In other words, only 7% of survey respondents chose that category as the one to answer the survey about, all the rest could not comment on this category. Likewise, the percentages get even smaller on the

product family level, since respondents are asked to select one to two product lines within a product category. In some cases a statistical minimum (of 30 data points) is not even reached. Finally, due to the fact that over 80% of respondents were either decision makers or key influencers, some of the technical questions were answered by only 40% of respondents.

In addition, the respondents are asked to rate each attribute on a scale of one to ten, one being unacceptable and ten being outstanding. Studies clearly point at disadvantages for a scale of ten over a scale of five or even seven. Respondents may not be able to differentiate between a six and a seven and if they do, it may not be consistent across respondents.

Moreover, only one general satisfaction question is aggregated into SUCCESS and its data is not aggregated based on average and standard deviation, but rather based on percent of respondents who chose above a certain rate. This way of measurement is representative if management wants to consider customer loyalty, since it is likely that very high satisfaction correlates with loyalty. However, this representation may fail to reflect customer satisfaction and compensate for a general improvement especially at the "problematic" accounts. Furthermore, it encourages account managers to concentrate on medium satisfied customers to push them towards very satisfied, while neglecting accounts that are clearly unsatisfied and have smaller chances to shift from one extreme to the other.

As mentioned above, this way of rating is used in all the reports across all attributes. Although, in these cases the percentage of responses for the low ratio are also presented, I still believe an average and standard deviation would be more representative. For example in one of the attributes for a product the attribute was flagged as a high performer with 34% highly satisfied. However, looking at the same attribute and product reveals that 28% were very dissatisfied. So, based on target measurement, we are golden with this product, yet are we really? Similarly, you can find cases where a product was flagged as a very poor performer with only 19% highly satisfied, while only 5% were very unsatisfied. Is this product better or worse than the first one?

Finally, the questionnaire analysis is lacking sufficient level of detail in order for the back-end to be able to extract operational feedback and learnings. Although, There are currently Customer Loyalty primes including primes per product/ process, they are generally "front-end" people. The organizational structure of the back end was not fully aligned with the front-end. So, since the questionnaire is aligned with customer segmentation and account management, back-end managers can not necessarily find a sense of ownership within the questionnaire. Not all there products are represented in the survey and not all the information they would like to know that implies their contribution to customer satisfaction is included in the questions.

c. Conclusion

To summarize, capturing and learning about customer satisfaction and priorities are key to implement CFSM. The back-end of the organization as well as suppliers need to close a feedback loop with the customers directly or indirectly. Internal communications is one way of achieving this goal, however is a large corporation there is a need for formal means of communication as well. A customer survey can be an important and effective tool for that purpose.

While most of the above opportunities for improvement can be implemented within the current survey and framework, there is still a need for a new survey. The current survey is a good medium for the front-end of the organization to learn about customer satisfaction and loyalty, and expanding it might jeopardize the focus of the survey and its response ratio. I believe a new survey targeted at different customer representatives with operations and supply chain considerations in mind should be designed.

The new survey would cover a selected range of products and drill down to specific products rather than stay at the product family level. In addition, the survey could specifically ask for customer satisfaction as well as priorities. Examples of issues to cover may include lead times, fulfillment, packaging, end of life management, order tracking, DOAs and more. Finally, the loop would be closed by assigning ownership to certain

products/ attributes and drive performance measurements of operations managers as well as suppliers based on the survey. This will ensure corrective actions are taken.

3. End Of Life Management (& Communication)

If you would ask customers about what they care about and what "makes them happy", I doubt proper End of Life (EOL) management would be on the list. Yet, it is one of those areas that can cause noise in the system and make customers unhappy when things go wrong due to poor EOL management. It is what I would refer to as a passive satisfier. EOL, as an outflow could originate anywhere in the value chain. It could start at the suppliers and end at the contract manufacturers, by simply identifying an alternative part or at the integrator redesigning the product. Alternatively, it could originate at the integrator deciding to discontinued a product due to a new generation or lack of sufficient demand.

Lack of management in either case, may cause significant dissatisfaction at Nortel's customers. In the first case, if a part is discontinued at the supplier level it may impact the end product due to shortages of inventory, which may cause backlogs and increased lead times. In the second case, if a product line is discontinued improperly, it may cause either shortages or excess inventory of the final product. If there is a new advanced product replacing the old one, customers may hold or even cancel orders for the old product as soon as they hear about the new one. Or, if there is no new clearly better product, customers might want to order more than usual number of units, since this is their last opportunity. This may cause shortages.

Finally, there are more potential loopholes and risks associated with poor EOL management. For example, deciding on a quantity of discontinued parts to stock up for maintenance and liability purposes (Last Time Buy). Forecasting demand after EOL announcement, or, providing sufficient time for all involved parties to put through orders and fulfill them. In this part, I will discuss how these issues are addressed at Nortel, especially in light of recent outsourcing of manufacturing and supplier management.

After reviewing the old and revised EOL management processes, it became clear this is something Nortel keeps high on its priorities. They had solid control over these issues during the transition from the old organization to the new one, besides on glitch that we will later look into. This is especially impressive due to the fact that there are thousands of SKUs managed by Nortel's Intelligent Internet group, and since the life cycles are relatively short, the group may have hundreds of discontinued SKUs. In the period of October 2000 to September 2001, there were over 900 EOLd SKUs in the Boston System House alone.

a. Old EOL Management Processes

In the old organization, Nortel had full control over these SKUs since they did most of the manufacturing and closely managed the contract manufacturers, first to third tier suppliers and commodities. As such, following is a list of roles and responsibilities, the group used to manage the process:

Table 3: Roles and Responsibilities in EOL Process

Function	Process Responsibility
Business Management	Holding Business Management responsible for creating the pricing strategy that will encourage customers to migrate to replacement products and services. They were also responsible for updating the Price Book to communicate end of life activities.
Legal	Holding a legal group responsible for creating agreements with business partners and end-users for the terms and conditions related to the purchase and support of products and services. And reviewing the impact of any end of life activity on those agreements and to assure that Nortel fulfills those obligations as a part of the end of life process.
Core Team	Holding a Core Team responsible for assessing the information

Function	Process Responsibility
	related to the end of life of a product and make recommendations to the Product Manager on the decision to enter the End of Life process. The team had representatives from all functional organizations that participated in the NPI process for a product including End of Life. These organizations included Product Manager, Program Manager, Manufacturing, Customer Service, Engineering Services, Business Management, Sales, Marketing and Legal.
Customer Service	Holding Customer Service responsible for supporting a product per any obligations that have been established for that product and per any agreements that have been made for specific customers or as required by an agency or country to conduct business with them. They were to review contracts, assess risks with entering the end of life process, develop support plans and make final buys that will support the repair commitments for that product until end of service.
Development	Holding a part of the Development organization responsible for completing the End of Life Engineering Change Order (ECO), flagging unique parts in the information system, phasing out documentation and agency approvals and pre-approving any ECO work requested for an "end-of-lifed" product.
Manufacturing	Holding Manufacturing team responsible for determining the supply and the demand requirements for an "end-of-lifed" product. They were responsible for monitoring and controlling material dispositions to mange costs on the product and responsible for completing the last production builds for customers and the Customer Service organization.

Function	Process Responsibility
Product Manager	Holding the Product Manager responsible for managing a product through the entire life cycle of the NPI process including Retirement or End of Life. The Product Manager convened the Core Team to make the decision to enter a product into the End of Life process, to make the internal notification that a product has entered the EOL process and to develop the Sustaining Engineering plan for the product.
Program Manager	Holding the Program Manager responsible for developing the implementation plan and obtaining commitments for the implementation team. The Program Manager was responsible for setting up review meetings during implementation and for assuring that the plan is met.
Sales and Marketing	Holding Sales and Marketing organizations responsible for reviewing customer impact from end of life of a product. They were also responsible for notifying the field of end of life activities and updating the Intranet with support information. They were also responsible for notifying the Channel organization of end of life activity and updating them with support information. They were also responsible for notifying a targeted set of customers of the end of life activities and reminding all customers of the last order date.

b. Improvement Opportunities

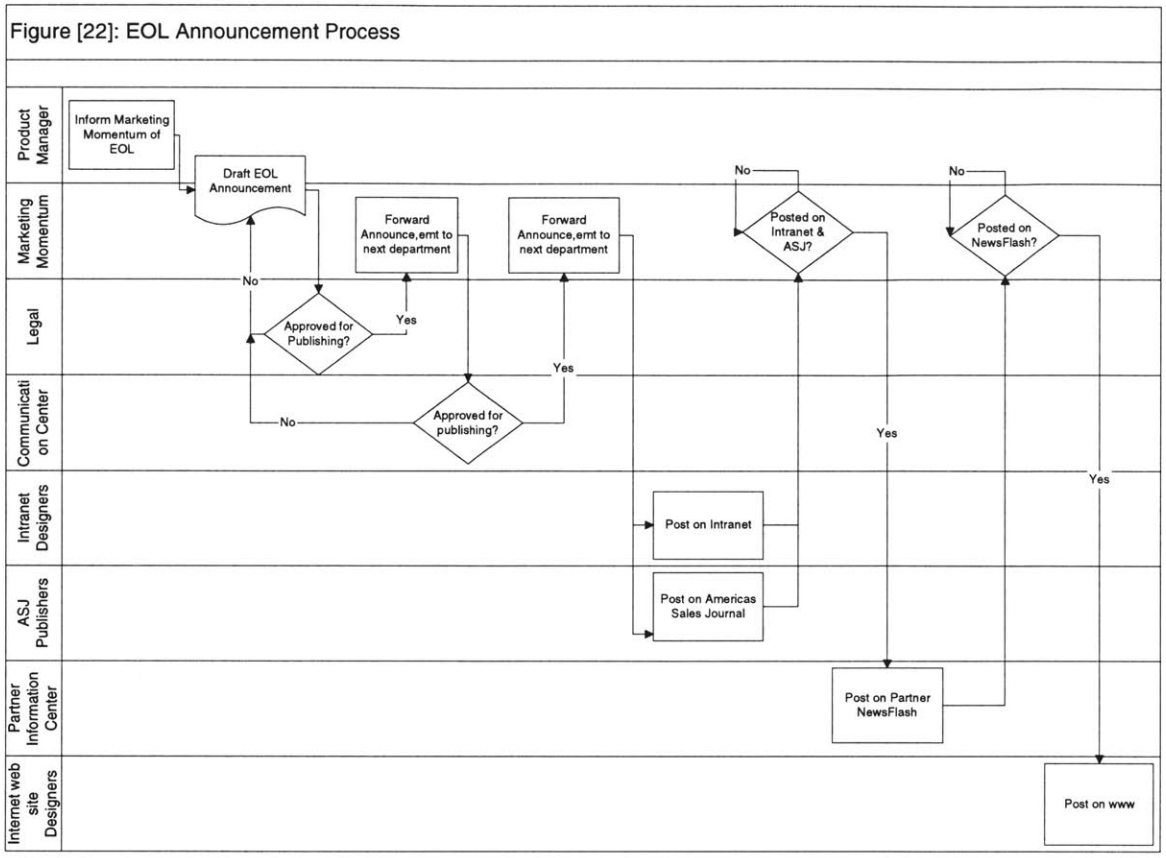
However, over time with reorganizations and the transition to the new outsourced model, the roles and responsibilities changed, leaving the Product Managers and Operations group largely in charged for most of these activities, yet with even less control over decisions and information. From this point on, it seems like the process was

divided into two parts. First, the logistics aspects of EOL and second was the communication aspect. The first was thoroughly addressed by the Operation group to ensure no shortages or excess inventories occur. The second however, was neglected in the grand scheme of things, and its revolution is described in this sub-section.

As part of my internship, I interviewed Product Managers as representatives of the front-end of the organization, and Operations and Supply Management managers as representatives of the back-end. When speaking with Product Managers a complaint was voiced, that they do not know of EOL decisions (originated by suppliers or CMs) enough in advance, and by the time they collect back information from the field regarding demand and customers' last buys, it is already too late, and the product/part can no longer be manufactured. When speaking with Operations managers, a complaint was voiced that they inform Product Managers months in advance of EOLs, yet receive orders from the field and from customers in the very last minute. This causes noise in the manufacturing system, having to run in the last minute after parts that are obsolete.

This was clearly a situation where no one was happy and "both sides" were complaining about the same phenomena. After tracking EOL process and announcements for a few products, I found that the source of the problem is mainly in the communications process. According to the process mapped based on interviews with the Marketing Momentum group, the group responsible for facilitating all outward communications, the EOL announcement theoretical process is presented in Figure 22. According to this process, the EOL announcement should reach Nortel's customers within 30 to 49 days. That as it is seems too long.

Figure 22: EOL Announcement Process



- Intranet – means of communication to all Nortel employees.
- External web site – means of communication with end customers. The web site is accessible to the entire public.
- America's Sales Journal – means of communication with the field sales force.
- Partner NewsFlash – means of communication with Nortel's partners and distribution channels.

Next step was to follow the actual process for a few products, which findings are documented in Table 4: Example of EOL External Announcement. It is important to remember that these examples were taken in the midst of major organizational restructuring and since this research was conducted, this process and most of the involved groups no longer exist.

In this example, the sequence of communication is out of order and the entire process takes too long. As you can see, the formal communications follow the discontinuation on the price list, which means that if customers are alert they will learn about the discontinuation of the product from the price list. However, if we assume they do not follow the list carefully every month, then they might learn about it just a few weeks prior to the last ship date. Yet, in any case, end customers might learn about the discontinuation (via the web) before partners do (via their newsletter), and either way, everyone learns about it after the last formal order date.

It seems like the cause for the complaints brought earlier, is a communication problem. In some cases the process for announcement is triggered too late and in others it starts on time but take too long. This may have many implications including shortages and therefore unhappy customers, or excess obsolete inventory due to late returns from distribution channels, and sometime even both.

Table 4: Example of EOL External Announcement Timeline

EOL Announcement Timeline for Product x

Date	# of days after last order date	Activity
31-Jul	0	Last order date
1-Aug	1	Discontinued on price list
12-Sep	43	Posted on intranet
18-Sep	49	Posted on external web site
26-Sep	57	Posted on America's Sales Journal
1-Oct	62	Posted on Partner NewsFlash
31-Oct	92	Last Ship date

c. Conclusion

To summarize, in Nortel's case, the restructuring reduced the number of groups involved and eliminated some of the bureaucracy in the process. Furthermore, awareness to this risk alone, is enough to accelerate the process and for functions in the organization to realize the importance of following through the communication process to the end. In addition, the importance of identifying a role for overseeing phase-in and phase-out of products was illustrated, to ensure that new product replacements are not launched prior to proper phase out of retiring products. Finally, to help expedite the process, a list of EOL triggers was prepared and integrated into the new process, and EOL predictions are routinely presented at staff and management meetings. The sooner everyone knows about EOL potentials the better.

4. Nortel and CFSM

Observing industry characteristics as described in II.3.a Industry Characteristics Nortel's Intelligent Internet group is in a fast clockspeed industry with high need for differentiation. Thus, Nortel stands to gain the most from becoming CFSM oriented but is also faced a challenging environment to do so.

In addition, the other company specific characteristics as described in II.3.b Company-specific Characteristics, are not making it easier for a CFSM implementation. The company is a large global corporation with tens of thousands employees and a very modular supply chain architecture: Nortel's groups as well as suppliers and customers are spread around the world (no geographical proximity); organizational structure is complex with functions that sometimes are split under separate management groups (no organizational proximity); culture is diverse due to historical acquisitions (no cultural proximity); and although the company has advanced intranet and reporting systems, the transactional systems are a combination of patches again due to acquisitions and fast growth (medium electronic proximity).

Furthermore, although Nortel has the market power to impact the value chain, it first has to bring its internal clockspeed in sync with the industry's clockspeed. For example, price lists are published once a month, with prices being set about a month prior to publishing it. Thus, any attempt to change a price on the price list due to inventory levels to shape demand would only have an impact two to three months later.

To summaries, at the time of the internship Nortel's Intelligent Internet group, was not yet ready to implement the seven CFSM steps. Nevertheless, smaller steps were taken when local improvement opportunities were identified. Once the survival stage in this current downturn is over, Nortel needs to analyze its supply chain architecture and define it, as they would like it to be. The first question Nortel's management needs to answer is how much of the supply chain management activities and responsibilities do they want to outsource. In the past two years, supply management activities from manufacturing to logistical distribution were consistently outsourced. Obviously, a company that does not control the supply chain has less impact on it becoming customer focused. Yet, if Nortel wishes to maintain control over supply chain management as well as improve internal integration, CFSM could be used as a trigger for such an effort kickoff.

IV. Conclusion

As described in this thesis, there is no doubt that with globalization and thus increased supply chain complexity combined with intensified competition and thus higher customer expectations, supply chain's role in strategic management and company's positioning is becoming key. There have been many approaches and buzz words thrown around in recent years trying to predict the next evolution of supply chain from collaboration through virtual integration to mass customization.

However, each of these approaches looks at the supply chain from a somewhat narrow perspective. Virtual integration looks at the value chain from an information-systems point of view. Mass customization looks at the issue from a strictly marketing and manufacturing perspective. Customer Focused Supply Management is a framework introduced attempting to generalize the necessary steps to enhance a supply chain to the next generation. This framework can be used as a guideline in parallel to other methods or strategies, such as mass customization.

The framework provides seven steps for realigning the back-end of the organization with the front-end, identifying potential strategic synergies and improvement opportunities. The framework also provides the tools to assess the extent of potential benefits as well as barriers in implementing CFSM, by industry and company characteristics. Since CFSM main goals are improving customer satisfaction and helping balance supply and demand, there are many more fringe benefits such as decreased bullwhip effect, reduced inventory levels and so on.

Finally, since the thesis followed a six month internship at Nortel Networks, three key processes were analyzed and documented, with the though of customer experience in mind. Due to the economic downturn and major restructuring at Nortel during the period of the internship, implementing CFSM in full scale was impossible. Nevertheless, numerous improvement opportunities were identified and implemented as well as a beginning of a cultural shift towards back-end awareness to customer satisfaction was launched.

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      CBS Market Watch

Appendix 1: Nortel's Recent Income Statements

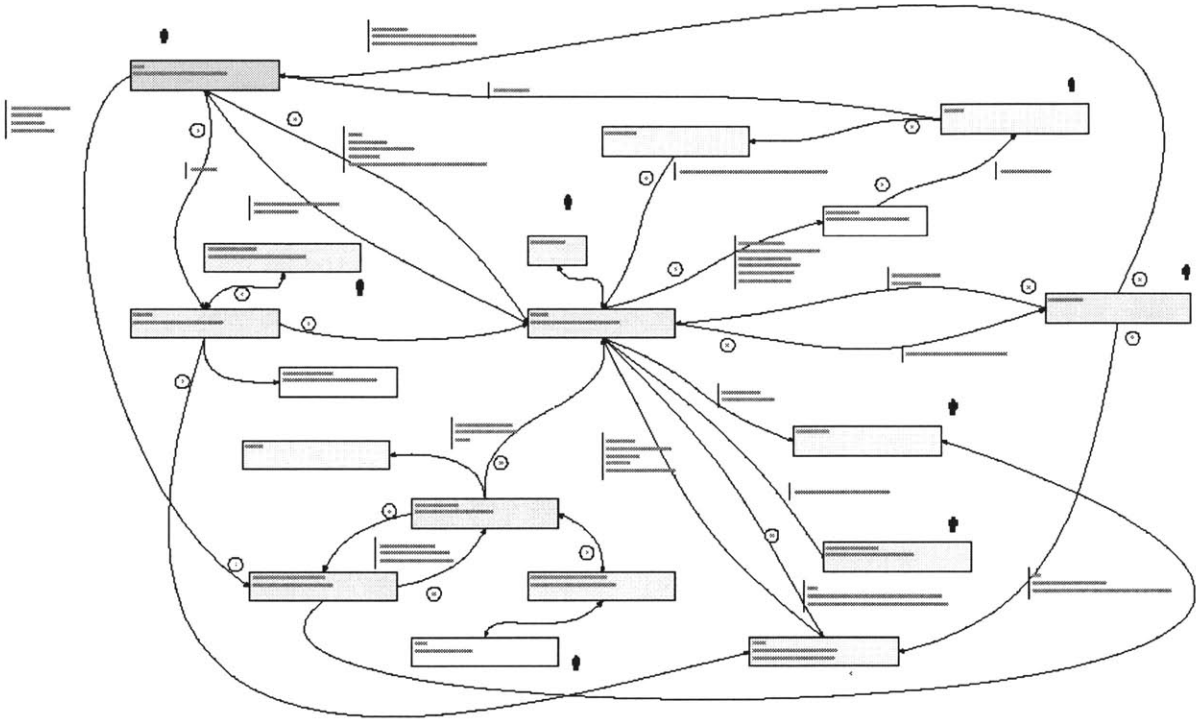
Table 5: Nortel's Income Statements 2000-2001

Period Ending:	Annual 2001	Q4/01	Q3/01	Q2/01	Q1/01	Annual 2000
Total Revenue	$17,511	$3,456	$3,694	$4,184	$6,177	$30,275
Cost Of Revenue	$14,167	$2,417	$3,673	$3,760	$4,317	$17,103
Gross Profit	$3,344	$1,039	$21	$424	$1,860	$13,172
Operating Expenses						
Research And Development	$3,239	$563	$808	$826	$1,042	$5,496
Selling General And Administrative Expenses	$6,020	$1,027	$1,951	$1,614	$1,428	$5,831
Non Recurring	$15,893	$989	$979	$13,537	$388	$271
Other Operating Expenses	$4,955	$526	$639	$1,821	$1,969	$4,813
Operating Income	($26,763)	($2,066)	($4,356)	($17,374)	($2,967)	($3,239)
Total Other Income And Expenses Net	($485)	($217)	($186)	($143)	$61	$1,016
Earnings Before Interest And Taxes	($27,248)	($2,145)	($4,680)	($17,517)	($2,906)	($2,223)
Interest Expense	$311	$91	$77	$88	$55	$169
Income Before Tax	($27,559)	($2,236)	($4,757)	($17,605)	($2,961)	($2,392)
Income Tax Expense	($3,252)	($410)	($1,289)	($1,187)	($366)	$1,078
Equity Earnings Or Loss Unconsolidated Subsidiary	N/A	$138	($138)	N/A	N/A	N/A
Net Income From Continuing Operations	($24,307)	($1,826)	($3,468)	($16,418)	($2,595)	($3,470)
Nonrecurring Events						
Discontinued Operations	($3,010)	N/A	N/A	($3,010)	N/A	N/A
Effect Of Accounting Changes	$15	N/A	N/A	N/A	$15	N/A
Net Income	($27,302)	($1,826)	($3,468)	($19,428)	($2,580)	($3,470)
Net Income Applicable To Common Shares	($27,302)	($1,826)	($3,468)	($19,428)	($2,580)	($3,470)

Numbers are in millions (data source: Yahoo! Finance)

Appendix 2: Forecasting Related Information Flow in IT Systems

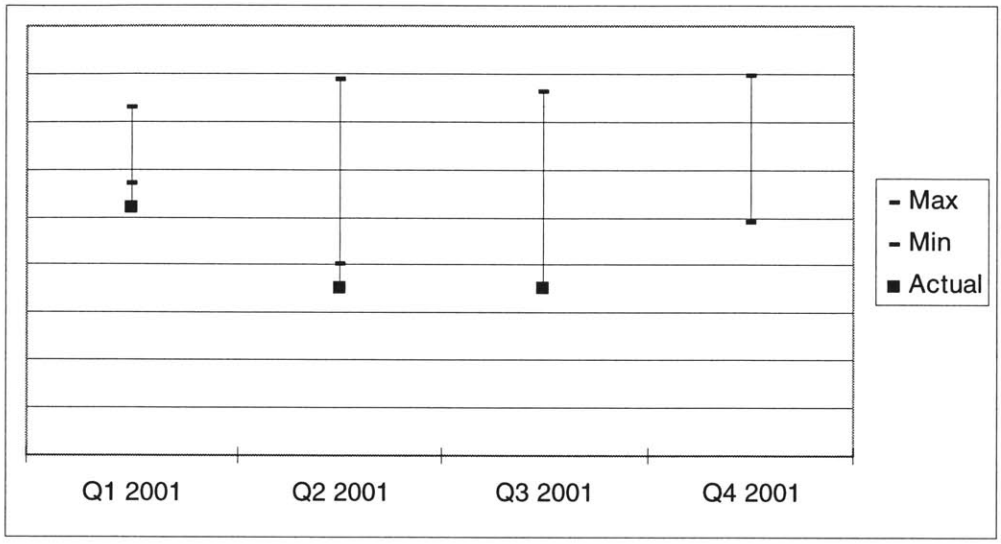
Figure 23: Map of Nortel's Related IT systems



Note: This chart is not intended for the reader to be able to read each system description but rather provide an overall visual representation of the number of information systems involved and complexity of data flow in the company.

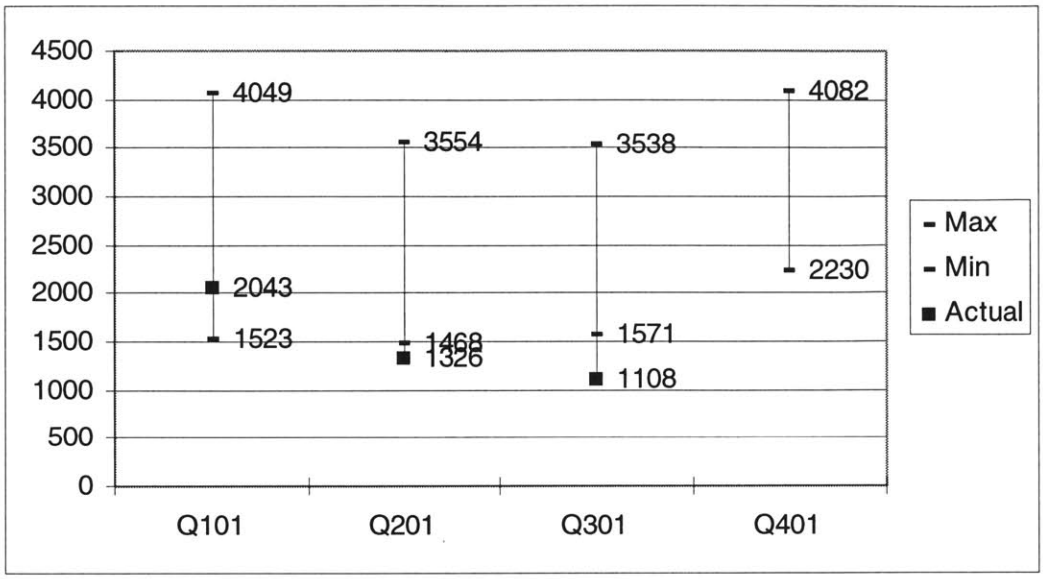
Appendix 3: Stock Charts for Forecasting Variability

Figure 24: Range of forecasts in comparison to actual (OSP for Product x)



This chart is based on Data from 11/2000 to 9/2001, and therefore Q4 is not complete, and there are no "actual" numbers for Q4. Nevertheless, The difference between maximum forecast and minimum forecast ((max-min)/min) for this period varies from 28% to 96%.

Figure 25: Range of forecasts in comparison to actual (units for Product x)



As shown in the chart, the difference between minimum and maximum forecast ((max-min)/min) within this period varies from 125% to 166% in this example.