SYSPRO

supply chain, inventory management and optimization

SKILLS FOR SMALL BUSINESSES

A comprehensive guide to the concepts, techniques, and technologies of SYSPRO supply chain, inventory management and optimization.

First Edition

SYSPRO™
Simplifying your Success

Sean Wheller

Supply Chain, Inventory Management and Optimization

Skills for Small Businesses

Sean Wheller
SYSPRO (PTY) Ltd.

Supply Chain, Inventory Management and Optimization: Skills for Small Businesses

by Sean Wheller and SYSPRO (PTY) Ltd.

Published 2004

Disclaimer

Every effort has been made to ensure that the contents of this book are factual and correct. However, this does not mean that the book is free from error. In addition, this book is intended as an introduction to the concepts and tenets of the subject matter and should be used as such. This publication is designed to provide general information regarding the subject matter covered. Each business is unique, laws and practices often vary from country to country and are subject to change. Because each factual situation is different, specific advice tailored to the particular circumstances should be obtained from a qualified expert. SYSPRO (PTY) Ltd. in no way accepts responsibility for any damage or loss incurred due to decisions and actions that are taken based on this book. The author and publisher specifically disclaim any liability resulting from the use or application of the information contained in this book, and the information is not intended to serve as legal advice related to individual situations.

Table of Contents

List of Figures

List of Examples

List of Equations

Preface

About this Book

When SYSPRO decided to develop an Inventory Optimization module for its Enterprise Application Suite, it became apparent that many of the people using the system would not be experts in this highly specialized field. It was therefore decided to write a book that would explain the tenets of Inventory Optimization and place it in context of modern supply chain practices, in a manner that is easy to understand, and so this book came to be.

Written as an introduction to inventory optimization, this book is well suited to people who have little or no knowledge of supply-chains, inventory management or optimization but, for one reason or another, now have a need to understand this subject. Perhaps the company you work for has just implemented an inventory management and optimization system. Perhaps you are considering how to improve the inventory management and optimization within an existing business. You may even be considering implementing such a system and integrating it with your already existing system. If you are in any of these situations but know little about Inventory Optimization, this book aims to provide you with a better insight into the tenets of supply chain, inventory management and optimization so that you may make better decisions or better understand the system you have or are about to implement.

In general, the book is divided into five parts. Each part focuses on a different aspect of inventory. The first part provides an introduction to supply chain, Inventory Management, and Inventory Optimization. This part acts as the glue to bring these subjects together so that the remaining parts of the book can be understood in context of one another.

Starting with the supply chain, the book takes a high-level look at how inventory moves from manufacturers through to end customers and the decisions a business must make in order to shape a supply chain that is well suited to its needs.

The next part takes a look at Inventory Management. This part is mostly concerned with the practices a business should have in place in order to have control of inventory. Sound Inventory Management practices and an understanding of supply chain are the foundations to Inventory Optimization. To understand Inventory Optimization, one must therefore have an understanding of supply chain and Inventory Management.

The third part of the book focuses solely on Inventory Optimization. It assumes you have not jumped directly to this point, but that you have read the parts on supply chain and Inventory Management. If you have read the book from the start, then understanding the concepts of Inventory Optimization will be easy. This is not a reference manual, but a book that should be read from front to back.

The last part brings everything back together again, this time also taking a look at the use of technology to implement an electronic collaborative supply chain that improves the way trading partners can cooperate.

Acknowledgments

Any work of this nature is a collective effort of many people. Thanks goes to the following people who contributed their time, knowledge and patience to the project.

Simon Conradie, a leading expert in the field of Inventory Optimization, without whose help it would have been difficult to separate facts from fiction. Many thanks for taking the time out in your busy schedule to review and comment. Your clear and simple explanations made understanding this complex subject so much easier.

To Stanley Goodrich, your years of experience as an editor have been an invaluable aid in improving this book. Thank you for all the time and effort you put into reading and checking, time and again as we went through the revisions.

To Phil Duff, CEO of SYSPRO. Thanks for believing in me when the work got tough. Your inspiration and determination to never drop the project is what spurred me on when I thought I could do no more.

SYSPRO Enterprise Software

SYSPRO enterprise software is the foundation of successful supply chain management. SYSPRO meets the comprehensive information technology needs of emerging companies with a totally integrated solution that encompasses: ERP, APS, CRM, Inventory Optimization and C-Commerce. SYSPRO software enables companies in a variety of industries to maximize the planning and management of business processes to better position themselves in their respective markets, ensure customer fulfillment, and ultimately, to improve bottom-line results. Visit the SYSPRO Web Site [http://www.syspro.com] for more information.

Tell Us What You Think!

As the reader of this book, *you* are our most important critic and commentator. We value your opinion and want to know what we are doing right, what we could do better, and other thoughts, words of wisdom and constructive criticism you don't mind sharing with us.

You can email the author [mailto:publications@za.syspro.com] of this book directly, with your opinions or with other book ideas that you would like to see on the subject of SYSPRO. If you have a story to tell about your experiences, share them with us.

We will reply to every message sent. However, please do not expect an immediate answer as it takes time to give ideas and comments serious consideration.

Conventions

The following admonitions will be found throughout the book:

A note presents interesting, sometimes technical, pieces of information related to the surrounding discussion.

A tip offers advice or an easier way of doing something.

A caution advises you of potential problems and helps you to steer clear thereof.

A warning advises you of a hazard condition that may be created in a given scenario.

Cross reference conventions for print will be shown as follows:

- Internal references will look like this: Part I, “Introduction” [1]. The numeral contained by square braces is the [page number].

- External reference, say to a Web Site, will look like this [http://www.somedomain.com].

PDF, HTML or XHTML versions of this document will use hyper-links to denote cross-references.

Type conventions will be shown as follows:

- File names or paths to directories will be shown in **`monospace`** type.
- Commands that you type at a prompt will be shown in **bold** type.
- Options that you click, select or choose in the user interface will be shown in **`monospace`** type.
- When variables, parameters, SGML tags, etc. are contained within a paragraph of text, they will be shown in **monospaced** type. Otherwise they will use the normal type.

Menu selections, mouse actions, and keyboard short-cuts:

- A sequence of menu selections will be shown as follows: File-> Open
- Mouse actions shall assume a right-handed mouse configuration. The terms "click" and "double-click" refers to using the left-hand mouse button. The term "right-click" refers to using the right-hand button.
- Keyboard short-cut combinations will be shown as follows: Ctrl+N. Where the convention for "Control", "Shift", and "Alternate" keys will be Ctrl, Shift, Alt, respectively, and shall mean to hold down the first key while pressing the second key.

Code conventions:

- Code and mark-up samples will be formatted in a grey block.

- Sometimes lines of code or mark-up examples will be longer than the page width. To avoid their running off the page, the slash character "\" is used to denote a soft line break. This means that the line of code is in reality meant to be on one line, but for print formatting it has been broken into two lines.

Part I. Introduction

Welcome to the first part of this book. Our objective in this part is to provide you with a broad overview of the subjects we will be covering in later parts. More specifically we aim to put the subjects of supply chain, inventory management and optimization in context for small business owners before we dive into explaining the concepts and considerations for each.

After reading this part you will:

- Be able to 'contextualize' supply chain, inventory management and optimization for small business.
- Be able to set objectives for attaining supply chain, inventory management and optimization for a small business.
- Understand the broader concepts for selecting and implementing processes and technologies to support supply chain, inventory management and optimization in a small business.

Table of Contents

Chapter 1. Introduction

Everyday thousands of people come into contact with inventory or participate in a supply chain in their homes, at work and in their leisure time. Most of the time they give very little thought to this fact because the roles they play and the actions they perform are so commonplace as to be virtually transparent.

One does not have to look further than one's own kitchen to see supply chain and inventory management in practice. Assuming your kitchen is already fitted and equipped, people who use the kitchen to prepare meals, buy in food from local stores and fresh produce markets, store the food until they need to use it as an ingredient to a meal and then replenish the store in order to have the ingredients available to make the next meal.

At each of these phases the principles of supply chain and inventory management are in action. If we use an ingredient, we have to go to our supplier and buy more. Often we use the same suppliers, the same super market chain, the same green grocer, or the same chemist. We visit them on a regular schedule that can be measured in days, weeks or months depending on how much of the ingredients stored are consumed in our meals. Each time we deplete an ingredient we add it to our 'shopping list.'

We take stock of the ingredients we have in store just before we plan to visit a supplier. We add to and modify our shopping list based on factors such as what we plan to eat or if we plan to have many guests for dinner, how much we plan to eat. On certain occasions we add or remove items to and from our list in order to cater for changing circumstances. This is called inventory management, and our suppliers are our supply chain. In this scenario, we are our own end customers because we manufacturer and consume our own meals.

Many factors come into play when we make our purchasing decisions. When doing our groceries, we will buy more or less of an item based on factors such as whether it is a perishable or not. For example, we will buy bread and milk daily because they are consumed rapidly and have a short shelf life. In response to this our suppliers regularly restock their shelves with fresh bread and milk in the early mornings. By evening, the morning's stock is depleted and the cycle starts over again. Another factor in our purchasing consideration is the cost of items. Most of our suppliers have a choice of two or more types or brands of a product. For example, in the tinned foods section there may be numerous brands of Baked Beans, each with a different price. As the customer, we may choose one brand over another based on a price that fits our budget or quality that fits our taste. If our supplier is running a

special discount on our favorite brand of Baked Beans we may buy more than we normally would to take advantage of the low-low price.

With some items we will refuse to buy above a certain price, but equally refuse to buy the product with the lowest price due to our perception that the quality is not right for our taste. Should a supplier not have stock of our favorite brand, we would willingly drive to another supplier and buy from there, even though it costs us time and petrol. If one of our suppliers is constantly out-of-stock, we may give up shopping at this store in favor of another store that always has stock. If many customers did the same, the effect would be a reduction in cash flow for one store and an increase for another.

Many people have their kitchen management down to a fine art and are continually searching for suppliers with lower prices at the quality desired. In these cases, many people choose to optimize their kitchen operations. For example, cooking in larger quantities and freezing the meals that can be quickly reheated in the microwave during the week is one example of optimization that takes place in a kitchen. The advantage here is that larger quantities of food can be purchased at lower prices and cooked with less electricity, time and effort. During the week time is saved in the early evenings as meals are already cooked and just need to be placed in the microwave. Consequently, we have more time to do other things. The result is convenience, a reduced food bill and, hopefully, more money saved each month.

Our kitchen analogy is not far removed from the world of business. The concepts we have described are very much the same in every business. The main difference is that the risks are higher. Not having a particular ingredient for a meal will not lose you business in the domestic kitchen, but may well lose business for a super-market. Business owners must pay more attention to their supply chain and inventory and constantly find ways to optimize their operations in order to meet or exceed customer expectations and increase their profits.

Chapter 2. Objectives for Small Businesses

Many small businesses have an organic approach to their supply chains and inventory management practices. Methods and practices employed are generally the result of a arly in the business' life and rarely change after they have been used unsuccessfully. As circumstances change with time, small businesses very rarely re-e supply and inventory policies. Often, this results in loss of business to competitors who take a proactive stance toward these matters and could lead to the business becoming nonviable despite a strong market demand.

Every business can avert this situation by setting objectives and working toward achieving them. But what are the key objectives that a business can focus on when evaluating supply chain, inventory management and optimization strategies?

The ultimate desired result of any change or improvement should aid the business in achieving some or all of the following:

- Increased Customer Satisfaction
- Lower Carrying Costs
- Increased Revenue
- Reduced Capital Expense

There are many ways to reach these objectives. The method used will differ between businesses and may be the result of careful and expert analysis. However, in today's world where business moves at the speed of thought and environment changes in markets can happen just as quickly, where transport and communications are fast enough to source suppliers on a global scale, where customers have a wider choice than ever, there are three characteristics every supply chain and inventory management strategy must deliver:

- **Agility** - The ability to respond quickly to short-term change in the demand and supply equation and manage external disruptions more effectively.
- **Adaptability** - The ability to adjust the design of the supply chain to meet structural shifts in markets; modify supply network strategies, products, and technologies.
- **Alignment** - The ability to create shared incentives that aligns the interests of businesses across the supply chain.

For most small businesses the main drive of operations has been to continually enhance the ultimate objectives through streamlining. Making things work faster and more reliable does have a positive impact, but in today's world can no longer be the only attribute for supply chain and inventory success.

For businesses that have implemented computer automated systems in the last decade much of their motivation for moving from manual to computerized methods has been a desire to gain a competitive advantage by delivering services faster with less cost. In other words, the thinking was, "more streamlined the system the better." However, in recent years, due to various global changes at political and socio-economic levels, these systems have proved to be inflexible and slow to adjust. The objective for the future is to implement systems that strike a balance between speed, agility and adaptability. Yet, attaining a supply chain that is agile and adaptive is not always possible without the cooperation other businesses in the ecosystem. Alignment of interests between all businesses in the ecosystem is a key factor for success.

Chapter 3. Extending the Enterprise

If small and medium businesses are to have the ability to compete with large enterprises, they will have to replace manual systems with computer-automated solutions. To attain the objectives and qualities mentioned in the previous chapter, this will mean employing many of the technologies large enterprises use. Yet, small businesses do not have the same financial and human resources to manage and implement many of the technologies employed by big business.

The first step for a small business wanting to enhance its supply chain and inventory management policies is not always related to technology. As you will learn in this book, many of the concepts and practices of supply chain, inventory management and optimization can be implemented using 'best practice processes' and manual methods. In fact, it would be a fault to simply implement current processes in a software system just because they work in the current system. Many of the processes used in manual systems become redundant in context of automated systems, and very often several steps are removed from the human process and automatically derived from data contained in a database.

Just by re-evaluating current processes against the ideas suggested in this book, small and medium businesses can achieve significant cost savings and increased profits. In turn, these profits can be used to finance the implementation of computerized systems that will, in turn, serve to further enhance the cost savings and profits attained by implementing improved manual systems. Whether you choose to implement manual or computerized systems will depend on the particular circumstances of your business. In many cases manual systems are just to slow to cope with the current volume or complexity of work. Manual methods work well and are cost effective up to a point and then become more expensive and less responsive as work increases in volume and complexity. Having said this, it is usually easier to implement computerized systems in companies that have been using 'best practice processes.' However, the longer a company takes to automate systems and the larger the company grows, the more time it will take to implement technologies. In addition, manual methods are not always easy to manage when trying to increase the level of cooperation and collaboration.

In implementing technologies small businesses are often under the misconception that they need to implement a full system in order to derive benefit. This is not necessarily the case. Very often small businesses can implement part of a system and

derive significant benefit. The trick is to identify those business processes where automation will produce most significant gains. They can then be implemented using a core platform that is both modular and a good fit to the business' requirements. By identifying such processes and prioritizing them in order of highest to lowests benefit, small businesses can plan an affordable information technology strategy and ensure interoperability and compatibility between core platforms and 'best of breed' solutions.

The initial focus of any information technology strategy will be on internal operations. However, this focus must remain sensitive to any future needs imposed by operations. As the implementation of internal systems progresses, there will be a greater shift towards streamlining and automating external processes.

Depending on the scale of internal implementations, there will come a point where the information system will need to extend beyond the logic borders of the internal business operations. The methods and concepts of this stage are explained in greater detail later in this book. The general concept is to continually extend the capabilities of the enterprise beyond the borders of the business so that information flows freely both intra- and inter-enterprise. By implementing in a modular manner and ensuring external considerations can be supported at all times, small businesses can gain additional cost savings, increased profits and an enhanced competitive edge against other small competitors. They can also more easily strive to level the playing field with their larger competitors.

Part II. The Supply Chain

Everything is Connected

This part provides an introduction to the modern supply chain. It explains the difference between the terms 'Supply Chain' and 'Logistics' and examines the basic decisions a business must make make about the supply chain and the mechanics that make the supply chain tick. This part also provides a description of supply chain taxonomies and their operations.

After reading this part you will:

- Understand the difference between supply chain and logistics activities.
- Understand the decision process required for supply chain planning.
- Understand the role your business plays in the supply chain.
- Understand the basic stages of a supply chain and the operations that take place with each.

Table of Contents

Chapter 4. Introduction

A supply chain is a linked set of resources and processes that begins with the sourcing of raw material and extends through to the delivery of end items to the final customer. A supply chain is comprised of vendors, manufacturing facilities, logistics providers, internal distribution centers, distributors, wholesalers and all other entities that lead up to final customer acceptance.

Every business is part of one or more supply chains and has a role to play in each of them. How a business plays its role in the supply chain has a direct impact on the efficiency of the business and the supply of goods to the final customer. Understanding how a business participates in a supply chain and the role it plays is an important part of doing business today. Businesses that are able to build and participate in strong supply chains have a substantial competitive advantage to those that do not. In this part of the book, we introduce the basic concepts of a supply chain, the management thereof and the impact of the supply chain on inventory within a business.

Supply Chain and Logistics

The terms *supply chain* and *logistics* are often used interchangeably. As a result, many people believe that these terms are just different words for the same thing. This is not the case. There is a difference between the concept of supply chain and the concept of logistics. 'Logistics' typically refers to activities that happen inside or between organizations in order to move items from one point to another. 'Supply chain' includes logistics, but refers to a network of businesses that work together in a coordinated manner to deliver a product to market. Confusion between the definitions of these concepts is common and most probably stems from a past where businesses attempted to own and control as much of their supply chains as possible. Many businesses do still own their own supply chains, but most businesses today choose to outsource as many of the functions of supply chain as possible in order to attain higher efficiencies and lower costs. Today's fast moving markets require a more flexible response with lower costs and higher efficiencies. Vertical integration has given way to "virtual integration." Businesses now focus on their core competencies and partner with other businesses to create supply chains capable of serving these requirements.

While logistics is a focus on transportation activities, such as procurement, distribution, maintenance and inventory management, supply chain management

acknowledges all of the logistic activities and extends to include activities such as marketing, sales, new product development, finance and customer service. The concept of supply chain is therefore more encompassing of all activities that play a role in fulfilling final customer requests. It views the businesses and activities conducted between them as a single entity as opposed to multiple separate entities. This perspective enables a system approach to be used in understanding and managing all the activities needed to regulate the flow of products and services. The ultimate goal of the system is to optimize all resources without conflicting the needs of various business requirements or sacrificing the service level provided to the end customer.

Effective management of the supply chain requires simultaneous improvements in both customer service levels and internal operating efficiencies of all businesses within the supply chain.

Basic Decision Pattern

Supply chain ecosystems are diverse in nature. Each has its own unique attributes, market demands and operating challenges. However, the basic issues remain much the same, allowing us to define a basic pattern of decision-making that is always the same. Whether collectively or individually, businesses must make decisions regarding their actions in five areas:

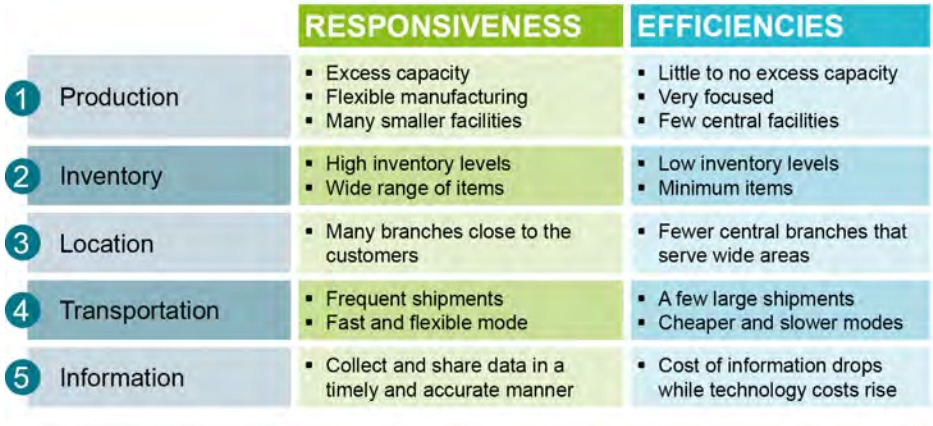
- **Production [17]**- deciding what to produce, how much and when.
- **Inventory [19]**- deciding what to stock at each stage of the supply chain, how much to stock and in what form.
- **Location [19]**- deciding where to produce and store inventory.
- **Transportation [20]**- deciding how to move inventory from one location to another.
- **Information [21]**- deciding what information to collect, how much and what to share with others in the supply chain.

Mechanics of a Supply Chain

In the previous section we outlined five key decision areas that form the basic pattern for supply chain management. These five areas are the points at which businesses can impact on the performance and capabilities of their supply chains.

In each area management will be faced with trade-off decisions between being more or less responsive or more or less efficient (See Figure 4.1, "Responsiveness versus Efficiency" [17]). The more responsive a supply chain is the better it can adapt to the market needs and unexpected increases in demand, but the greater are the costs. The more efficient a supply chain the less flexibility is available, but costs are lower. In the following section we discuss the trade-off under consideration for each of the areas in more depth.

Figure 4.1. Responsiveness versus Efficiency



Production

Production defines a business' capacity to make and store products. Similarly, production also defines the capacity of a supply chain's factories and warehouses to make or store products.

Production decisions are centered on establishing and maintaining a balance between responsiveness and efficiency. Production facilities that have capacity surplus to requirement are better able to respond to changes in demand than those that do not.

Yet, one cannot have capacity without cost. Factory or warehouse capacity is not cheap and, therefore, expensive to obtain in the first place. It carries on-going cost, and when not in use does not generate revenue. As a result, greater excess capacity adds to costs and makes the operation less efficient.

Facilities for production can be either *product focused* or *functionally focused*. When product focused, the facility is normally involved in the complete range of activities required in order to make a product. When functionally focused, the facility is more narrowly focused on performing a subset of the complete activities. Both methods have their benefits and drawbacks.

A product approach generally needs the facility to develop expertise about the whole product level with the result that there is a much reduced level of expertise for each component that comprises the product. Conversely, the functional approach results in a high level of specialist expertise about a component and a much-reduced level of expertise on the whole product.

As with production facilities, storage facilities can also be built to accommodate different approaches. In general there are three main approaches:

- **Stock keeping unit (SKU)** - This is the most conventional and easy to understand approach to storing products. It involves keeping and storing all products of a given type together in the same place. This approach makes optimal use of storage space, but makes the job of picking and packing more difficult.

- **Job lot storage** - In this approach different products related to the needs of a job are stored together. Job lot storage does not make optimal use of storage space, but dramatically improves picking and packing operations.

- **Crossdocking** - In this approach product is not actually kept in the facility for storage. Instead, arriving products of a single item are delivered in large loads that are broken into smaller quantities as customer orders are assembled to once again make a large load comprised of multiple product types. Arriving stock is not destined for storage. The crossdocking station is merely a transitory point to receive large loads in a single location and assemble customer orders that will be distributed to multiple locations. This approach is a mix of the previous two approaches. It requires efficient coordination in picking and packing operations, but if managed well, requires less storage space than either of the other methods.

Inventory

Inventory is found throughout the supply chain. It takes on many forms, from raw materials to finished goods. Most of this book is about inventory and the management thereof, because this is where most of the problems of business and the supply chain end up.

As with everything in the supply chain, managers must decide where they want to position themselves in the responsiveness and efficiency equation. Holding large amounts of inventory allows a company or an entire supply chain to be very responsive to fluctuation in customer demand. However, the production and storage of inventory are costs, and to achieve high levels of efficiency, costs of inventory must be kept to a minimum.

There are three types of inventory, each of which requires decisions that will impact on the production of inventory and the storage thereof:

- **Basic Stock [54]-** The exact quantity of an item required to satisfy a demand forecast.
- **Seasonal Stock [58]-** A quantity buildup in anticipation of predictable increases in demand that occur at certain times in the year or a known event such as a promotion or sale.
- **Safety Stock [58]-** A quantity in addition to basic inventory that serves as a buffer against uncertainty.

Location

The geographical location of facilities is an important factor to consider in the responsiveness and efficiency equation of the supply chain. The compromise here is the decision whether to centralize activities in fewer locations to gain economies of scale and efficiency or to decentralize activities in many locations close to customers and suppliers in order to be more responsive.

When considering location, managers should also take into account a range of factors that relates to a location, including: costs of the facility, labor, local skills availability, surrounding infrastructure, taxes and tariffs and proximity to suppliers and customers. Location decisions tend to be strategic in nature because they commit

large amounts of financial resources to long-term plans. They have a strong impact on cost and performance within the supply chain and are often definitive of the number of paths through which products can pass en route to the end customer.

Transportation

For inventory to be found throughout the supply chain it needs to move between the businesses in the chain. Transport costs of a supply chain operation can equal one third of the total operating cost. Transport decisions, therefore, not only impact response and efficiency, but also the cost of the product as it is traverses the supply chain. In transportation the trade-off between responsiveness and efficiency is realized when one mode of transport is chosen over another. In general, faster modes of transport provide a higher level of responsiveness in the chain, but are costly. Slower modes of transport are cost-effective, but rarely afford much flexibility.

There are four categories of transport: air, sea, land, and electronic, providing businesses with a range of eight transport modes:

- **Ship** — cost-efficient but slow, this method requires the business to be close to ocean ports with the capabilities to handle cargo.
- **Train** — cost-efficient but slow, this method requires the business to be close to rail terminals with the capabilities to handle cargo.
- **Pipeline** — very cost-efficient and quick, though restricted to liquid, gas or dry powder products that can be moved by pneumatics. Pipelines are however highly susceptible to pilferage.
- **Conveyor** — very cost-efficient and quick, this method requires a fixed point-to-point conveyor and belt infrastructure and can carry across reasonably flat terrain.
- **Cableway** — very cost-efficient and quick, this method requires a fixed point-to-point cable and bucket and can carry long distances over virtually any terrain.
- **Truck** — relatively cost-efficient, quick and flexible mode of transport. However, the cost is prone to fluctuations as fuel prices fluctuate and road conditions vary.

- **Airplane** — a very fast and responsive mode of transport, air transport is more expensive than most modes of transport and relies on the availability of appropriate airport facilities.
- **Communications** — electronic communication is the fastest and cheapest of all transport modes, but it relies on the product being in electronic format for transmission and reception.

It is common for a supply chain to employ a mix of transport modes when deciding how products will move between businesses. The type of product will often determine what transport modes can be used and how effective or responsive the supply chain needs to be. In general, higher value products, such as electronic components or pharmaceuticals, require a higher response level. Lower value products, such as bulk commodities or industrial machinery, require a network that is balanced in favor of efficiency.

Information

To make decisions about the supply chain managers need information that can connect and provide insight into all the other supply chain drivers. Information is used for two purposes in supply chain decision-making:

- **Managing activities** — Information is pivotal for decision making related to the production, inventory, locations and transport mechanisms in the supply chain as it enables businesses to determine supply and demand requirements. This, in turn, enables them to decide on production schedules, inventory levels, transportation routes and stocking locations.
- **Planning and forecasting** — Accurate, historical data is vital in anticipating future demand. Information is used to make forecasts that can be used as a guide for setting production schedules and timetables for a given period. Information can also be used for planning decisions, such as whether or not to build new facilities, enter a new market or exit an existing one.

As with the other supply chain drivers, there is a trade-off between efficiency and responsiveness. Good information is valuable, but the cost of obtaining accurate data is often high. In addition to this cost, businesses must also make decisions related to how much information they share with other businesses. Sharing information with

partners increases the overall efficiency of the supply chain. However, the more information that is shared, the greater the risk that the information may fall into the hands of a competitor. With an insight into product supply, customer demand, market forecasts and production schedules, competitors could devise counter strategies that could ultimately inflict damage on a business' bottom line.

Chapter 5. Taxonomy of a Supply Chain

A supply chain is comprised of segments. Within each segment are businesses. Each has inputs and outputs from/to other businesses. In this way businesses are connected with the purpose of moving a product or service to the end consumer. The simplest supply chain structure is comprised of three segments:

- Suppliers
- Sellers
- Buyers

Figure 5.1. Simple supply chain

A business within a supply chain is usually active in all three segments, as it generally needs to buy goods or services from suppliers (input) and sell to buyers (output). In order to make a profit a business must buy goods from suppliers at a lower price than a buyer is prepared to pay. To be viable a business must protect its profit margins.

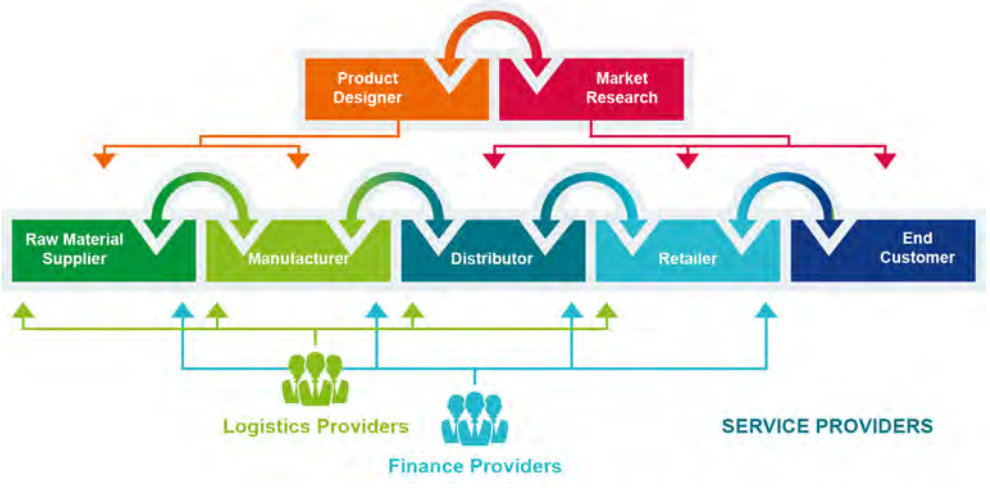
This simplistic view of a supply chain is common knowledge. Businesses are normally aware of this supply chain perspective, but rarely look beyond to understand what is called the "extended supply chain." Extended supply chains contain three additional types of participants:

- *Source Suppliers* - the supplier's supplier is usually located at the beginning of the supply chain.
- *End Customers* - the buyer or customer's customer located at the end of the supply chain.
- *Service Providers* - vertically aligned businesses that provide services to businesses in the horizontal supply chain.

Figure 5.2. Extended supply chain

This perspective of the supply chain is more complex and requires a broader perspective. Within any extended supply chain there can be any given combination of companies performing different or a combination of similar functions (See Figure 5.3, “Example of Extended Supply Chain” [25]). There may be companies that are in manufacturing (producers), distributors (wholesalers), retailers, and companies or single individuals that are the end customers (consumers). Service providers aligning their businesses with various segments of the extended supply chain, may support single or multiple vertical segments.

Figure 5.3. Example of Extended Supply Chain



The extended supply chain offers diverse choices and increases competition. Understanding what type of company a business is and the function it plays is an important part of running a business as it enables management to identify and focus on the core competencies of the business. In doing so management can better align their supply chain and business strategy. In the following sections we take a brief look at some of the common characteristics of each business type and the main role they play in an extended supply chain.

Producers

Any business involved in making or providing of a product or service is a producer, including:

- Businesses in the mining sector produce gold, platinum, gas, coal, etc.
- Businesses in agriculture that breed animals or grow crops.
- Businesses in manufacturing that use raw materials to make a finished product.
- Businesses that provide a service such as landscaping, construction, musician or artist.

Products can be produced in two forms:

- *Tangible* - bricks, wheels, paintings
- *Intangible* - software, music, film

Distributors

Distributors are businesses that buy products from producers in bulk quantity. Distributors generally hold large quantities of stock and supply smaller businesses rather than supplying direct to the public. Since distributors hold larger quantities of an item, their inventory level does, in effect, protect the retailer from most of the fluctuations caused by demand and supply. Some distributors provide services that assist retailers in the delivery of a number of product items to a given location. It is therefore common to find distributors running large warehouses operating in a cross-docking model. Distributors mainly act as agents, promoting products, tracking their demand and ensuring that the supply is always adequate.

Retailers

Retailers are businesses that sell directly to the end customer. Their inventory levels are generally lower than distributors, and they also sell in smaller quantities. Retailers, even in the same industry, are normally differentiated by the way they shape their businesses around the requirements of a specific group or type of customer. For example, a discount store uses price as the factor to attract price sensitive customers, while an up market furniture store attracts customers interested in quality, unique design or high service level.

Customers

Customers are generally individuals or businesses that purchase the final product or service for their own use or with the intention of reselling it as an integral component of a larger assembly. Customers are the drivers of demand. The greater the number of customers wishing to purchase a product or service, the higher the demand well be. When a product is in short supply, the product can generally command a higher price until such time as the balance between supply and demand is reached.

Service Providers

Service providers are businesses that have developed specialized skills to suffice a need. Service providers can be:

- *Horizontally focused* - providing a reasonable level of service across multiple stages of the supply chain.
- *Vertically focused* - providing a high-level of service and specialized functionality for a specific stage of the supply chain.

Service providers are also considered producers as they create the packaged or custom solutions or services their customers need.

Aligning Supply Chain and Business Strategy

Supply chain requirements are driven by customers' needs. Collectively, customers' needs create a general market requirement, which the supply chain has to service. In today's markets, businesses must design supply chains that are both efficient and responsive in order to address market requirements and remain competitive. Decisions made concerning the supply chain are therefore strategic in nature and an integral part of how a business approaches the markets it serves. To be successful, a business must combine an appropriate mix of responsiveness and efficiency. The overall result of the trade-offs made between efficiency and responsiveness must result in a corporate strategy that provides the best mix of both situations so that the business can gain or retain market share.

To develop and align corporate strategy with its supply chain, a business needs to have an understanding of the current and potential markets it serves, strengths and weaknesses, role in the supply chain and core competencies. This information is often helpful in assisting the company to determine a clear vision, mission and goals that can be communicated both internally and externally to the business. Once this is done, the business can focus on developing only those supply chain capabilities that it needs. Again, the decisions made about the five mechanics of the supply chain will be important in helping to determine the type and mix of supply chain capabilities needed to service market needs.

For example: A convenience store at a gas station and a high street super market will have different supply chains geared towards serving different customer needs. Customers shopping at the convenience store want the store to be in close proximity to their homes or offices. They are prepared to pay a premium price for goods in exchange for the ability to quickly get a small quantity of what they want without having to drive too far. Or they may be willing to pay the premium in order to buy goods in an emergency when the super market is closed. The extra cost is not a problem because the convenience store saves the customer time, the cost of fuel or the need to go without until the super market opens in the morning. The super market customers are almost the opposite. Price is an issue, so they are willing to drive further and buy in larger quantity to obtain a discount.

Consider how serving these two customer types will impact on the supply chains of the two businesses. The convenience store needs small quantities of a cross section of items to be located in close proximity to customers in order to provide the

maximum convenience. The supply chain should therefore be responsive in order to cater to the high-level of customer service expected from the market. The super market needs to keep prices down and hold a greater quantity and cross section of goods than the convenience store. The super market does not need as many stores. They can also be larger to serve as both a space for sale and storage of inventory. Efficiency will be key in this supply chain, to continually drive down costs.

Chapter 6. Supply Chain Operations

When discussing the operations of a supply chain, it is helpful to make reference to a working model. For this purpose we will use the SCOR model developed by the Supply Chain Council [http://www.supply-chain.org/]. The SCOR model (see Figure 6.1, “The SCOR Model” [32]), identifies four stages of business operations:

- *Planning* - Planning is the first activity of any business operation. It enables a business to organize how it will execute the other three operational activities. The main activities of planning are focused on:
  - Forecasting
  - Aggregate Planning
  - Pricing
  - Inventory Management

  Each of these activities is discussed in greater detail in Part III, “Inventory Management” [33].
- *Sourcing Products* - Sourcing operations include activities that are needed in order to identify and purchase the raw materials or components needed in order to create products or services. Broadly speaking, sourcing operations include:
  - Purchasing
  - Consumption Management
  - Vendor Selection
  - Contract Negotiation
  - Contract Management
  - Credit Management
- *Making* - Making operations include activities required in order to develop and build a product or service, including:
  - Design
  - Production
  - Facility Management
  - Order Management
- *Delivering* - Delivery operational activities are centered on receiving orders and delivering ordered products to customers. The main task in delivering is "Delivery Management."

These operations are executed within the constraints of decisions made when a business decides on the "Mechanics of a Supply Chain [17]."

Figure 6.1. The SCOR Model

Part III. Inventory Management

Controlling Your Stock

Part II, “The Supply Chain” [11] introduced the fact that every business is a part of a supply chain and that inventory exists at every point of the chain. We explained the difference between the terms supply chain and logistics. We highlighted the basic decision pattern every business in the supply chain undertakes in deciding trade offs between responsiveness and efficiency across the operations that make the supply chain tick.

In this part we focus on Inventory Management. We discuss the practices that are needed in order to control your 'stuff' and the basis upon which to implement an effective inventory optimization plan.

After reading this part you will

- Understand the principles of good inventory management.
- Understand the factors and considerations that impact inventory management.
- Understand the basic practices and planning techniques required for inventory management.
- Understand the available methods for recording inventory.
- Have the capability to recognize when things are wrong and take corrective action.

Table of Contents

Chapter 7. Introduction

Within the supply chain stock control is a key aspect of almost any business. The marketing success of a business is often dependent on its ability to provide customers with the *right* goods, at the *right* price, at the *right* time. The right goods are those that the customer wants; the right place is in the business' inventory, not the supplier's warehouse; and in today's economy the right time is immediately.

Inventory that comprises a business' stock is one of the most visible and tangible aspects of doing business. As a result, all the problems of business end up in inventory. Failure to have the right goods in the right place at the right time often leads to lost sales and profits and even worse, to lost customers. The reality of today is that there is very little to differentiate between products of the same type, and customers will, more often than not, choose to return to businesses that meet all three of these conditions, even choosing relatively unknown brands over known brands.

The role of inventory management is to coordinate the actions of all business parts, in particular, sales, marketing and production, so that the correct level of stocks are held to satisfy customers demand. In doing so, inventory management aims to balance the supply and demand equation by regulating the supply of goods to affect their availability in such a way that they match demand conditions as closely as possible. This aim is focused on two targets - customer service and cost reduction (inventory costs and operational costs). Hitting both targets results in improved customer satisfaction and increased profits.

Before we continue, it is necessary to make a distinction between the terms "Inventory Management" and "Inventory Control." For the purpose of this book the term "Inventory Management" will be used to refer to methods or processes. The term "Inventory Control" is used to refer to data or information retrieved from a ledger or computer.

Inventory management is a fundamental requirement prior to considering inventory or supply chain optimization. The processes for effective inventory management do provide a level of optimization, but are not considered to be optimization per se. Businesses that have not had effective process and control practices in place will therefore experience measurable results purely from the adoption of inventory management practices.

Many of these activities are logical and can be performed using manual techniques.

Small businesses that do not have large volumes can therefore easily implement inventory management practices without the need for software. As a business grows and inventory volumes and turnover increase, maintaining a manual control system becomes unfeasible and subject to problems, such as delay and human error. At this point, implementation of software specifically designed for inventory management helps to make the maintenance and management of inventory practices an easier, more accurate and streamlined process. However, before using such applications it is beneficial for people to have an understanding of these practices as it improves their ability to use and understand the features and functions provided by the computerized control systems. For this reason we discuss the concepts and activities of inventory management from the manual perspective.

As highlighted in the first part of this book, inventory management practices do not take place in a vacuum. Supply chain factors and the unique nature of a business often determine what inventory management practices are implemented and how they work.

From a financial perspective inventory equates to capital investment — money that is tied up until such time as the inventory is sold. How inventory is managed therefore has a direct impact on the cash flow of a business. The management of inventory is just as much about reaching customer service and cost reduction targets as it is about managing and controlling the financial assets of the business.

Since it is rarely the case that any business has the luxury of unlimited capital, inventory controllers have to make important decisions about what to buy, how much, and when to buy within the capital limits of the business. We call these value decisions. Excessive inventory investments can tie up capital that may be put to better use for other purposes within other areas of the business. On the other hand, insufficient inventory investment leads to inventory shortages that, in turn, lead to reduced availability. A balance must be struck and maintained.

Pricing strategy will also have a large impact on how this balance is maintained. Some businesses choose a strategy of low profit and high volume through lower prices, while others choose a high profit and lower volumes. Inventory quantities must be balanced with these volumes.

It is common to hear inventory referred to as an *asset*. However, in situations where there is an imbalance between supply and demand, inventory can soon move from the asset column to the liability column. Since perfect balance is often a difficult state to achieve, managers should always keep in mind that inventory may not be an asset until such time as it has been sold at a profit. It then increases the capital value that was initially invested in it.

Value decisions performed by the inventory controller revolve mainly around balancing the supply and demand equation by monitoring whether or not inventory management practices are achieving the desired targets for customer service, inventory and operational costs.

Decisions concerned with customer service can be considered from two perspectives depending on the nature of the demand environment. There are two types of customer service demand situations:

- **General stores** - service expected is 'availability ex-stock.'
- **Supply to specification** - service expected is delivery against request date.

Decisions concerned with the costs of inventory are made on the premise that capital tie up in stock will be kept to a minimum. Value decisions are generally focused on reducing the period for which items remain in stock. Importance is placed on slow moving items that are of high value or that consume large amounts of store space. Items that do not consume large amounts of resources are generally not considered to be a problem, unless they are large in volume and slow moving.

Decisions concerned with the costs of operations are made on the premise that services such as operations, stock control, purchasing and transportation are performed in the most efficient and cost-effective way so as to reduce the overhead of doing business.

While the purpose of inventory management is to optimize the performance of these objectives, the role of the inventory controller is to orchestrate inventory management to meet all objectives at the same time. To perform this role effectively the stock controller must constantly monitor a number of variables and must be trained in identifying the effects they have on objectives. Knowing the cause of a problem is often half the battle and reduces the time in which inventory problems can be solved.

In the section called “Mechanics of a Supply Chain” [17] we discussed a framework under which trade-off considerations between efficiency and responsiveness had to be made. Within this framework there is a fine line between keeping too much and too little inventory. In addition to these considerations, inventory controllers must also be concerned with:

- Maintaining a wide assortment of stock - but not spreading the rapidly moving items too thin.
- Increasing inventory turnover - but not sacrificing customer service levels.
- Keeping stock low - but not sacrificing service or performance.
- Obtaining lower prices by making volume purchases - but not ending up with slow-moving inventory.
- Having adequate inventory on hand - but not getting caught with obsolete items.

How effective a business can be in addressing these concerns varies between businesses. Since factors such as the types of inventory, turn around rate and type of business result in varying outcomes.

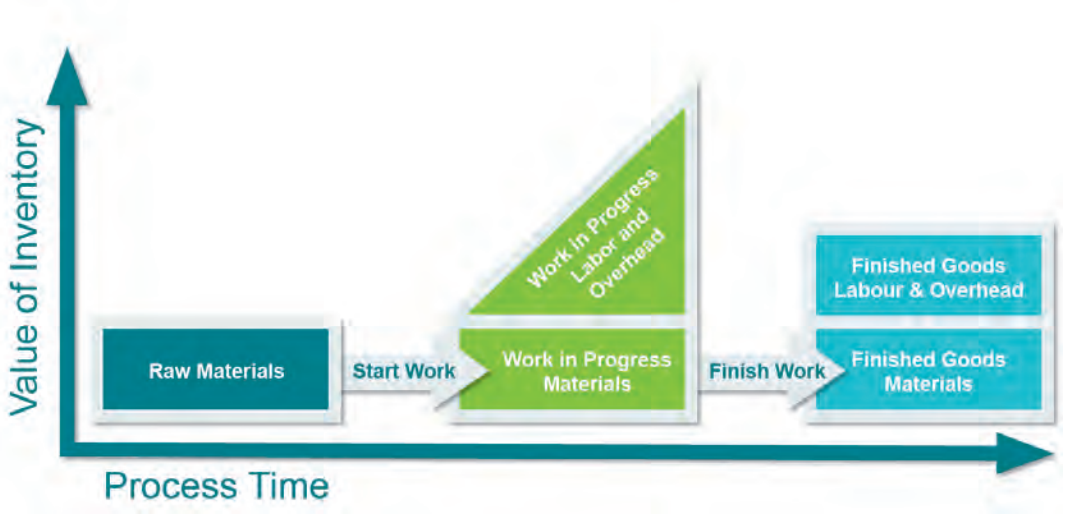
Chapter 8. Inventory Flow Cycle

Whether a business is in manufacturing, service or merchandising, the basic forms and valuation mechanisms of inventory management will be the same with varying degrees of complexity. Inventory consists of all items necessary for doing business and is described as being in one of the following forms:

- **Raw Materials** - Materials purchased for use in production.
- **Work-in-Process** - Products or services on which production is underway but is not yet complete.
- **Finished Goods** - Completed products or services that are available for immediate sale to customers.

Within the business these inventory forms flow through a cycle that starts with receipt of goods and ends with the sale of goods. Between these two points value must be added. This is known as the *inventory flow cycle* (See Figure 8.1, “The Inventory Flow Cycle” [42]). Value is added to raw materials by labor and overhead while it is in the work-in-process form. Therefore, finished goods inventory value not only includes the investment in raw materials, but also the investment in labor and the overhead of carrying the inventory. So long as inventory remains in a company's possession, money from raw materials, labor and overhead is being tied up. However, some types of inventory needs to be deployed in advance of a customer order so that fulfillment can take place. Regardless of the business type, inventory needs to be held by the company, and as we have learned in the previous part, also by suppliers and other companies in the supply chain.

Figure 8.1. The Inventory Flow Cycle



However, not all business types require all three forms of inventory. Manufacturing businesses will, while service businesses may only have work-in-process and finished goods, and merchandising businesses may only have finished goods. The total number of inventory forms managed by a company increases the level of complexity for the inventory controller, since inventory changes form as it moves toward the customer.

A common area of concern is in the area of work-in-process inventory. Businesses often neglect the importance of this inventory form by overlooking the fact that the cost of materials, the cost of labor and the cost of overhead all represent capital invested until such time as the product or service is complete and can be moved to finished goods and finally removed from the liability column when billed to a customer.

Work-in-process inventory is the point where businesses add value to their inventory. Despite this, many businesses fail to realize that capital invested in work-in-process can be even more critical than capital invested in raw materials or finished goods. As with any inventory, work-in-process ties up capital that may be better used elsewhere. In addition, there is a unique risk with work-in-process

inventory. The capital invested usually cannot be recovered until the product or service is complete. An item that is a work-in-process has little or no market value, whereas raw materials that are no longer needed can often be returned to the supplier or sold at wholesale prices and excesses of finished goods can be discounted and sold. In most cases, excessive work-in-process inventory can only be reduced through completion of the final product and sale.

Management of the inventory levels within the flow cycle in all forms is key to ensuring targets are met and to the financial well being of the business.

Chapter 9. Control Practices

In this chapter we look at the specific operational practices that should be implemented and executed to achieve inventory control within the flow cycle in context of the supply chain. Each section of the chapter deals with a single aspect of the control mechanism in context of the SCOR model stages that were outlined in Chapter 6, *Supply Chain Operations* [31].

Combined, these mechanisms form the processes for control of inventory in each of its forms within the flow cycle.

Inventory management can be defined by four activities each requiring a number of actions:

- Acquiring an adequate supply and variety of inventory to meet production and sales needs.
- Providing adequate stocks to meet demand and unexpected demand or delays in inventory replenishment.
- Investing in inventory wisely so that excessive capital is not tied up, excessive space is not required and unnecessary borrowing and interest expense are not required.
- Maintaining accurate and up-to-date records to help identify and prevent shortages and to serve as a database for making value decisions.

To enable control of these activities and ensure timely action, these activities need to be executed in a controlled manner. The application of control mechanisms ensures proper management of the capital investment while it is in one of the forms of inventory.

Establishing inventory control is accomplished by:

- Establishing comprehensive inventory policies and guidelines.
- Promptly identifying and eliminating overstocks.
- Replenishing inventory in anticipation of customers' demand and production requirements.

Once this is done, inventory investment can be planned and controlled in the flow cycle in accordance with predetermined review periods.

Planning

Failing to plan is failing to manage. If businesses create forecasts but fail to plan how they will react to information presented, then all the work done in creating a forecast is lost, and the forecasts are worth only the paper they are printed on. In this section we take a look at the planning practices that are directly related to planning for inventory management, including:

- Sales Forecasting Plan [46]
- Aggregate Planning [50]
- Pricing Plan [51]
- Inventory Management Plan [53]

Sales Forecasting Plan

Forecasting is a process that enables businesses to estimate expected sales (demand) in the future. Forecasting takes into consideration four variables:

- **Demand** - the overall market demand for a product.
- **Supply** - the overall quantity of a product in the market.

- **Product Characteristics** - features and functions that influence the customer's demand for the product.
- **Competitive Environment** - the actions of all businesses striving to create demand and satisfy demand with a given product.

There are four types of forecasting methods, used in combination, for creating a forecast:

- **Qualitative** - speculative in nature, this method relies on a person's opinions of a market.
- **Casual** - assumptive in nature, this method assumes that demand is strong based on specific environmental and market factors.
- **Quantitative** - also known as "Time Series," scientific in nature, this method uses historical patterns as an indicator to forecast future demand.
- **Simulation** - a combination of casual and "Time Series," this method aims to imitate consumer behavior in a given set of circumstances.

While most businesses use a combination of all these methods to produce forecasts and combine the results, the two methods that have the most impact on decision-making are a combination of the "Quantitative" and "Qualitative" methods. It is generally agreed that a combination of all methods with weighted importance on these two methods produces the best results. However, when evaluating forecasts, keep in mind the following:

- Short-term forecasts are the most accurate.
- Aggregate forecasts are more accurate than forecasts for individual products for small market segments.
- No forecast can be 100% accurate, so expect some degree of error.

Demand forecasts based on historical data available in inventory and sales records pertaining to a review period, combined with the other forecasting methods will produce relatively accurate sales forecast, if record keeping is accurate. It is

therefore important to ensure that record keeping practices are performed accurately. In addition to the quality of record data, the quantity thereof is also important. Data dating three or more years back is ideal as it provides a foundation for identifying whether the sales trend increased or decreased over the years for the given review period. For example, if sales data shows a year-to-year growth rate, it can be measured as an average percentage. This enables the inventory controller to estimate the sales projection for current review period by adding the average sales growth to that of the previous year.

When analyzing review periods, it is important to review the same period in each year. For example, it does not help to analyze inventory and sales records for the Christmas period with those of July. In addition, it is useful to keep in mind that the shorter the review period the more accurate the sales forecast. Analysis of a whole year will not be of much value in compiling sales forecasts for the Christmas period. It would be better to use data pertaining to the last quarter of the year (October, November, December). Consider the following example.

Example 9.1. Forecasting

On the 1st of January a bicycle manufacturer wants to maintain two month's supply in inventory of a specific model. Sales of this model have grown by 20% year-to-year. Sales in January, February and March of the previous year are as follows:

```
January + February + March
2000 + 1500 + 1500 = 5000
```

Add 20% to this amount to reflect sales growth, and expected sales for the review period January through March would be calculated as follows:

```
Sales Growth = Growth Rate x Review Period Sales
.20 X 5000 = 1000
```

Expected Sales = Sales Growth + Review Period Sales
1000 + 5000 = 6000

The manufacturer should therefore have 6000 bicycles of this model in inventory on the 1st of January. This inventory level should be a sufficient supply to satisfy demand from retailers over the quarter.

Using the calculations above provides a basic method by which to forecast. However, in performing these calculations it is important that the inventory controller also consider events related to availability. For example, sales and inventory data should be correlated in order to determine whether or not the sales figures were affected by stock outs. If the business experienced stock outs during the review period, this would have prevented customer requests from being fulfilled. As a result, historical sales figures would not be an accurate reflection of the demand, and the average sales growth percentage that was added to the previous year's sales would not reflect nor account for this problem.

While stock outs are easily detectable, it is not always easy to detect how many sales were lost during a stock out period in every situation, especially in merchandising businesses. To be as accurate possible, forecasting requires measurement of customer demand for a particular item and the number of pieces the customer wished to purchase, not just those orders that were fulfilled. If information on unfulfilled customer requests is available, such requests should be added to actual sales for the review period. This will provide a more realistic demand forecast.

Aggregate Planning

Aggregate planning, takes into consideration the entire business and not just each *Stock Keeping Unit* (SKU). It aims to satisfy demand in a way that will maximize profit. Aggregate planning sets the optimum levels of production and inventory that will be followed over the next 1 to 6 financial quarters. The aggregate plan provides a framework within which short-term decisions can be made about:

- **Production** - determining parameters such as:
    - Rate of production
    - Amount of production capacity
    - Size of workforce
    - Overtime Budget
    - Outsource use
- **Inventory** - How much demand will be satisfied:
    - Immediately from stock on-hand
    - Later as backlogged orders
- **Distribution** - how and when the product will be moved between supply chain stages

When creating an aggregate plan trade-off is required between:

- Amount of production capacity
- Level of utilization of production capacity
- Amount of inventory to carry

Between these trade-offs the following approaches can be taken:

- **Match Production Capacity with Demand** - This approach assumes capacity is used 100% at all times. When demand rises, capacity is added, and when it drops, capacity is removed. This normally involves hiring and firing in response to demand. While financially effective, this method takes a heavy toll on the work force if they are employees. People generally do not like being hired and fired every few months. The solution to this is to hire contractors for outsource. This has a higher cost but enables layoffs to be made without incurring compensation penalties.

- **Match Varying Production Capacity with Demand** - If a facility has capacity that is normally surplus to requirement, then there is an opportunity to meet changing demand by increasing or decreasing utilization of production capacity. The size of the workforce can be maintained at a steady rate and overtime and flexible work scheduling used to match production rates. This approach results in low inventory levels and lower than average capacity utilization. The approach makes sense when the cost of carrying inventory is high and the cost of excess capacity is relatively low.

- **Match Inventory to Demand and use Backlogs** - Using this approach provides for stability in plant capacity and workforce while enabling a constant output rate. Production is not matched with demand. Instead, inventory is either built up during periods of low demand in anticipation of future demand, or inventory is allowed to run low and backlogs are built up in one period to be filled in the following period.

  This approach results in higher capacity utilization and lower costs of changing capacity but has the negative effect of generating large inventory holdings and backlogs over time as demand fluctuates. It should be used when the cost of capacity and changing capacity is high and the cost of carrying inventory and backlogs is low.

Pricing Plan

Pricing can influence both short and long term demand for a product. As with everything else, pricing requires a trade-off. In this case the trade-off is between maximizing revenue and maximizing profit. Lower prices have a greater appeal to customers, as the product is more affordable. More people can buy in greater

quantity (maximized revenue). Higher prices do the opposite but usually mean a higher profit margin. Finding a balance between the two, while enabling flexibility in the pricing to stimulate demand during peak demand, is the position of choice. This position maximizes gross profit during peaks to compensate for low demand periods.

The degree of flexibility a business has with pricing is largely dependent on the cost structure and the approach taken in the aggregate plan. Those businesses that are flexible can afford to do additional promotions and give price incentives during peak, because they can easily increase their production capacity. Those that cannot; need to take advantage of low demand periods when production facilities have capacity that is surplus to current requirement. Both approaches are strategic in nature and use price as a way to:

- Increase product consumption.
- Persuade consumers to buy one product over another.
- Encourage customers to increase their purchase quantity or stock-up while prices are low.

There are eight pricing methods and strategies businesses can use in their pricing plans:

- **Cost plus** — this method entails taking the cost and adding the desired profit to it. This is a common practice but not the proper method of pricing.

- **Perceived value** — this method entails charging by the value provided regardless of the cost. The price is that which a customer sees as good value.

- **Skimming** — this method entails charging a higher price than required and *skimming* high profit margins. It is customary with new novel items.

- **Penetration** — this strategy entails capturing maximum market share on the basis of low-cost. It requires mass production to reach economies of scale and a large market appeal.

- **Quality** — this strategy uses *perceived* value to command a higher price. The quality of the product associated with a brand trust are usually instruments used in this method. However, consumers will also attribute a high price with uniqueness or craftsmanship.

- **Competition** — this strategy entails meeting or beating competitors' prices. To increase or retain a market share the seller uses a pledge to match or better any competitor's price for the same product.
- **Scale** — this strategy entails deciding price on the size of the market. The larger the market the lower the price can be, as volume will create the income to cover costs and make a profit. In small markets, volume is low, and prices must therefore be higher in order to cover costs and make a profit
- **Elasticity** — this strategy entails adjusting the price in accordance with the customers' levels of resistance to price increases. Buyers with elastic demand do not take well to price increases, while the opposite is true of inelastic consumers.

Inventory Management Plan

The aim of inventory management techniques is to balance reduced inventory holdings to the lowest point without negatively impacting availability or customer service levels while maximizing the businesses ability to exploit economies of scale in order to positively impact profitability.

Inventory management is an ongoing process that takes its inputs from forecasts and product pricing and is executed within the cost structure of the business under an overall plan as described in the section called “Aggregate Planning” [50]. To manage the balance, inventory within the three inventory forms, within the flow cycle, are categorized into three elements:

- Basic Stock [54]
- Seasonal Stock [58]
- Safety Stock [58]

The challenge here is to weigh the balance in favor of basic stock so that the business holds as little safety stock as possible and provides 'just the right amount' of seasonal stock. However, the predictability of demand has a direct impact on just how much safety stock a business must hold; the more unpredictable the demand the higher the required level of safety stock.

Basic Stock

Basic stock, also referred to as *cycle inventory*, is an amount of inventory that is sufficient to satisfy the demand of a sales forecast. For finished good inventories this is an amount that will provide customers with a reasonable selection of finished goods in accordance with regular sales. For raw materials, basic stock is the amount of inventory in production at any given time. Basic stock exists because economies of scale deem it desirable to make fewer, larger quantity orders as opposed to many orders of a smaller quantity. So while consumers may buy a product in small quantity, it is often more efficient and therefore cheaper to produce and order in larger *lot sizes*. The size and frequency at which lot sizes are ordered varies between businesses. Some businesses will find it better to order larger quantities at longer intervals while others may find it better to order smaller and more frequently. Again, the decision factors will depend upon the balance a business wants between efficiency and responsiveness (See Figure 4.1, “Responsiveness versus Efficiency” [17]).

The most effective amount for a business to order at any time is called the Economic Order Quantity (EOQ). The formula for calculating EOQ helps to determine the right quantity to order to suffice supply while keeping inventory levels at a minimum. It is good practice for a business to know the EOQ for each of the products it buys. The EOQ is calculated as follows:

Equation 9.1. Calculating Economic Order quantity

$$EOQ = \sqrt{\frac{2xUxO}{hxC}} \text{ (square root of 2UO / hC)}$$

U = annual usage rate
O = ordering cost
C = cost per unit
h = holding cost per year as a percentage of unit cost

The result of the EOQ calculation determines the most efficient investment of capital

in inventory by determining the lowest total unit cost for an inventory item (See Figure 9.1, “The Result of EOQ Calculations” [55]).

Figure 9.1. The Result of EOQ Calculations

It is not acceptable to maintain a minimum inventory level equal to the production time of an item. The reason being that this would not account for unexpected events or problems that could delay supply to the point where a stock out of basic stock occurs. To accommodate this position, we introduced an inventory element called Safety Stock [58]. A basic stock position also does not take into considerations, such as the affects of seasonal demand.

While the EOQ tells just how much of a product needs to be purchased in order to maintain the lowest item cost, it does not give any indication as to whether the resulting quantity is the desired level of inventory required in order to meet targets. Combined calculation of the lead-time, Basic Stock [54] and Safety Stock [58] can be used to determine a desired inventory level. This level is equivalent to a replenishment target and is expressed in 'days', 'weeks', 'months', or 'years'.

Assuming the lead-time for a particular item is two weeks and the safety stock that a business wishes to maintain is a four-week supply with a one-week basic stock, then the desired inventory level is the sum of these factors.

Example 9.2. Calculating Desired Inventory Level

Inventory Level = Lead-time + Safety Stock + Basic Stock
2 + 4 + 1 = 7 weeks

The desired inventory level should be considered an *order point*. Whenever the stock of an item falls to this point, an *open-to-buy* should be triggered, and items should be purchased or produced. Consider this example for calculating the order point.

Example 9.3. Calculating Order Point

In our Forecasting [48] example the bicycle manufacturer wanted to maintain two months' supply of an item in inventory for the first quarter. Average sales per month over the quarter are forecast to be 1300 units per month. The order point would therefore be 2600 (2 months X 1300 units).

In this way, buyers can answer the question, "What to buy or produce?" But they still need to determine when and how much to produce.

When determining a quantity to order, the buyer must take into consideration the usual time between orders. This period, called the *ordering interval*, is important to maintain sufficient supply so that inventory averages out to the desired level between orders. To compensate for the order interval, a stock equal to expected usage during the order interval should be added to the order point. This quantity determines the *order ceiling*.

Example 9.4. Calculating Order Ceiling

Taking our bicycle manufacturer example, if we assume that the order interval is every two weeks, then the inventory depletion rate would be 650 ([1300/4] X 2) units. The order ceiling can therefore be calculated as follows:

Order Ceiling = Order Point + Order Interval Usage
2600 + 650 = 3250 bicycles

Before placing orders buyers must take into consideration the actual standing of their inventory. So, if the manufacturer has 300 bicycles on hand when preparing the order, calculations should take this quantity into account in order to ensure that an overstock position is not reached.

Example 9.5. Calculating the Order Quantity

Order Quantity = Order Ceiling - Stock on Hand
3250 - 300 = 2950 bicycles

In the event of an undelivered order, the order should be reduced by the number of units expected. For example if the undelivered order quantity is 1800, then the new order quantity would be 1850 (2950 - 1800).

Seasonal Stock

Seasonal stock is an amount of inventory that is produced and stockpiled in anticipation of a known future demand. For example, a business may decide to run a discount promotion during a period when it has never traditionally done so. This would increase customer demand, and an adequate supply will need to be available. Since the promotion may be an event that happens only once or for a short period, it is not economically viable to increase the production capacity of facilities. The answer is therefore to compensate for this demand by increasing production during times of low demand.

The aim of seasonal stock is to obtain the best economies of scale given the capacity and cost-structure of the operation. To manage seasonal inventory demand forecasts need to be accurate as large amounts of inventory will be produced and stockpiled over a period where demand is low. A business can easily run the risk of producing too much and find itself in a position where the stock has become obsolete or where holding costs can become prohibitive to selling at a profit. Planning in marketing and sales departments and promotion to the channel and end customer must be done well in advance to help mitigate these risks. In general there are four ways to reduce risk and the amount of seasonal inventory produced:

- *Reduce demand uncertainty* — produce better demand forecasts.
- *Reduce order lead-times* — a shorter lead-time means it is easier to obtain needed coverage at short notice.
- *Reduce lead-time variability* — the more reliable the transport method and lead-time the less chance of problems.
- *Reduce availability uncertainty* — ensure that there will be enough stock in the supply chain when demand increase occurs.

Safety Stock

Safety stock is a portion of inventory that acts as an insurance policy against unforeseen events that may lead to a stock out situation. Safety stock is therefore surplus to requirement and aims to cushion stock as a protection against such occurrences. The exact size of safety stock is dependent on the number and extent of factors that may interrupt production and deliveries. Guidelines therefore vary

between industries and are normally the result of inventory controllers' cumulative experience.

When talking about safety stocks, the topic of inventory optimization will come to the fore. However, since inventory optimization is an activity that can only be performed once inventory management practices are in place, we will be discussing the subject separately in the Inventory Optimization [93] part of this book.

As a general rule, the higher the level of uncertainty, the higher the required level of safety stock. Safety stocks should be defined on a per item basis. Safety stock can be defined as an amount of inventory on hand when the next replenishment is received. Unlike basic and seasonal stock elements, safety stock is an element that does not turnover. It is in effect a fixed asset. As such, it will drive up the costs (reduce efficiency) of holding inventory. However, safety stock ensures a higher level of probability that customer demand will be met with a greater degree of consistency so responsiveness is improved, and customer service targets are more easily attainable.

Businesses need to maintain a fine balance between their desire to carry a wide range of products and offer a high level of availability across the product line and keeping inventory costs to a minimum. In Part IV, “Inventory Optimization” [93] we will see that this balance is literally reflected in a business' safety stock.

Sourcing Product

Product sourcing entails activities to acquire the inputs necessary to create products or services. Broadly speaking, there are two activities businesses need to perform at this stage:

- Procurement [60]
- Credit and Accounts Receivable

Since this part of the book is about inventory management, we will focus most of our attention on Procurement [60]. This is not to say that proper credit and accounts receivable management are unimportant. They are vital functions of keeping a business liquid by ensuring that product is only sold to those customers who can demonstrate their abilities to pay for them so that the business can purchase more inputs to make more product and repeat the cycle. However, credit and accounts receivable are activities that take place once inventory is ready for sale and a

customer wishes to make a purchase. As such, it does not directly impact the way in which inventory is managed.

Procurement

The objective of procurement is to source and acquire the ingredients required in order to deliver a product or service. The aim is to acquire the ingredients at the lowest price but with the best quality.

The activity of procurement has become sophisticated over time. Businesses today no longer consider the act of purchasing to be the only activity in procurement. Main activities of procurement now include:

- Purchasing [61]
- Consumption Management [62]
- Vendor Selection [65]
- Contract Negotiation [66]
- Contract Management [66]

Purchasing

Purchasing is a routine activity carried out to ensure that goods are purchased to input to the company. The are two types of business inputs for purchasing:

- *Direct* — materials or services needed to produce products or services.
- *Indirect* — materials or services consumed by the business in daily operations.

The processes for purchasing of both inputs are the same.

Purchasing Cycle

1. Purchasing decision is made based on calculated information. Purchase orders are issued.
2. Vendors are selected and contacted for quotation or proposal.
3. Negotiation and due diligence to ensure the best deal and right vendors are selected.
4. Orders are placed under contractual constraints.

This process is largely driven by formula where results are the main input to arriving at a purchasing decision. However, it is not possible to run all of a business by formulas alone as they only serve, just as management applications do, as a guide on which to base decisions. There are times when one must ignore the scientific facts and apply intuition, but before doing so, one should be sure to have a good reason.

One such time worth considering is when suppliers offer limited time only quantity discounts or price specials. It is natural for inventory controllers to want to capitalize on these opportunities since they see the ability to profit from potential savings. While this could be the case, inventory controllers must take caution not to order quantities that are far in excess of what they need. The risk of entering such a position is that the discount can be easily lost when sales volumes slow and capital becomes tied up for longer than necessary. In this situation inventory in any form becomes a high liability, and businesses often find themselves in the position of

having to liquidate the discount inventory at distress prices that do not even cover the original cost.

It is important to remember that while quantity discounts and price specials can increase profitability when managed correctly, they are a double-edge sword. If it were possible to investigate the real reason for these offerings, one would often find that the supplier is exercising practice number one of inventory management - elimination of overstocks. Be careful not to make another inventory controller's problems your own.

Consumption Management

In the section called “Planning” [46] we discussed how to forecast, determine economic order quantities and calculate desired inventory levels. These activities are the precursor to, but are also reliant on consumption management activities:

- Overstock Elimination [63]
- Inventory Replenishment [63]

Both activities need to be executed on an ongoing basis and reviewed against expected and actual consumption levels. This data can be found in the forecast and receipt accounts data produced and collected by the business. Evaluation of scientific data, combined with intuitive knowledge, can serve as a check or safe guard against both over- and under-stock inventory positions. Higher or lower than expected consumption levels could have a number of meanings, depending on how you look at it.

Higher than expected consumption levels could mean either that the demand is increasing due to an external environment or market factor or that a change in marketing or sales tactics/pricing is having a positive impact. Lower than expected consumption levels could mean either that the demand is decreasing due to an external environment or market factor or that marketing and sales are under performing with negative impact.

In either instance it may also be that initial expectations derived from the demand forecast were inaccurate. Whatever the cause, it must be identified and corrective action taken in a timely manner. In Chapter 11, *Problem Identification* [83] and Chapter 12, *Corrective Action* [89] we discuss how to recognize and address problems.

Overstock Elimination

Since demand predictability changes on a continual basis, a policy of systematic review of the entire inventory - raw materials, work-in-process and finished goods - is required for all three stock elements in order to continually identify excess inventory levels as soon as they occur.

Early identification and 'elimination of overstocks' enable excess levels to be cleared at reasonably favorable prices and prevents the situation where, over time, the business may find itself with increasing numbers of inventory developing due to declining market demand. Elimination of overstocks is therefore a corrective action that reduces the negative effects of inventory management problems after they occur.

Inventory Replenishment

Whereas overstock elimination is a corrective action, systematic procedures for inventory replenishment, whether purchasing raw materials from a supplier or scheduling production for finished goods inventory, minimizes the possibility of problems developing.

Inventory replenishment practices strive to reduce the possibility of overstocks through production and purchase planning. In addition, replenishment practices help avoid shortages that will result in increased costs realized in forfeiture of discounts, premium shipping charges or costly overtime.

A critical point to determine and monitor when doing inventory replenishment is lead-time. The definition of what lead-time is varies for each of the inventory forms found in the inventory flow cycle.

For raw materials inventories, lead-time is the time between order placement and receipt of goods. For finished goods inventories, lead-time is the time required for production, assuming that the required raw materials are already in inventory. If raw materials are not ordered until a production is made, then delivery time for raw materials must be added to the production time in order to determine lead-time.

Maintaining a minimum inventory level that is equal to the production time of an item, more often than not, results in the supply for a particular item being insufficient to meet demand. The reason for this is that the ratio is so exact that it does not take into consideration unexpected events and problems that may extend production time to the point where delivery can only be taken after a stock out has

occurred. For example, an unexpectedly large order from a customer may deplete stocks to such an extent that it would make it difficult or impossible to fulfill other orders.

A strike, conflicting production requirements, manufacturing problems or unforeseen weather conditions, could all seriously delay production so that a stock out of "basic stock" might last for an extended period. To guard against such circumstances businesses maintain what is called "safety stock."

To overcome the problems associated with uncertainty the conventional approach is for businesses to hold Safety Stock [58] and Seasonal Stock [58] in addition to the exact Basic Stock [54]. There is, however, another approach known as '*Just In Time*' (JIT).

The principle of JIT is to have inventory when it is needed and none when it is not, a zero inventory philosophy. The core difference between the conventional method and JIT is realized in different trade-offs. For the conventional method the trade-off is between 'availability' and 'stock holding.' For JIT the trade-off is between 'organization' and 'stock holding'.

JIT is not a practice that every business can adopt. It requires that the supply chain be very well organized with minimal existence of uncertainty. JIT is, however, a target for businesses to aim toward, as the basic concepts of JIT are reliant on good inventory management techniques within the business and the supply chain of which it is a part.

Vendor Selection

Vendor selection is an ongoing process to define those businesses capable of meeting the procurement requirements needed to support an operational business plan. There are five areas against which vendors can be evaluated to assure optimal price, quality and delivery.

- **Price** - Businesses should aim to purchase materials and services at prices that are competitive. Fairness will be determined by competition.
- **Quality** - Businesses should purchase products of the highest affordable quality.
- **Service** - Businesses should expect pre- and post-service and expect information that is accurate and factual. Once an agreement has been made with a vendor to deliver a product or a service, the vendor should be expected to honor its commitments.
- **Performance** - Evidence of the right price, quality and service will be demonstrated by performance. Buyers should prefer long-term relationships to sporadic 'good deals.' This has the effect of raising the barrier to entry for new vendors since they will have to make significant improvements in price, quality or service before a buyer will change from an existing supplier.
- **Value** - Many factors are considered with respect to value (i.e. price and quality). Ultimately, a representative of the buyer should determine the value of a product or service to the business. As a result, considerations other than price may determine the outcome of a particular purchase.

Once a vendor has been selected, that business is considered to be on the buyer's 'preferred suppliers' list and is bound by the terms of a contract to meet commitments. To get on the list the vendor should satisfy the requirements for each area. People within the buyer's organization have therefore a degree of security in knowing that there are purchasing agreements and protocols in place. In addition, if everyone in the organization buys from the preferred vendors, relationships with those vendors is enhanced. The greater the volume, the better the pricing, and the more likely it is that the vendor will be willing to go out of its way to solve a problem.

Contract Negotiation

Contracts are used to record agreements between two businesses. The contract contains details such as prices, service levels and payments. As a business' needs change, contracts must be renegotiated.

The level of complexity involved in contract negotiation varies depending on what is being purchased and the mission critical nature thereof. For example, items such as raw materials often require commitment to exacting quality standards in order to meet governmental regulations or simply to ensure consistency in the produced product's quality. Items such as telecommunications systems are complex and require high service levels and technical support. The contract and negotiations in these examples will be far more complex than for office stationary.

Contracts typically fall within a business' overall business plan and require planning and execution in their negotiation. Negotiation is an art. Being prepared and knowing what you want before entering the negotiation is paramount. Show the facts, and have data on hand to support your statements. This information can often give insight and help a person make decisions or be more open to explaining positions. No negotiation should take the attitude of 'take it or leave it.' However, if the outcome of a negotiation is not what was expected and required by the business plan, then do not accept it. It is better to find a new supplier that can meet your requirements. It is also often the case that in hindsight of the negotiations, managers will re-evaluate their position and return to provide solutions they had not thought of prior to or during the meeting.

Contract Management

With contracts in place, the business must continually measure vendor performance and test that the stipulated commitments remain pertinent to the changing environment of the business.

To perform these tasks a business must routinely collect data about the performance of suppliers and monitor whether the framework of the agreement is meeting operational requirements. Deviation from the business plan can negatively impact the bottom line and competitive situation of the business.

Making Product

In this section we take a look at how product design can impact production and subsequently the management of facilities used to make and store products.

Different products have different manufacturing requirements. Some products need all components to be manufactured from scratch. Others can be assembled from already available, generic sub-assemblies. The design of a product, the number of parts it has and the requirements it has to meet all have an impact on the overhead that will be incurred in managing the supply chain and production activities of a business.

Design the Product

The design of a product often depends on the technology available. As technology advances, parts become smaller, lighter, more or less expensive, and even increase in functionality so that fewer parts can be used to assemble a new product. All these points will eventually impact on the supply chain and the inventory within.

The competitive nature of the business environment drives businesses to constantly improve on their ability to deliver improvements in efficiency and responsiveness. To accommodate this requirement, businesses should consider designing products that have a minimal number of parts and mechanical joints. Anything else that takes wear and tear should be kept to a minimum and be modularized for easily replacement. This type of consideration is not merely to suffice product quality or customer requirements but also to reduce the size of the supply chain and inventory items the business must carry during production and for customer service purposes.

Designing a product that has many parts usually means that a greater number of suppliers need to be sourced, monitored and managed over time. This not only increases the administrative overhead and reduces profitability but also increases the risk that production may be negatively influenced if suppliers decide to discontinue parts or close their business. The greater the number of suppliers, the greater the risk of such problems occurring; risks such as these may eventually halt production or necessitate part or complete redesign of the product, giving competitors an opportunity to gain market share that may be very hard to win back.

The product design will affect the shape of the supply chain, how inventory is managed and often the very success of the business. As a result, many businesses now use cross-functional design teams comprised of design, procurement and

manufacturing experts. Combined, they can pose questions and discuss the relevant issues surrounding the product. This approach generally reduces development time and costs, resulting in a faster time to market and competitive costing. So important is the area of product design that a class of enterprise applications known as Product Lifecycle Management (PLM), is now readily used to promote the level of collaboration between internal departments and also with suppliers.

Production Management

Once a product design is complete, the task at hand becomes the management of production. A job well done in the design stage can often make life easier in the production stage, enabling production to focus on allocating available capacity without having to endure design related problems. The aim at this stage is to utilize capacity in the most efficient manner possible. To do this a balance must be made between:

- Plant Utilization
- Inventory Levels
- Customer Service

Production requirements should always be reviewed to determine if productive capacity is sufficient to meet the demand requirement in the time allotted. If not, the production interval used in determining the order quantity may have to be extend; or, if this would create a serious conflict with expected requirements for other products, overtime should be scheduled; or the original estimates of safety stocks and basic stocks should be re-examined to locate and eliminate any apparent excesses without impacting customer service levels.

The scheduling required for production of a single product is relatively straightforward. Schedules need to be organized for optimum efficiency at a level that meets product demand. Scheduling for several different products within the same facility is a more complex task, as each product needs to share the time available on the production line. In addition, production time is often reduced since the line will often need to be setup or modified in order to produce a different product. These downtimes can be expensive.

To reduce downtime the production manager should start by determining the *economic lot size* for each product's production runs. The formula for this calculation is the same as that used for EOQ and the inventory control process (See Figure 9.1, “The Result of EOQ Calculations” [55]).

The objective is to balance production setup costs with the cost of carrying the product in inventory. It stands to reason that the frequency at which setups occur has a direct impact on inventory levels. Frequent setups will result in lower inventory levels (lower carrying costs) but higher production costs. Infrequent setups will result in higher inventory levels but low production costs (higher carrying costs).

When production quantities have been calculated, the next step is to determine the best sequence in which to run the production of the products. The general rule of thumb is that products with a low inventory level relative to demand are scheduled first. Products with a high inventory level relative to demand are scheduled later. To help determine which products should be produced first one can calculate the *run out time* to total depletion of inventory holdings using the following formula.

$$R = P / D$$

where:
- R = run out time
- P = number of units of on hand product
- D = product demand in units for a period

Delivering Product

Production of the product means that orders can be taken or completed and deliveries made. These tasks must be managed. In this section we discuss the processes for order and delivery management and how they impact production and inventory within the supply chain.

Order Management

There are two sides to order management. The first and most obvious is being able to take orders from customers knowing that the inventory required to fill the order is on hand. The second aspect of order management is concerned with passing information back through the supply chain so that suppliers and production can have insight into the forward operations and demand. Information detailing delivery dates, product substitutions and back orders is useful and can be obtained from various documents, such as: purchase orders, sales orders, change orders, pick tickets, packing lists and invoices.

Traditionally, the amount of information available to the supply chain has been limited, since it was not easily accessible and companies did not want to share information of value. This position has started to change as globalization takes place and companies move from using the telephone or printed documents to electronic systems that use the Internet. Increasingly, newer technologies are helping to streamline the order management process by reducing the long lead- and lag- times commonly found in the supply chain. These changes have given progressive companies competitive advantages in the way products are sold and customer service levels sustained. However, the main reason for these advantages is that technology is helping to reduce the difference between decisions concerning the efficiency and responsiveness of the business. The closer these two polarities are brought together, the greater the comparative advantage.

Despite these technological advances, the basic principles of order management still apply and can be implemented manually, if required. However, the level of integration between order management and other activities is significantly reduced without technology-based systems. The basics include:

- Capture data once only
- Automate order handling
- Increase order status visibility
- Integrate order management with other systems

Delivery Management

There are two general methods by which deliveries can be scheduled:

- *Direct deliveries* - made between the origin and receiving locations.
- *Milk run deliveries* - made between the origin location and multiple receiving locations.

The decision on which method to use depends largely on the chosen transportation method used and the size of the shipment quantities to be delivered. For example, if deliveries are made by truck (road transport) and the EOQ is the same size as a

truckload, then the direct delivery method makes sense. However, if the EOQ is smaller than a truckload, then this delivery method becomes less efficient. In addition, the direct delivery method results in high receiving expenses, because each location must handle separate deliveries from different suppliers as well as store them.

The opposite is true of the 'milk run' delivery method. If a business has orders that do not fully optimize the container space of the transport mode, then the empty space can be filled by orders from multiple receiving locations. The trick is then to sequence the delivery in a route that is cost-effective in terms of time and fuel.

How the schedule is routed for efficiency will also depend largely on the sources from which the delivery will be made. The decision whether to use multiple distribution centers or a single location will be determined by the economies of scale you are dealing with. In situations where volume or turn over is high it will often make sense to move inventory from a single location, such as a factory, to distribution centers in close proximity to the receiving points. Without economies of scale it would be too costly to maintain multiple distribution centers. Inventory would therefore have to be centrally warehoused in close proximity to the factory.

Maintaining Control

Systematic review of inventory purchases and production decisions is the most effective means of preventing overstocks and avoiding lost sales. The availability of accurate inventory, sales and production records, combined with the good judgment of an inventory controller, can guide a business to sound purchasing decisions.

To maintain an in-stock position of wanted items and to dispose of unwanted items, it is necessary to establish adequate controls over inventory on order and inventory in stock. There are several proven methods for inventory control.

- **Visual control** - enables the manager to examine the inventory visually to determine if additional inventory is required. In very small businesses where this method is used, records may not be needed at all or only for slow moving or expensive items.
- **Ticker control** - enables the manager to physically count a small portion of the inventory each day, so that each segment of the inventory is counted on a regular basis.

- **Click sheet control** - enables the manager to record the item as it is used on a sheet of paper. The information is then used for reorder purposes.

- **Stub control** - (used by retailers) enables the manager to retain a portion of the price ticket when the item is sold. The manager can then use the stub to record the sales.

As a business grows, there is an increasing need for more sophisticated and technical forms of inventory control. The decreasing cost of mid-sized computers and widespread existence of computer service organizations have driven down the cost of computer systems, making them an affordable and feasible alternative to manual control methods. Computer-based inventory management systems can, more often than not, be linked to company accounting and billing systems to help streamline reorder and inventory management procedures. Two of the most common computer systems linked to inventory management are:

- **Point-of-sale terminals**. These systems are usually integrated with cash register systems that relay information to the inventory management systems each time that a transaction is concluded. At regular intervals, managers receive information printouts for review and action.

- **Off-line point-of-sale terminals**. These systems are normally located in the back-office operation and relay information directly to the suppliers ordering system. As the information arrives, it is used to create an order so that additional items are automatically shipped to the buyer/inventory manager.

Where businesses do not have the luxury of inventory control systems that are integrated with point-of-sale or financial systems, it is common for inventory control to be performed by outside agencies. The agency is normally a representative of the manufacturer tasked with visiting retailers on a scheduled basis to take stock and write new orders. Unwanted merchandise is removed from stock and returned to the manufacturer through a predetermined and authorized procedure.

One of the main goals of the methods we have described is to assist in determining the minimum possible annual cost of ordering and stocking each item. Two major control values are used:

- **Order quantity** - the size and frequency of orders.
- **Order Point** - the minimum stock level at which additional quantities are ordered.

These variables are used in calculating the EOQ. The EOQ is widely used as a method of computing the minimum annual cost for ordering and stocking each item by taking into account the cost of placing an order, the annual sales rate, the unit cost and the cost of carrying inventory.

Chapter 10. Recording Inventory

Successful inventory management requires timely, accurate information for decision-making purposes, including:

- Determining purchase requirements for replenishment of raw materials inventory.
- Determining production requirements for replenishment of finished goods inventory.
- Scrapping or clearing of obsolete items.
- Adding new items to inventory.

The source of this information is inventory records. These should include accurate records of sales, production usage and stock on hand for every item. Stock records tell you what you have. Sales and production records tell you what is needed.

Recording Systems

The selection of a recording system is dependent on understanding the number of different items carried. At the very least, any business should have a manual inventory control system. Manual systems are generally based upon an inventory control card. An inventory control card exists for each item in inventory, either raw materials or finished goods. The stock status shows the daily changes in inventory as either "IN" or "OUT."

Figure 10.1. Example Inventory Control Card

Finished Goods Inventory Control Card
Style 72 Dress

Date	On Hand	IN	OUT
05/01	50	0	0
05/02	55	10	5
05/04	70	15	0
05/06	60	0	10
05/08	54	0	6
05/10	56	12	10

For finished goods inventory, the "IN" column lists all completed production, returns from customers, etc. The "OUT" column lists all sales, 'scrapage,' etc.

For raw materials inventory, the "IN" column lists all receipts from suppliers and any material returned from production. The "OUT" column lists materials used for production and 'scrapage.'

Another useful inventory record is a sales or production summary for each item in inventory. The sales summary can also be periodically compared with stock on hand so that items with insufficient sales activity can be cleared through promotional emphasis, price reductions or scrapping. In this way, space and capital invested in inventory are made available to more active and potentially more profitable items.

Figure 10.2. Sales or Production Summary

Sales Summary
Style 72 Dress

Month	Sold	Produced
January	75	60
February	85	100
March	80	90
April	60	50
May	50	50
June	50	50

A monthly summary of production usage and receipts from suppliers is used for control of raw materials inventory, so that the future purchases can be planned. As with the sales summary, raw material inventories that have shown little or no movement can be identified, so that they can be returned to suppliers, sold to other businesses or scrapped.

Periodic Inventory Changes

Inventory levels should be in a state of constant flux. As goods are purchased or produced, inventories increase. As they are sold, inventories decrease. To determine the inventory at the end of any period one begins with the inventory on hand at the beginning of the period. Then, the end inventory can be calculated by accounting for all additions and deductions made during the period and reconciling the result against that of a physical stock count.

Ending Inv. = Opening Inv. + Additions - Deductions

Example 10.1. Calculating Ending Inventory

Our bicycle manufacturer has 200 units in inventory on the 1st of April. During the month 500 bicycles are produced and 15 are returned from customers. Total

inventory additions for the month would be:

500 + 15 = 515 units added

Bicycles sales during the month are 300 and 10 units were damaged because of warehouse handling damage. The total inventory deductions would therefore be:

300 + 10 = 310 units deducted

Closing inventory on the 30th of April would therefore be calculated as follows:

200 Opening Inventory (April 1) + 515 Additions - 310 Deductions =
405 Closing Inventory (April 30)

Determining Inventory Value

In most businesses, inventories are valued at cost. For example, a men's clothing manufacturer makes a jacket in a certain style at a cost of $4.00 and sells it at $8.00. The value assigned to each jacket in inventory would be a finished cost of $4.00.

Example 10.2. Calculating Cash Valuation

The clothing manufacturer has $100,000 inventory of finished goods on the 1st of June. During the month, sales are $50,000 and the cost of sales was $30,000. Production of the goods was $60,000. The value of inventory for June would therefore be calculated as follows:

100,000 Beginning inventory (at cost) + 60,000 Production (at cost)
- 30,000 Sales (at cost) = 130,000 Ending inventory (at cost)

Since inventory represents capital invested, it is important to know its total capital value. While inventory calculations based on units are useful for determining the physical quantities of a particular item, they do not provide the capital value of the stock. In addition, total inventory is usually comprised of a mix of various items in various inventory forms (finished goods, raw materials, or work-in-process). Adding

the unit counts together would not determine how much of the business' working capital is invested. The total inventory value can therefore only be calculated as a capital figure (financial currency).

Work-in-process inventory also does not lend itself to convenient unit measurement, as is the case with raw materials and finished goods. Items in production rarely have any value until their production is complete. So while it may cost $4.00 to make a jacket, the cost is comprised of multiple items such as fabric, shoulder padding, buttons, cotton thread, labor, etc. Should a jacket in production be damaged before it is completed, the cost could be much less than the finished cost of $4.00, but the value would be $0; a loss.

In continuous manufacturing operations, work-in-process inventories can be valued on a percentage-of-completion basis. Following is an example of how work-in-process inventories can be valued.

Example 10.3. Valuation of Work-in-Process Inventories

A manufacturer of letterboxes knows that each letterbox has a finished cost of $10.00. Three operations are involved in the manufacturing process - cutting, assembling and packaging. From cost studies, the manufacturer knows that, on average, the letterboxes are 40% complete when in cutting, 80% complete in assembly and 90% complete in packaging. If there are 50 units in cutting at month end, 100 in assembly and 100 in packing, the work-in-process inventory could be valued as follows:

Figure 10.3. Calculating Work-in-Process Inventory Value

Production Stage	Completion %	Cost of Each Unit at this Stage	Number of Units at this Stage	TOTAL COST OF UNITS AT THIS STAGE
Cutting	40%	$4	50	$200
Assembly	80%	$8	100	$800
Packaging	90%	$9	100	$900
				Total Cost of Work-in-Progress $1,900

The value of each stage is calculated by multiplying the percentage of completion by the finished cost - % Completion X Finished Cost = Value of Stage

0.40 X $10 = $4.00

The cost of cutting a fixture is $4.00, which is then multiplied by the number of units in cutting (50), to find the total value of units in the cutting stage ($200 [50 X $4]). The same approach is followed to evaluate the value of units in the assembly and packaging stages. The total value of work-in-process inventory is then the sum of values in all three stages ($1900).

Job Order Costs

It is common for small manufacturing and service businesses to use a system of *job order costs*, particularly if they are in custom service and manufacturing where a specific job is performed for a specific customer. The job order cost system starts by assigning each new job a job number and maintaining a cost control card like the one shown below.

The job cost control card is used to keep a report record of each item of cost used for the particular job. Costs are classified as labor, material and overhead. The total at any time is the total value of work-in-process inventory that the job represents. The business' total work-in-process inventory at any time is the sum of the costs of all jobs in progress.

The development of product and services costs is, of course, far more detailed than this. For our purposes this overview is very brief. It serves to illustrate how such costs might be determined and to distinguish the valuation techniques used for work-in-process inventory from those used for raw material and finished goods inventories.

Figure 10.4. Job Cost Control

JOB COST CONTROL OUTDOORS COMPANY					
Job no.: C-25		Customer: University Hospital			
Date		Labour	Material	Overhead	Total
10/07	Payroll - W. Smith	$150	$0	$200	$350
10/10	Metropolitan Supply - pipe	$0	$180	$0	$530
10/14	Payroll - W. Smith	$120	$160	$0	$810

Physical Inventory

Inventory records are posted from documents that describe sales, production, receipts, and other inventory movements. The following are examples:

- Customer invoices to record sales.
- Packing lists from received shipments that record raw material receipts from suppliers.
- Credit memos that record customer returns.
- Credit requests that record returns to suppliers.
- Material requisitions to record transfer of materials from raw material inventory to production.

A "physical inventory" should be taken periodically to be sure that quantities on hand equal those shown on inventory records. The inventory records must then be adjusted to reflect any differences between "physical inventory" and "book inventory," the quantities shown on the inventory records. The actual quantity of each ite must be counted and compared with that shown on the inventory record. neccessary adjustments should be made immediately.

Differences between book and physical inventories may arise for the following reasons:

- Pilferage
- Faulty sample management procedures
- Faulty receiving procedures
- Faulty sales recording procedures
- Faulty customer returns recording procedures
- Faulty supplier returns recording procedures

Any of these reasons can result in inventory shortages. While most businesses take careful steps to guard against the first reason - pilferage - many overlook the need for controls to guard against inventory shortages that may be caused by the other reasons.

Chapter 11. Problem Identification

Spotting problems in the ratio of sales to inventory turnover is the key to problem identification in inventory. In the previous section we noted that inventory levels are determined in terms of an equivalent number of "days", "weeks" or "months" supply. However, the amount of inventory held is also dependent on the nature of the business. The turnover of a specific item or whether or not the finished goods or raw materials are perishable makes a large difference to inventory holdings.

While a tyre manufacturer might be able maintain two months supply of a fast moving tyre model, a baker, faced with spoilage, climate-storage and high cost would only store a few days of inventory. The same would apply to their raw materials. The tyre manufacturer could store large amounts (1 month or more) of raw materials that form the compound for making tyres. The baker may store only a few days of baking ingredients.

Determining inventory levels in this way permits you to:

- Compare inventory levels with similar businesses to detect shortages or excesses that should be corrected.
- Evaluate the inventory of individual items so that prompt action can be taken to correct shortages or excesses.
- Establish replenishment cycles and policies so that inventories can be sustained at realistic levels, minimizing the possibility of lost sales, production delays or excessive investments.

Supply Calculation

To calculate the supply of any item in inventory, the inventory on hand is divided by the expected sales or usage in the coming period.

Example 11.1. Calculating Supply (Finished Goods)

```
Inventory / Average [period] Sales = [period] Supply
```

Example 11.2. Calculating Supply (Raw Materials)

```
Inventory / Average [period] Usage = [period] Supply
```

Replacing the `period` with "days", "weeks" or "months" restates the equation. For example, a tyre manufacturer has 1000 tires of a particular model in inventory and expects to average 500 sales per month. The month's supply of tyre inventory would be calculated as follows:

```
Inventory / Average Monthly Sales = Months Supply 1000 / 500 = 2.0
```

The same calculation can be made in dollars. If the inventory valuation of the tires, at cost, is $800 and average monthly sales (at cost) is $400, then the month's supply in dollars would be calculated as follows:

```
Inventory / Average Monthly Sales = Months Supply $800 / $400 = 2.0
          months supply
```

Since work-in-process inventory represents partially finished goods or services, they are measured in terms of sales. For example, a repair shop may have work-in-process inventory of $5000. Average daily sales, at cost, are $1000. The day's supply of work-in-process inventory would be calculated as follows:

```
Inventory / Average Daily Sales = Days Supply $5000 / $1000 = 5 days
          supply
```

Turnover

It is standard practice in accounting to consider inventory as part of a business' assets. The reason for this is that analysts assume that inventory can be sold in the near future, turning it into cash. Therefore, in order to prepare a balance sheet, auditors must estimate the value of the inventory a company has on hand.

For example, a computer manufacturer many have 5000 units of its latest and greatest monitor in a Taiwanese warehouse. The company expects to sell the

monitors for $100 each to distributors. If they sold all the monitors, they would be able to put $500, 000 (5000 X $100 each = $500, 000) on the balance sheet. This is the current value of their inventory for this monitor. However, the reality is that not all the monitors will be sold at the same time. If production still roles out monitors during the year to maintain a basic stock of 5000 units, over time, keeping the inventory at this level could present two risks:

Obsolesce

A better monitor will supercede this monitor a year from now. As the launch date for the new product draws near, fewer stores will be willing to by the current model at $100, even if it is still the most current, updated and advanced on the market. Although the inventory is carried on the balance sheet at a value of $500, 000, it is actually losing value over time. If not aware of the problem a business may be forced to take what is called an "inventory write-off charge." What this means is that management found that the value of the stock was not what they thought they could get for it and had to make adjustments to reflect the stock's true value.

If production was stopped and only 3000 of the 5000 units remained in storage, management may decide to lower prices in order to help move this remaining inventory. If they lowered the monitors price to $80 each, they would have an inventory holding of $240, 000.

The risk of obsolesce is particularly high with technology companies and manufacturers of heavy machinery.

Spoilage

Spoilage is a concern for businesses where the raw materials or finished good are perishable. The risk here is that inventory may go bad and have to be disposed. The cash invested would be a loss. In this case the estimated value of the goods would be deducted from the balance sheet. In effect the company loses only the cost paid for the goods, but on paper the estimated market value is deducted.

The faster a company sells its inventory, the smaller the risk of value loss. This is why a common measure of effectiveness of inventory management is the annual inventory turnover rate. The following equations can be used to calculate the annual turnover rate of finished goods, work-in-process and raw materials.

Example 11.3. Calculating Turnover (Finished Goods and Work-in-Process)

Sales / Average Inventory = Annual Turnover Rate

Example 11.4. Calculating Turnover (Raw Materials)

Usage / Average Inventory = Annual Turnover Rate

When calculating turnover, it is important to take into account whether you are calculating inventory units or a dollar value. When calculating inventory, units sales must be average inventory in units, and when calculating turnover in dollars, both sales and inventory value must be expressed *at cost*. For example, if your average finished goods inventory value is $20,000 and sales are $60,000 at cost, the turnover rate would be calculated as follows:

Annual Turnover Rate = Sales / Average Inventory $60,000 / $20,000 = 3.0
Annual Turnover Rate

The turnover rate tells you how many times your average inventory is sold during the year. The higher the turnover rate, the more sales volume produced from a given investment in inventory.

Comparisons of Inventory Ratios

Expressing inventory in terms of turnover rate or equivalent monthly sales or usage permits comparison of your current inventory level with any of the following:

- Industry average (available from national trade associations)
- Inventory levels in previous periods
- Internal inventory policies

Comparison of inventory levels in absolute dollars with similar businesses or with previous periods provides little insight. For example, if current inventory level is $25,000 and industry average is $45,000, this would not tell you whether your inventory is high or low. It is more useful for comparative purposes to express inventory in terms of an equivalent number of daily, weekly or monthly sales or usage.

For example, if your finished goods inventory is equivalent to 2 months' average sales and the industry average is 1.5 months, then one could say that the finished goods quantity is higher than required to support sales volume.

Comparison of your current inventory supply or turnover rate with performance in previous periods also enables you to determine whether your inventory control is improving or slipping. Many businesses establish policies for inventory based on expected sales. This information is useful in controlling inventory investment and planning financial requirements.

For example, a manufacturer has a policy of maintaining a 5-week supply of raw materials in inventory. If the actual inventory reached a 6-week supply level, then the inventory must be reduced back to 5 weeks by either clearing at wholesale prices or by slowing purchasing until inventory reaches the required level. Conversely, if the inventory level is reduced to 4 weeks' supply, then, provided there is a demand, more materials should more than likely be ordered to avoid lost sales or production delays.

The same analysis techniques can be applied to individual items in inventory so that prompt corrective action can be taken. One of the common causes of excessive inventories is that slow moving, high cost items are not being cleared. When this

happens, sales may be lost or production reduced as a result of the effect this has on capital restriction. Capital invested in such items could often be better utilized in cheaper or faster moving items that have higher sales and profit potential.

These individual problems can be detected by periodic measurement of the month's supply of individual items. When an overstock is detected, action can be immediately taken to perform an elimination of overstocks. For example: a toy manufacturer might have finished goods inventory equal to 3 months' average sales. Examination of individual inventory records shows that many items have supplies equivalent to 12 months' sales or more. Prompt action should be taken to reduce these overstocks.

Chapter 12. Corrective Action

Whenever a problem in inventory is discovered, immediate corrective action can minimize the consequences while preventing the problem from getting worse. The appropriate corrective action for any problem depends on the inventory form and whether the problem is due to excesses or shortages.

Unattended problems have a tendency to have a knock-on effect in other parts of the business. Here are some examples:

- A shortage of one raw material would diminish the usefulness of another raw material used in the same production process.
- Excess of work-in-process inventory may tie up capital required to purchase new raw materials inventories.
- A neglected overstock of finished goods inventory caused by market surplus leads to further deterioration in the market price of an item.

In some cases, the need for prompt disposal is particularly acute. Seasonal items must be cleared before the season passes. The cost of storage until the next season is usually prohibitive. Prices on items with a short market life fall rapidly. Goods subject to spoilage may have no market value after just one or two days.

Situation of Excess

Situations of excess need to be monitored for all inventory types. As soon as the supply of any item in finished goods inventory appears to be excessive for foreseeable market requirements, the supply should be reduced. The following is a list of approaches that can help in this situation.

Excessive Finished Goods Inventory

- Promotion to create demand.
- Sales incentives such as extra commissions or bonuses to stimulate selling effort.
- Price reductions to retain a competitive position in a declining market.
- Disposal to discounters or other merchandisers of distress goods.
- Scrapage to free storage space.

When the supply of any item in raw materials inventory appears excessive, consider the following steps:

Excessive Raw Materials Inventory

- Return to suppliers for credit.
- Use in manufacture of other products.
- Sell at below or wholesale prices to competitors or other businesses in associated fields.
- Scrap to free storage space.

The cause of excessive work-in-process inventory is different from one situation to another. Whenever excess occurs, the following corrective approaches should be considered:

Excessive Work-in-process Inventory

- Analyze each job or product in process to determine which can be completed most quickly for transfer to finished goods inventory or sale to customer.
- Review production processes to reduce the overall time requirement.
- Consider subcontracting to accommodate some production requirements.
- Re examine production processes to identify ways of reducing the total time requirement (start to finish).
- Re-evaluate production priorities to see if jobs nearer completion can be accelerated.

Situation of Shortage

Although problems associated with inventory excess are probably more prevalent, the problems of shortage are equally damaging to a business. Excess and shortage are also very frequently linked, as the cause of an inventory shortage of one item is simply that an excess of another item has tied up capital and limited the business' purchasing power. In other cases, a number of other factors must be considered.

Shortage of Finished Goods Inventory

- Accelerate production through overtime, subcontracting or re-prioritizing production.
- Examine possible deficiencies in raw materials inventory that are causing production delays.
- Analyze work-in-process to see if any needed finished goods are being delayed unnecessarily in production.

Shortage of Raw Materials Inventory

- Place a rush order, ignoring quality discounts and freight costs if economically feasible.
- Consider the use of alternate suppliers.
- Purchase from a competitor or other user of the same material.
- Divert material from some other production or manufacturing process.
- Consider the use of substitute materials.

Work-in-process is an essential intermediate step between raw materials and finished goods. So technically there can never be such a thing as a "shortage" of work-in-process inventory. Not having enough work-in-process inventory can only mean that there is either a shortage of raw materials or a shortage of sales orders. Nevertheless, since this inventory form generally has near to or no market value, it is always a "best practice" to limit work-in-process inventories to a bare minimum that will accommodate the demand for the supply of finished goods.

Part IV. Inventory Optimization

Maximizing while Minimizing

Part III, “Inventory Management” [33] introduces the basic concepts and practices for good inventory management. These methods are the foundation of Inventory Optimization.

For businesses that have not previously maintained good inventory management practices, their implementation alone will yield significant savings and improvements in customer service levels. However, in today's competitive market environment these improvements are rarely sufficient to improve a competitive edge. Nor are they sufficient to leverage optimally on the operating capital of the business.

The preceding part of this book explained inventory management and control practices in context of the SCOR model and gave us broad insight as to how inventory can be managed by improved forecasting, reduced cycle times, lower setup costs, improved inventory visibility and lower carrying costs. By this time, you should have a fairly good idea of what inventory management is and how its management within the business and supply chain impacts marketing success.

These concepts and practices are the foundation of inventory optimization, which takes inventory management to the next level, so that businesses may further reduce inventory levels while improving customer service levels and maximize on their capital investments.

After reading this part you will be able to

- Understand the dynamics of inventory
- Understand dynamics of safety stock
- Understand the decision factors for inventory replenishment
- Understand how to determine the amount of safety stock to keep in inventory

Table of Contents

Chapter 13. Introduction

We have seen that purchasing, producing, storing, moving and accounting for inventory are inevitable tasks that tie up capital in a business. Understanding a business' position and role in the supply chain is paramount to management that reduces exposure to risk through improved stock availability, better customer service and reduced costs.

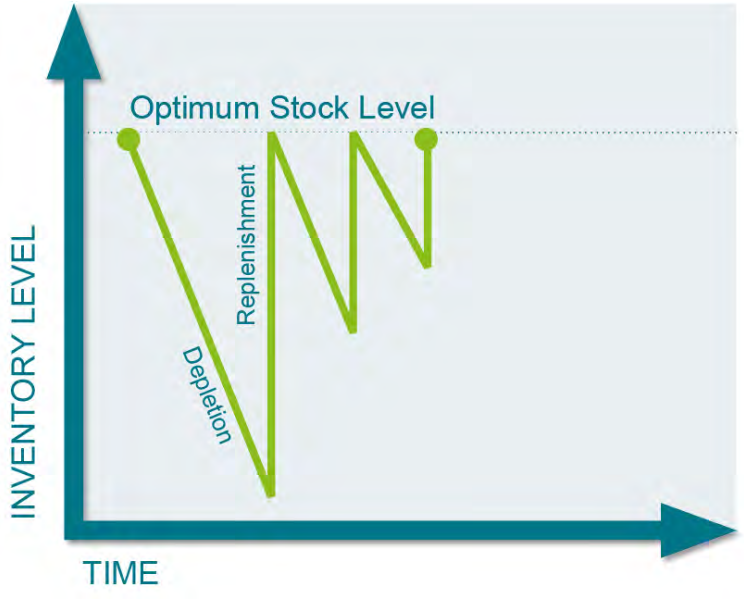
The practice of inventory optimization is centered on 'Safety Stock', that element of stock that serves as an insurance or buffer against the effects of uncertainty stemming from unexpected high or low demand and high or low lead-times. Maintaining minimum, basic and safety stock levels ensures a greater degree of availability and protection from unforeseen problems. However, safety stock is a quantity that is in excess of demand and means that a percentage of capital is forever tied up in inventory. The aim of inventory optimization is to minimize the amount of safety stock a business is required to carry so that capital may be released in order to reduce the effects of 'capital restriction' under which all businesses operate.

In addition to basic and safety stock our inventory plan presented in the section called “Inventory Management Plan” [53] also introduced a third element of inventory called 'Seasonal Stock'. All three elements of inventory must be managed as inventory moves through the raw-materials, work-in-process and finished goods forms of the inventory flow cycle (See Figure 8.1, “The Inventory Flow Cycle” [42]). However, for simplicity in explanation we will exclude seasonal inventory from our explanations and focus only on the relationship between basic and safety stocks.

Chapter 14. Inventory Dynamics

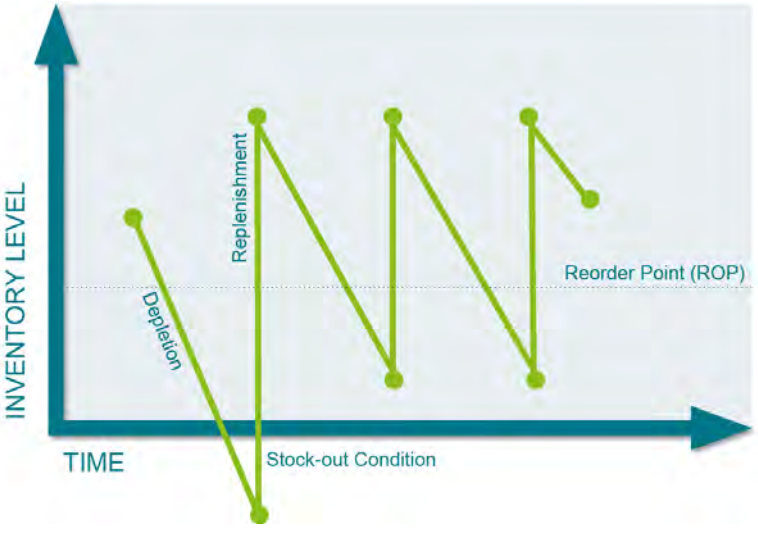
Inventory dynamics is a term used to describe the cycle of replenishment and depletion that occurs over a period of time (See Figure 14.1, “Stock Cycle” [99]). The optimum stock level of a business is assumed to be as accurate possible and is derived from demand forecast calculations. Over time consumers buy, and materials are used. This results in a depletion of the amount of inventory in stock. Left unchecked, this would result in a 'stock out' condition demonstrated in Figure 14.2, “Stock out Condition” [100].

Figure 14.1. Stock Cycle



Stock out conditions, a critical dimension of inventory management, are to be avoided. They take a heavy toll on customer confidence and often result in a loss of market share as competitors satisfy consumer demand. Stock outs also affect material handling costs as the business moves quickly to rectify the situation. The condition is apparent when a replenishment order arrives too late in order to satisfy demand.

Figure 14.2. Stock out Condition



When a stock out condition occurs, a business has three possible plans of action, none of which is completely suitable:

- **Lose sales** — this option is not so much an action as it is the lack thereof and should be avoided using either or both of the other action plans.
- **Backorder** — this option entails taking a customers order and satisfying it in the future. This option depends on the customers' willingness to wait.
- **Substitute** — this option entails providing a similar product that is acceptable to the customer. This option depends on the price and quality being equal or better than the stocked out item, and the customer's urgency.

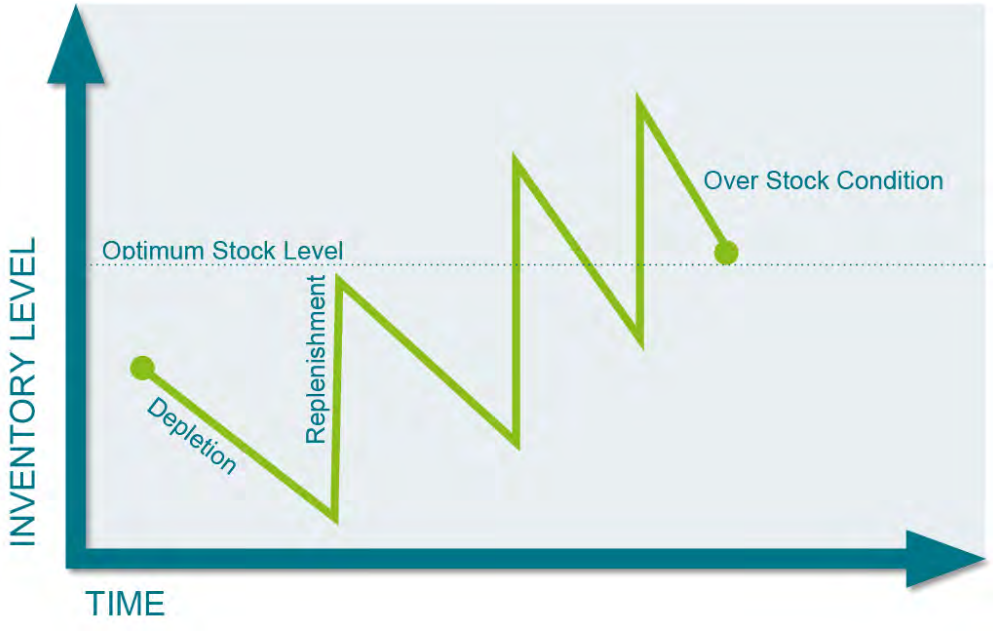
To avoid this position without safety requires exact timing and insight into the future. The inventory controller must ensure that production is scheduled at a lead-time that enables replenishment stock to be produced and delivered in just enough time to avoid the stock out condition.

The opposite of a stock out condition is an 'overstock' condition. These stocks should be eliminated as quickly possible. In Figure 14.1, “Stock Cycle” [99] we see that the

amplitude of the cycle is not consistent. This indicates that stock is being delivered in quantities that are acceptable to the optimum stock level required, but that orders are not being placed at the right time. When this happens, the cost of holding inventory is increased since the delivery schedule is increased, and there is bound be less than optimal utilization of transport loading capacity.

This position is not yet critical and can be easily rectified. The danger in this situation arrives when replenishment stocks are delivered in a quantity that is in excess of the optimal stock level, as shown in the figure below. Unless the overstock quantities are promptly eliminated, there is a danger that this position may increase. Holdings of overstocked items will tie up capital and consume storage space to the point where there is not enough space to house items that are moving and are not overstocked. At this point desperate measures are usually called for as the excess is released at distressed prices that often cannot recoup the investment cost in materials and labor.

Figure 14.3. Overstock Condition

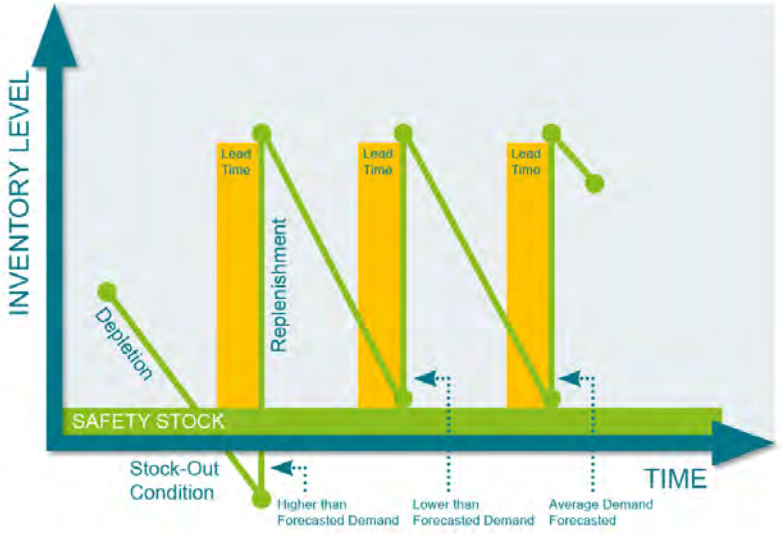


Too much in either direction causes problems. The aim is never to be in either position. Implementing the practices explained earlier in this book will help to avoid both situations and stabilize the swings between depletion and replenishment. Calculation of the EOQ will help determine the most effective amount to order, since EOQ determines the most efficient investment of capital in inventory by determining the lowest total unit cost for an inventory item. However, it does not give any indication as to whether the resulting quantity is the desired level of inventory required in order to meet targets. To establish this one must first calculate the desired inventory level and establish a calculated order point. Examples of how to calculate the desired inventory level, order point, order ceiling (desired inventory level) and order quantity can be found in the section called “Basic Stock” [54].

Chapter 15. Safety Stock Dynamics

From a business perspective safety stock is seen as an insurance against uncertainty. Technically, safety sock can be defined as the amount of stock on-hand when a replenishment quantity is delivered (See Figure 15.1, “Safety Stock Dynamics” [103]). So the safety stock quantity is the amount of inventory available at the end of the depletion limit just before replenishment occurs.

Figure 15.1. Safety Stock Dynamics



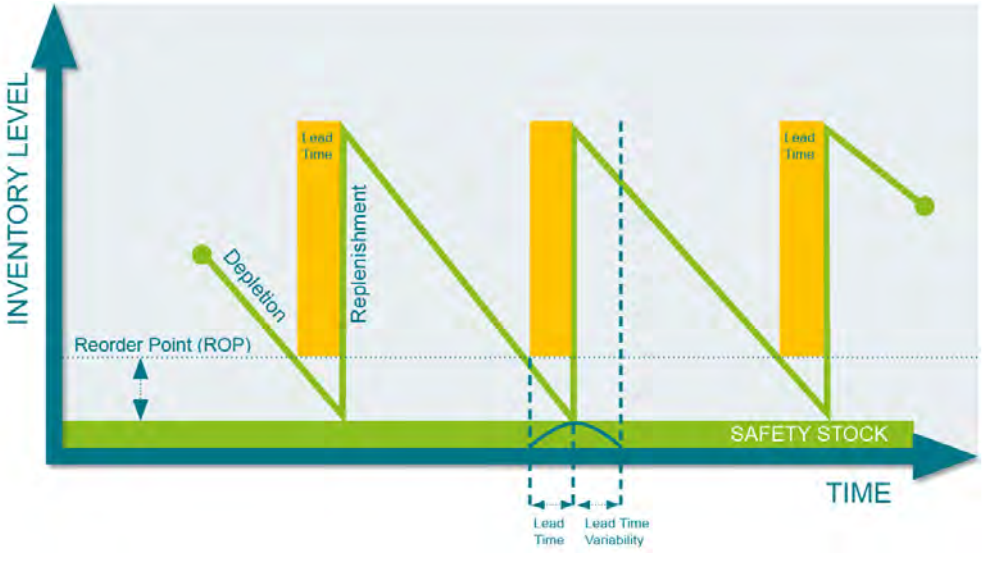
Basic stock exists to satisfy normal demand. Safety stock exists to protect from higher than expected demand or circumstances that are beyond the control of the business, thus protecting from a stock out condition. Regular use of safety stock should be protected against under normal conditions of average demand. Assuming that conditions are normal and demand is average, calculation of the lead-time required in order to replenish basic stock is critical in preserving safety stock.

As explained in the section called “Inventory Replenishment” [63], replenishment practices strive to reduce the possibility of overstocks through production and purchase planning and avoiding stock out conditions. Lead-time is pivotal to both situations, but the definition of what lead-time is varies for each of the inventory forms found in the inventory flow cycle.

For raw materials inventories, lead-time is the time between order placement and receipt of goods. For finished goods inventories, lead-time is the time required for production, assuming that the required raw materials are already in inventory. If raw materials are not ordered until a production is made, then delivery time for raw materials must be added to the production time in order to determine lead-time.

This presents a problem, since calculation of lead-time requires knowledge of an order point that will leave enough in stock to suffice *lead-time demand* without having to use safety stock before the next replenishment delivery and knowledge of how long it will take for delivery (See Figure 15.2, “lead-time” [104]). In businesses that have both raw and finished goods inventories lead-times for both inventory forms must be calculated.

Figure 15.2. lead-time



Another method of calculating both inventory forms is the 'run out time' method. This method approaches the problem from the perspective of production scheduling to avoid the product's run out time. This period is calculated as the number of days, weeks or months it will take to deplete the on hand basic stock inventory given the current and expected demand. The calculation is explained in the section called “Production Management” [68].

Chapter 16. Safety Stock Quantity

Unless properly managed, safety stock can easily become a large proportion of the inventory holding. In this chapter we discuss the method used for calculating safety stock.

The amount of safety stock a business holds is linked to the desired customer service level the business want to provide customers. The level of service may vary from item-to-item and where items are sub components of assemblies trading under the same brand, such as automobile brake pads. The service level for the same item may differ between the brands. So, a Toyota™ part used in both standard and luxury models may have different service levels attached. In such instances safety stock calculations must be done for both models on the same part.

There are several methods for calculating safety stock. The most common method is a rule of thumb called the KISS principle: Keep it super simple, proposed by Gordon Graham in his book, "Distribution Inventory Management for the 1990s" [1] [131]. This method sets safety stock levels equal to 50% of the lead-time demand. Graham claims that this method will usually provide a service level near 90%. As simple as this method is, it is also not accurate enough for today's environments and often leads to larger than required quantities of safety stock.

What is needed for small businesses today is a method that is simple but more accurate than Graham's method. J. Christopher Sandvig, Ph.D., professor at Western Washington University in Bellingham, Washington, offers a solution that calculates the order cycle service level. Sandvig defines the order cycle service level as the probability that demand will not exceed supply during the lead-time. So if a business needs a service level of 85%, then it should be able to satisfy all demand during the lead-time approximately 85% of the time. The formula for calculating the safety stock level is as follows:

```
Safety Stock = Target Service Level X Standard Demand Deviation X Order Lead
        Time
```

Most businesses know what level of service they want to deliver and also know the lead-time they need in order to take delivery of replenishment inventory. The question remaining is how to calculate Standard Demand Deviation.

To answer this question, the standard demand deviation and lead-time need to be expressed in the same unit of time. The sum of these standard deviations equals the

Standard Deviation. So, if standard deviation and lead-time are expressed in days then deviance is:

Standard deviation Squared = lead-time Days X Standard Deviation per day Squared

To get the standard deviation of the lead-time demand (instead of the variance), we have to take the square root:

lead-time Demand = Square Root of lead-time Days X Standard Deviation per day

Given the standard deviation of demand per month, we can calculate the standard deviation per day as follows (assuming 30 days per month):

Variance per Day = Variance per Month / Square Root of 30

The thing to remember is that first you have to figure out the standard deviation per day, per week or per month, using the equation above then write the lead-time in the same units, either days, weeks or months so that you can use the preceding equations to calculate the lead-time variance for the period.

Part V. Supply Chain Optimization

Extending the Enterprise

Preceding parts of this book have mainly focused on conveying the basics of supply chain, inventory management and optimization using manual methods and techniques that can be applied in any business. In this part we focus mainly on the use of technology to automate these methods and techniques.

After reading this part you will be able to

- Understand the concept of supply chain optimization and the relationship it has with inventory optimization.
- Understand the effect of supply chain collaboration on the supply chain.
- Understand the basic framework for collaborative planning, forecasting and replenishment.
- Understand the technologies and enterprise applications that serve as collaborative commerce enablers.

Table of Contents

Chapter 17. Introduction

As a business grows, so do demands. At some point it is no longer feasible to manage using manual methods. The use of technology is required to increase capacity, efficiency and responsiveness while maintaining accuracy and visibility.

Fortunately, computer and communications technologies have improved to such degrees that today it is possible to manage supply chain operations and the inventory within. These technologies have also become sufficiently cost-effective to enable small businesses to take advantage of their benefits and level the playing field with their larger competitors. Since the 1980's, a clear trend has emerged. Small businesses that adopt technology consistently experience greater competitive advantage and growth when compared to those that do not. This trend is mostly attributed to the fact that computerized businesses have greater capability to react to demand fluctuations and market changes.

Despite these facts, many small businesses make little use of computerized technologies and communications to manage their supply chain relationships and inventories. In a good case, small businesses perhaps have one or two computers that run a financial program. These systems are typically independent of one another and are used by a small number of people, perhaps one or two. There are a number of reasons for this position:

- Business owners perceive enterprise systems to be expensive and neglect to research whether or not this is true for their business.
- Business owners are not technology people. They often shy away from learning to use a computer. They are secure in doing things in a way they know and cannot see a reason to change. After all, "if it ain't broke, don't fix it."
- Business owners are aware that technology can be used to improve their business, but are confused by all the options and jargon of the electronics world.
- Business owners are often so busy taking care of business that the last thing on their minds is how to use technology to improve their operations. Problem solving is in the here and now. Very little vision and analysis are done on problems, and so strategy is lacking.

This list could go on for another two pages, at the end of which you will notice that every reason has one common factor, lack of action. Unfortunately, it is not always possible to change this position. The sad part is that these businesses inevitably end up closing their doors as customers increasingly prefer to shop with competitor stores where they get quality, consistency of service, value for money and everyday low prices.

In the coming chapters we discuss how small- and medium-sized businesses can leverage technologies to help them better manage their supply chains and inventory management operations. In writing these chapters we assume that your business has already adopted a technology strategy and is now looking to leverage this existing investment for further or greater returns by improving your supply chain efficiency. If your business has not implemented a system, this section will still be of value to you. First, it will give you insight into the possibilities that are now available. Second, it will give you some inclination of what systems a business needs internal to the organization and how they may be extended beyond the logical business borders.

Chapter 18. Supply Chain Collaboration

Supply chain efficiency has become a major area of interest to businesses that already have enterprise systems in place. While there is always room for improvement in internal processes and transactions, such improvements do not generally have sufficient impact to provide significant improvements in positioning or competitive advantage. Businesses have realized that one of the few ways to significantly improve their internal environments is to identify and improve problem areas external to their business.

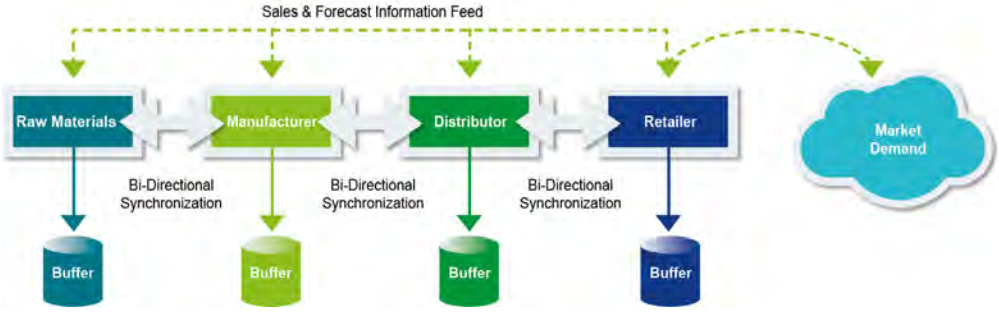
The idea is that businesses in a supply chain will cooperate with one another so that activities related to the supply and demand of inventory are shared. By sharing information, all parts of the supply chain will have greater visibility into the demand for supply and therefore be able to perform better planning. With improved visibility and planning, the supply chain becomes easier to control and better organized and uncertainty is reduced. These factors are prerequisite to the adoption of a "Just in Time" strategy for inventory management.

This is where the role of software and communications really comes to the fore as they enable businesses to collaborate in a manner that is near real-time regardless of their geographic location. In the enterprise application space this is called "collaborative-commerce," or c-commerce for short. In the book "SYSPRO e.net solutions - The Definitive Guide" [6] [131], the concept of c-commerce is explored in some depth and states that c-commerce requires an "Extended Enterprise" strategy in order to achieve supply chain collaboration. This strategy makes use of the Internet and XML-based technologies to integrate enterprise applications both internal and external to the organization for the purpose of obtaining:

- Increased reach
- Information value
- Velocity and agility
- Threshold management

The basis for any extended enterprise strategy is that all businesses in a supply chain will agree to cooperate by inter-connecting and sharing their applications, data and businesses processes. If this is done, then information about market demand can be passed upstream in the supply chain to secure the objectives (See Figure 18.1, “Information Flow in the Collaborative supply chain” [114]). This leads businesses to the position where they can collaboratively cooperate planning, forecasting and replenishment activities.

Figure 18.1. Information Flow in the Collaborative supply chain



Effect of Collaboration on Activities

Extended enterprise application deployment strategies enable supply chain coordination practices that are a great improvement on traditional methods by enabling better management of supply chain and inventory activities, such as demand forecasting, order batching, product rationing, pricing and performance incentives.

Demand Forecasting

The main effect collaboration has on demand forecasting activities, is to increase visibility to actual customer demand for businesses that are up stream in the supply chain. Up stream businesses are often presented with a skewed or distorted view of market demand, as they are not in direct contact with the end consumers.

Through increased visibility, such businesses are able to calculate their demand

forecasts based on orders received instead of consumer demand data. Combined with the significant reduction in the time it takes to obtain such information, the reaction time to problems is greatly improved. In addition, since demand forecasts are calculated on orders received, the 'bull whip' effect caused by order batching, which results in exaggerated demand swings in the upstream supply chain, is eliminated.

Order Batching

The concept of order batching is that companies will periodically place orders for quantities of an item to minimize their order processing and transportation costs based on an EOQ calculation. Order batching is necessary but has the nasty side-effect of producing ever increasing distortions to demand the further up stream one goes in the supply chain. This is because the lot size resulting from the EOQ calculation is often greater than the actual demand required by a customer. The customer, however, in an effort to reduce order processing and transportation costs would rather place an order for a greater quantity than have to pay the full cost of transportation that is not fully loaded.

Through increased visibility and implementation of automated electronic ordering systems, the cost of order processing is significantly reduced. In addition, better use can be made of logistics service providers who can optimize their loads by *part loading* until the container space is full and then schedule the optimum delivery route.

This has the overall effect of enabling customers to take receipt of much smaller quantities of replenishment stock with greater frequency. Reorder Points can therefore be scheduled earlier so that levels of basic and safety stock can be maintained at lower quantity levels. Actions such as product rationing are therefore reserved to situations of absolute crisis.

Product Rationing

Production rationing occurs when demand outstrips the rate at which manufacturers can supply. In this situation, suppliers resort to back ordering which, in turn, leads to customers increasing their order quantities.

Better visibility into demand heightens a manufacturer's ability to react to sporadic increases or decreases in demand. The overall agility of the supply chain is improved.

Pricing

Changes in a product's price generally increases or decreases demand, depending on whether the price was raised or lowered and the degree of market captivity. Price decreases, such as special promotions, present the most problem as they encourage consumers to buy more than the normal quantity. This result in increased demand often causes a shortage of stock to which manufactures respond by increasing production capacity. When the price returns to normal, there is a danger that this information may not be conveyed in a timely manner to the manufacturer, which then continues to produce at a rate that is now surplus to demand. The result is an over supply that produces a 'glut', forcing stock to be sold at distressed prices.

A common problem that also affects pricing is 'performance incentives.' Sales people are often given a bonus when reaching predetermined targets for a period. When nearing the end of the period, sales people may reduce prices in order to reach their targets. This artificially increases the demand perceived by manufactures that again react by increasing production.

Once again visibility is the answer. As prices are changed, manufacturers with insight to the short, medium and long-term forecast and other data can see that the change is in preparation of an event with a fixed duration. Insight into such events can ensure that manufacturers are able to prepare for increasing and decreasing their capacity. They have the ability to better match their production levels with the curves of demand.

Collaborative Planning, Forecasting, and Replenishment

Coordination between multiple businesses is easier said than done, especially between small and medium-size businesses, which typically do not have full time systems administration staffs with expertise in implementing a collaborative supply chain. To reduce the barrier to entry a group known as the Voluntary Interindustry Commerce Standards [http://www.cpfr.org/] (VICS) setup a committee to investigate Collaborative Planning, Forecasting, and Replenishment issues. The work of the committee results in recommendations based on industry best practice and serves as a basis for developing collaborative supply chains.

In a document entitled "Collaborative Planning, Forecasting, and Replenishment (CPFR) - An Overview" [21] [132], the VICS committee outlines a model for supply chain collaboration, places it in the context of industry scenarios and maps a route for implementation.

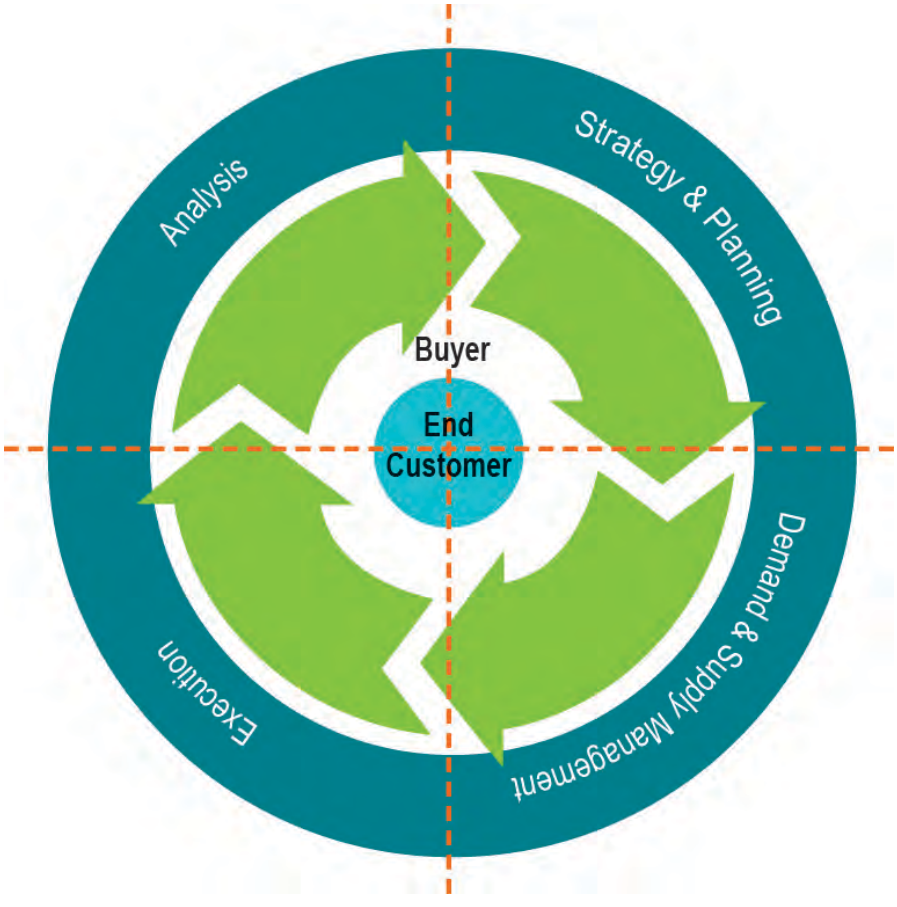
Documents such as these can greatly assist small business owners to obtain a generic understanding of a concept or method enabled by technology without having to understand the differences between the competing technology vendors' products. Armed with an understanding, businesses managers can therefore approach technology vendors or their distribution channel parts with an idea of what it is they want to do, why and how.

In this section we provide a brief introduction of CPFR. We will not attempt to explain it in full, only provide an insight that will hopefully encourage reading the full document and further research into the subject.

The CPFR Model

The CPFR model provides a framework comprised of four activities. Businesses involved, or wanting to be, in a collaborative supply chain will cooperate on these activities with the aid of technology. Figure 18.2, “Framework of the CPFR Model” [118] shows the model as a logical cycle. In reality businesses will be involved in all activities, to a greater or lesser degree, at any moment in time because each activity can impact on the other.

Figure 18.2. Framework of the CPFR Model



In the document "Collaborative Planning, Forecasting, and Replenishment (CPFR) - An Overview" [21] [132] these activities are further broken down into the specific tasks buyers and sellers will engage in. We will not go into detail on each of these tasks. It is enough to understand that each activity mandates a number of tasks. There are three task categories, including:

- Seller tasks
- Joint tasks
- Buyer tasks

These tasks are lists, but not detailed, in the following sections. Seller and buyer tasks are independently executed and provide input to the joint tasks.

Strategy and Planning

This activity is concerned with establishing the ground rules for the collaborative relationship. Buyers and sellers are required to agree on topics, such as product mix and placement, and develop event plans for the period. Figure 18.3, “Strategy and Planning Tasks” [119] lists the tasks in which buyers and sellers must engage to provide input to the joint tasks that enable collaboration.

Figure 18.3. Strategy and Planning Tasks

Demand and Supply Management

This activity is concerned with projecting the consumers' demands, orders and shipping requirements for the period. Figure 18.4, “Demand and Supply Management” [120] lists the tasks in which buyers and sellers must engage to provide input to the joint tasks that enable collaboration.

Figure 18.4. Demand and Supply Management

Execution

This activity is concerned with order placement, preparation and delivery of shipments, receiving and stocking of products, recording of sales and making of payments. Figure 18.5, “Execution” [120] lists the tasks in which buyers and sellers must engage to provide input to the joint tasks that enable collaboration.

Figure 18.5. Execution

Analysis

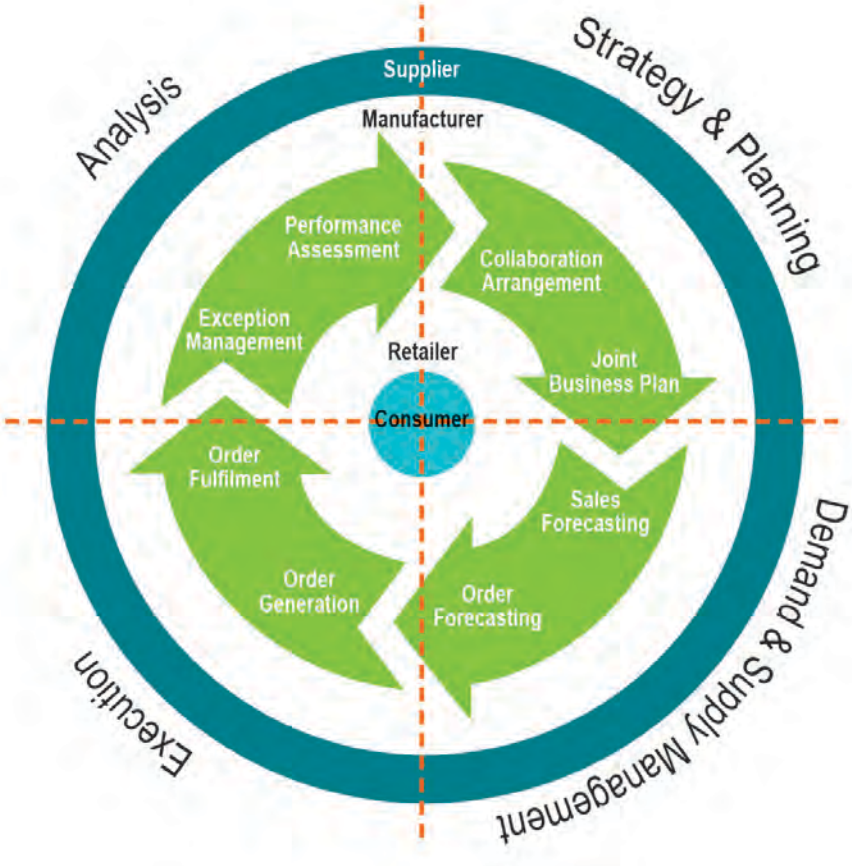
This activity is concerned with monitoring of planning and execution activities so that results, aggregated across the supply chain, can be used to produce *Key Performance Indicators* (KPI). The shared results can therefore provide insights that will enable everyone to identify problems and adjust their plans. Figure 18.6, "Analysis" [121] lists the tasks in which buyers and sellers must engage to provide input to the joint tasks that enable collaboration.

Figure 18.6. Analysis

CPFR in the Extended Enterprise

For simplicity of explanation our model of CPFR (See Figure 18.2, “Framework of the CPFR Model” [118]), shows a two-tier relationship between a buyer and seller. However, the CPFR model can be extended to include more than two tiers of trading partners that encompass all parties in the extended supply chain (see Figure 5.2, “Extended supply chain” [24]). This is known as an *n-Tier* configuration and typifies the full implementation of an extended enterprise application deployment strategy.

Figure 18.7. n-tier



Chapter 19. Technologies Supporting CPFR

Implementation of CPFR is reliant on 4 categories of technology:

- Data Communications [124]
- Data Exchange [125]
- Data Storage [127]
- Enterprise Applications [127]

These technology categories are found in most organizations that have a *Local Area Network* (LAN) connecting all their computer systems and applications. To support CPFR the technologies found in each of these areas must be extended beyond the logical boundaries of the current LAN. Some new systems need to be added, and some existing systems need to be extended. In the following sections we discuss each technology area. There is no sequence in which businesses should approach these areas. Each is dependent on the other when implementing a collaborative environment.

By definition, collaboration takes place between two or more businesses. It is therefore helpful to keep in mind that there is no use implementing technologies for the purpose of collaboration when other trading partners do not support the same capabilities within their own information systems. For collaboration to work everyone must have the same or similar capabilities and must be willing to extend some or all of those capabilities beyond their network so that all trading partners can cooperate on the joint tasks discussed in the section called “The CPFR Model” [118] in an efficient manner.

In "Essentials of Supply Chain Management" [5] [131], Michael Hugo suggests that one way to start with the implementation of a collaborative supply chain is to first measure the effect of the 'bull whip' effect on a business over time and plot them on a graph so everyone can see the divergence between incoming customer orders and outgoing supplier orders. This level of visibility provides insight to management so they can see the effect that the divergence is having on the various business

departments and serves as a motivator to fix it. This logic is certainly correct, but once again, collaboration takes place between two or more businesses. What Hugo stops short of suggesting is that the information from the graph should also be shared with other trading partners and discussed so they understand not only the impact on the business but also themselves.

Data Communications

The foundation technology upon which all collaboration is dependent is communications technology. For a collaborative supply chain to work in near real-time, businesses must have permanent communications between one another. For small and medium-size businesses, broadband technology, such as *Asynchronous Digital Subscriber Line* (ADSL), provides a cost-effective, always-on connection to the world by way of an *Internet Service Provider* (ISP). Having a permanent and reliable connection to the Internet is important, since one can never tell when one of the trading partners will be sending or retrieving data from the information systems. For businesses who work with trading partners that are in different time zones this requirement is even greater, since they may be working while you are sleeping and visa-versa.

The Internet

The Internet is a global data communications network to which virtually every country in the world is connected. Within these countries telecommunications operators and ISP's deliver services to millions of institutions, private businesses and home users.

Computers and computer networks connected to the Internet can talk to each other regardless of their geographic location. Messages can be sent and received across the network in many forms and are transported by a protocol called *Internet Protocol* (IP), sometimes also referred to as TCP/IP (*Transmission Control Protocol over Internet Protocol*).

Broadband

Prior to the Internet, businesses wanting to connect between one another would have to lease dedicated lines. These lines are point-to-point, meaning they would only connect between two points. With dedicated lines, each trading partner with which a business needs to exchange data must have a line. While dedicated lines provide a better quality of service, speed and security, they are expensive and therefore not an option for small and medium-size businesses.

The best solution for small and medium-size businesses is to combine the use of the Internet with Broadband technology. While this solution does not provide the same quality of service, speed and security of dedicated connections, it is far cheaper. In addition to using broadband communications, such as *Asynchronous Digital Subscriber Line* (ADSL) for collaborative commerce, this single connection can also be used for a host of other applications. Starting with ADSL, a business can hook up with its trading partners today and, as the amount of data increases, gradually increase the size of their broadband connection to meet the increasing demand.

Data Exchange

Once a data communications infrastructure is in place, business computer systems have the ability to communicate both internally and externally to the organization but cannot necessarily do so until everyone can speak the same language. So the next step is to decide how trading partners will exchange data between their systems using a common language or format. There are essentially two methods to achieve this:

- Electronic Data Interchange [125]
- Extensible Markup Language [126]

Electronic Data Interchange

Electronic Data Interchange (EDI) is the older of the two data exchange methods. Developed in the early 1980's, EDI was designed to transmit common data types between mainframe systems of large enterprises, such as those in the automobile or aeronautics industries.

While prices of EDI solutions have been reduced as vendors started to publish and make available standard data sets, this technology is still too expensive for most small and medium-sized businesses. In addition to its price tag, EDI has another drawback. EDI data sets are very rigid and therefore not easy to customize. Their rigid nature also means that if any of the enterprise systems should change so much as a field size, both systems will not be able to exchange data without risking data corruption. This situation often means that businesses are not able to upgrade their systems to take advantage of new features and technologies as cost-effectively and as easily as they would like.

Extensible Markup Language

Extensible Markup Language (XML) technology is a markup language that defines or describes what data is. XML has several advantages over EDI. The most important advantage from a small business point of view is price. XML is an open standard and is free for everyone to use. It is also flexible, meaning that anyone can write an XML file and can use the *Extensible Style Sheet Transformations* (XSLT) to transform their files into a structure and format acceptable to a remote system. This means that where EDI requires fixed definition of transactions and processing sequences in order for two systems to exchange data, XML can be transformed to meet the expectations of the remote system at any point in the system.

The result of this flexibility is a lower cost and ability to upgrade end systems without the fear that the upgrade will cause the entire system to fail or data to be corrupted. These factors have resulted in an increasing movement for technology vendors to use XML-based technologies in their products. As this momentum increases, XML is sure to supplant the use of EDI, even in large enterprises.

Web Services

In recent years, the rise of XML has resulted in a number of technologies supporting methods by which systems can interact and pass XML between one another using standard Internet protocols. One of the most popular of these technologies is Web Services.

A Web Service is a component that runs on a Web server and allows client programs to call its methods over any standard Internet Protocol. Each method of the component appears as a *Universal Resource Indicator* (URI) and may return data and accept parameters. This technology is based on an open specification called SOAP (*Simple Object Access Protocol*). This specification enables any server

running Web Services to be available to virtually any client, regardless of language or platform.

A Web Service is a software that exposes application functionality and, in the case of enterprise applications, business logic to other Internet connected systems. Standards-based Web Services use XML to interact with each other, allowing them to link up on demand using loose coupling, a method of communications well suited to the Internet environment.

The combination of the Internet, XML and Web Services is very powerful as it enables businesses to link and share their business applications, businesses logic and data in a manner that is secure, fault tolerant and cost-effective.

Data Storage

The foundation component of most enterprise systems is the database, an organized collection of information or data. In the electronic world, databases are used to rapidly store, search and retrieve captured information and data. The information and data are accessed by applications that have the ability to provide different views of the information for different audiences. The information is also used as input to transactions so that applications can automatically process requests. The results of transactional requests are often stored back in the database where this information can then be reused. Over time, the amount of data stored in the database becomes a powerful tool in activities such as forecasting, planning and replenishment by enabling management to have quick access to actual statistics and indicators.

Enterprise Applications

Enterprise applications within a business provide processing capabilities to capture, store, and retrieve data. They also provide logic to automate transactions in a process that is designed to support various operations of the business. Each business in the supply chain will have enterprise applications configured in such a manner. The number of application types and their configurations will vary between businesses. The following applications within a collaborative supply chain will support optimization of the supply chain and the inventory within:

- Enterprise Resource Planning (ERP) [128]
- Advanced Planning and Scheduling (APS) [128]

- Inventory Management System (IMS) [128]
- Transportation Planning System (TPS) [129]
- Customer Relationship Management (CRM) [129]
- Supply Chain Management (SCM) [129]
- Warehouse Management System (WMS) [130]

Enterprise Resource Planning (ERP)

ERP (Enterprise Resource Planning) is an industry term for a broad set of applications that supports business activities, including product planning, parts purchasing, maintaining inventories, interacting with suppliers, providing customer service and tracking orders. ERP systems are typically multi-module architectures. Modules can be installed on their own or with other ERP modules.

When all ERP applications are installed, they support a process-orientated view of the business that spans multiple business departments. Most other enterprise applications are dependent in some way on the existence of an ERP system to receive their data inputs. Core components of an ERP system generally cover accounting, distribution and manufacturing functions of a business.

Advanced Planning and Scheduling (APS)

APS (Advanced Planning and Scheduling) is an industry term for an application that provides analysis capabilities that assess plant capacity, material availability and customer demand. The result of the analysis is used to produce production schedules for each manufacturing facility and item. APS systems provide management with a comprehensive, real-time view of the shop floor. They are particularly helpful in dynamic manufacturing environments.

Inventory Management System (IMS)

Inventory Management Systems (IMS) ensure the availability of products by linking customer demands, product reservation, and allocation processes.

Inventory management software helps create invoices, purchase orders, receiving

lists and payment receipts and can print bar coded labels. An inventory management software system configured to your warehouse, retail or product line will help to create revenue for your company by controlling operating costs and providing a better understanding.

Transportation Planning System (TPS)

Transport Planning Systems aim to achieve optimum quality, timing and allocation of transport methods in support of a business' specific operational goals.

Building an effective transportation plan requires that a business determine the best shipping methods by which a customer's requirements can be met at the lowest cost. The greater the volume of transactions, the harder it is to manually prepare a transportation plan. Automation of the planning process enables greater flexibility that provides improved carrier performance, customer service and reduced annual transportation costs.

Customer Relationship Management (CRM)

Customer Relationship Management (CRM) is a set of methodologies, software and usually Internet capabilities that helps a business manage customer relationships in an organized way.

CRM includes all sales, marketing and service business processes that have customer touch points. For example, an enterprise might build a database about its customers that describes relationships in sufficient detail so that management, salespeople, service personnel and even the customer can access information, match customer needs with product plans and offerings, remind customers of service requirements, know what other products a customer has purchased and so on. Customer Relationship Management systems play an important role in integrating internal and external business functions with one another.

Supply Chain Management (SCM)

The concept of Supply Chain Management (SCM) is to provide an oversight of materials, information and finances as they move from upstream in the supply chain toward the end customer. Supply Chain Management involves coordinating and integrating these flows both within and among companies.

A Supply Chain Management system is a key technological component to enabling

collaboration that, by definition, reduces the latency in communications between trading partners. The aim of SCM is to reduce inventory with the assumption that products are available when needed.

Warehouse Management System (WMS)

Initially a system to control movement and storage of materials within a warehouse, the role of WMS has expanded to include light manufacturing, transportation management, order management and complete accounting systems. The primary purpose of a WMS is to control the movement and storage of materials within an operation and process the associated transactions. Directed picking, replenishment and put away are the keys to WMS. The detailed setup and processing within a WMS can vary significantly from one software vendor to another; however, the basic logic will use a combination of items, locations, quantities, units of measure and order information to determine where to stock, where to pick and in what sequence to perform these operations.

Bibliography

Books

[1] Gordon Graham. Copyright © 1987 Inventory Management Press. 0 31701 548 6. Inventory Management Press. *Distribution Inventory Management for the 1990s*.

[2] Colin Lewis. Copyright © 1997 Woodhead Publishing Ltd. 1 85573 241 6. Woodhead Publishing Ltd. *Demand Forecasting and Inventory Control*. A Computer Aided Learning Approach.

[3] Dr. Edward Frazelle. Copyright © 2002 The McGraw-Hill Companies Ltd. 0 07 137599 6. McGraw-Hill. A division of The McGraw-Hill Companies Ltd. *supply chain Strategy*. The Logistics of Supply Chain Management.

[4] Tony Wild. Copyright © 1997 Woodhead Publishing Ltd. 0 471 25341 3. John Wiley & Sons, Inc. *Best Practice in Inventory Control*.

[5] Michael Hugos. Copyright © 2003 John Wiley & Sons, Inc. 0 471 23517 2. John Wiley & Sons, Inc. *Essentials of Supply Chain Management*.

[6] Sean Wheller. Copyright © 2003 SYSPRO (PTY) Ltd. / SYSPRO Press. no isbn. SYSPRO (PTY) Ltd. / SYSPRO Press. *SYSPRO e.net solutions*. The Definitive Guide.

[7] Eliyahu Goldratt and Jeff Cox. Copyright © 1992 North River Press. 0 884 27061 0. North River Press. *The Goal*. A Process of Ongoing Improvement.

[8] Kenneth Mc Gee. Copyright © 2004 Gartner, Inc. 1 59139 299 3. Harvard School Business Press. *Heads Up*. How to Anticipate Business Surprises and Seize Opportunities First.

[9] Thomas Nagle and Reed Holden. Copyright © 1995,, 1987 Prentice-Hall, Inc. 0 13 669376 8. Prentice-Hall, Inc. *The Strategy and Tactics of Pricing*. A Guide to Profitable Decision Making.

[10] Tom Peters. Copyright © 2003 Dorling Kindersley Limited. Copyright © 2003 Text: Tom Peters. 1 4053 0049 3. Dorling Kindersley Limited. *Re-imagine!*. Business Excellence in a Disruptive Age.

Papers

[11] Jon Schreibfeder. Copyright © 2003 Microsoft Corporation. Microsoft Business Solutions. *Effective Inventory Analysis*.

[12] Jon Schreibfeder. Copyright © 2003 Microsoft Corporation. Microsoft Business Solutions. *Effective Replenishment Parameters*.

[13] Jon Schreibfeder. Copyright © 2003 Microsoft Corporation. Microsoft Business Solutions. *Maintaining Stock in Branch Locations*.

[14] Jon Schreibfeder. Copyright © 2003 Microsoft Corporation. Microsoft Business Solutions. *Improving the Accuracy of Your Forecasts*.

[15] Jon Schreibfeder. Copyright © 2003 Microsoft Corporation. Microsoft Business Solutions. *Keeping Stock Balances Accurate*.

[16] Jon Schreibfeder. Copyright © 2003 Microsoft Corporation. Microsoft Business Solutions. *The First Steps to Achieving Effective Inventory Control*.

[17] Copyright © 2003 JustEnough Software Corporation. JustEnough Software Corporation. *Inventory Planning & Optimization: Demand Management*.

[18] Copyright © 2002 Best Software, Inc. Best Software, Inc. *Achieving Effective inventory Management*.

[19] Jim Brown. Copyright © 2003 Tech-Clarity Associates. Tech-Clarity Associates. *Optimizing Capacity Deployment and Reducing Capital Investment*. Going Beyond Basic supply chain and Manufacturing in the Process Industries.

[20] Copyright © 2004 The supply chain Council. The supply chain Council. *supply chain Operations Reference-model*.

[21] Copyright © 2004 Voluntary Interindustry Commerce Standards. Voluntary Interindustry Commerce Standards. *Collaborative Planning, Forecasting, and Replenishment*. An Overview.

The model for creating business value has changed. Companies today participate in extended supply chains, where real operational efficiency and revenue enhancement come from greater visibility, integration, and synchronization among connected partners.

However, for most small and medium businesses, thinking in terms of collaboration is something believed to be just for big business, a dream in the future. The main reason for this perception is often a lack of understanding about the concepts and technologies employed in Supply Chain, Inventory Management and Optimization systems and how they can deployed in collaborative environments.

Written as an introduction to these subjects, this book is well suited to people who have little or no knowledge of supply-chains, inventory management or optimization but, for one reason or another, now have a need to understand this subject. The book covers the tenets of these subjects in context of small and medium business and leads up to how the various practices can be aligned in order to deliver greater visibility, integration, and synchronization among connected partners.

If you are a SYSPRO customer, this book is also an ideal starting point to understand the business benefits of SYSPRO's Forecasting and Inventory Optimization engine.

Reader level:
Beginner to intermediate

Produced by:
SYSPRO Press