(54) Title: METHOD AND SYSTEM FOR MANAGING MANUFACTURING

(57) Abstract: A method and system for managing manufacturing a supply chain comprises a business planning system having a supply chain overview process. The process comprises a manufacturing scheme wherein a customer orders for products can be compiled and archived with historical demand patterns to form an existing demand pattern. A statistical forecasting module can statistically analyze the demand pattern. The analysis can indicate non-random patterns that represent demand/supply fluctuations. Both product managers and sales personnel can independently evaluate the fluctuations. A master production schedule can be created and implemented within the production department. The finished products can be forwarded to inventory where the customer orders can be shipped.
METHOD AND SYSTEM FOR MANAGING MANUFACTURING

The present application claims benefit of United States Provisional Application Serial No. __/______, entitled “Method and System for Managing Manufacturing”, filed on May 26, 2000 in the name of Slocum, et al., attorney docket no. 08EB03058.

CROSS REFERENCE TO RELATED APPLICATIONS


BACKGROUND OF THE INVENTION

The present invention relates to a method and system for managing manufacturing, and, more particularly, to a method and system for managing a manufacturing supply chain process.

Conventional transactional execution systems, such as the Business Resource Planning/Material Requirements Planning/Distribution Requirements Planning type systems, are typically architected as hierarchical to pass data between independent nodes, rather than to solve planning and scheduling problems, as they exist throughout a supply chain. Dependencies for multiple enterprises between demand, material, capacity, logistics, customer allocations, supplier allocations, and related business constraints are not solved by these conventional systems. When using conventional transactional execution systems, each enterprise generates its own plan from its point of view.

Business Resource Planning (BRP) has been used in manufacturing businesses
in orders to increase the speed of new products to market, to provide sufficient products to customers by carrying sufficient inventory, and to reduce production costs. BRP processes which directly impact inventory are demand forecasting, inventory planning, master production planning, material requirements planning, and distribution requirements planning.

Material Requirements Planning (MRP) is concerned with the ability to assemble and make available all the materials, parts, and supplies needed for a production run. Material Requirements Planning uses the projected inventory from the master production schedule to communicate the need for various materials throughout the manufacturing process and to inform suppliers of quantities and delivery dates. Inaccurate and out-dated projected inventory causes the manufacturing facility to order too much or too little material, leading to frequent orders changes to suppliers.

Distribution Requirements Planning (DRP) is concerned with the ability to maintain adequate inventory at distribution points outside the manufacturing facility. Such distribution points might be warehouses, terminals, or consignment stock at a distributor or customer. Distribution Requirements Planning systems calculate and set restock trigger points so that products can be shipped in time from the manufacturing facility to the distribution points. Distribution Requirements Planning depends on the accuracy of the demand forecast. Traditional ways to generate Distribution Requirements Planning use only the lead-time needed to manufacture and transport products from the manufacturing facility to the distribution point. No consideration is given to the customer orders lead-time available when a customer requests products from the distribution facility.

One conventional technology used by enterprises to share information is an electronic data interchange (EDI). This protocol provides a way to administer change management and control within a supply chain. However, EDI has problems with respect to achieving customer driven goals such as real time orders promising and true supply chain cost optimization, assembly coordination, and inventory deployment. Even with EDI, the lack of integrated production plans within the
supply chain causes problems in that plans are constructed based upon old or inaccurate information and material and capacity exceptions at each level are not solved before requirements are passed to the next level in the supply chain, thus compounding problems down the supply chain. Consequently, it becomes increasingly difficult to effectively coordinate and create business relationships that efficiently and effectively fulfill customer needs.

The Design for Six Sigma can be applied to any process such as a business, manufacturing, service, etc. The sigma value is a metric that indicates how well that process is performing. The higher the sigma value, the better the output. Sigma measures the capability of the process to perform defect-free-work, where a defect is synonymous with customer dissatisfaction. With six sigma the common measurement index is defects-per-unit where a unit can be virtually anything - a component, a piece part of a jet engine, an administrative procedure, etc. The sigma value indicates how often defects are likely to occur. As sigma increases, customer satisfaction goes up along with improvement of other metrics (e.g., cost and cycle time).

The six sigma methodology has been used by a number of companies such as Motorola Semiconductors, Texas Instruments, Allied Signal and Digital Corporation. All of these companies use this process for a specific application such as semiconductor manufacturing in the case of Motorola and Texas Instruments. A drawback to specific applications of the six sigma process is that there is a lack of flexibility to allow for the existing implementation to be applied to other business processes.

BRIEF SUMMARY OF THE INVENTION

An exemplary embodiment of the method and system disclosed herein is a method for managing manufacturing. The method comprises a supply chain process. The supply chain process receives a customer orders for a products. A plurality of demand data is compiled for the products based on the customer orders. A demand pattern and a supply trend are calculated using the plurality of demand data for the
products. The future demand of the products is forecasted using an integrated performance feedback process. A master production schedule is generated based on the forecasted demand. The products are produced using the master production schedule. The products are placed in an inventory. The products are delivered to the customer.

These and other features and advantages of the present invention will be apparent from the following brief description of the drawings, detailed description, and appended claims and drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will be further described in connection with the accompanying drawings in which:

Figure 1 is a flow diagram illustrating an exemplary embodiment of the method and system for managing manufacturing of the present invention;

Figure 2 is a histogram plot of demand variability data of the present invention;

Figure 3 is a histogram plot of demand/output stability and relationship to Product-Sales-Inventory of the present invention;

Figure 4 is an exemplary embodiment of the statistical forecasting module of the present invention;

Figure 5 is an exemplary embodiment of a statistical forecast of a demand pattern for products using the statistical forecasting module of the present invention;

Figure 6 is a Gaussian curve indicating a normal distribution using a Six Sigma statistical analysis;

Figure 7 is an exemplary embodiment of a statistical forecast after applying Six Sigma analysis;
Figure 8 is an exemplary embodiment of a MTO/MTS Classification Data Matrix of the present invention;

Figure 9 is an exemplary embodiment of a Carrier Ramp Up Forecast using the capture and analysis of products delivery dates of the present invention; and

Figure 10 is an exemplary embodiment of the tracking of carrier’s actual delivery dates using the capture and analysis of products delivery dates of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

In a conventional manufacturing process such as BRP, MRP or DRP, the sales branch and the manufacturing branch of a company do not communicate with one another. The sales branch of the company monitors the respective dollar amounts for products ordered while tracking future forecasts. The manufacturing branch of the company oversees the manufacturing scheme for products. Typically, the two branches acting independently fail to meet the customer’s expectations.

A method and system for managing manufacturing comprises a supply chain process operating within a Business Planning System. The Business Planning System provides business rules and financial targets to the Supply Chain Process so that it can initiate manufacturing or shipping in response to demand. Figure 1 illustrates an exemplary embodiment of a flow diagram for a Supply Chain Process 20. The Supply Chain Process 20 can include a Planning Feedback Process 22 and a Production Feedback Process 24. A plurality of customer orders 26 indicates a desire for products processed by the supply chain process 20 at a Customer Orders site 28. The supply chain process 20 can initiate manufacturing products if the products are not currently in inventory by submitting a demand signal 30 to a Demand data site 32. If the ordered products are available, the supply chain process 20 can initiate transferring the products from an Inventory site 62 by sending a ship signal 34 to Orders-Ship-Bill site 64.
The customer demand is processed at Demand Data site 32. Demand Data site 32 compares the demand signal 30 to the historical demand pattern of the customer and products, and transmits the information to a Scheduler Tools site 38 and a Finished Goods Services site 44.

The Planning Feedback Process 22 begins at Finished Goods Services site 44. The Finished Goods Services site 44 analyzes the products and customer information using a statistical forecasting module. The analysis is independently examined at a ProdMgr Roll site 46 and a Sales Track site 48 and, if necessary, adjusted at a Product-Sales-Inventory adjustment site 50 and Marketing Intelligence site 52. The adjusted information is correlated at a Finished Goods Interface site 54 and transmitted to a Master Production Schedule site 56.

The Production Feedback Process 24 can begin at the Master Production Schedule site 56. The Master Production Schedule site 56 coordinates the production schedule with Scheduler Tools site 38 and Purchasing System site 58 before transmitting the production schedule to a Production site 60. Purchasing System 58 can transmit material purchase and consumption information to an Inventory site 62. Production site 60 forwards the finished products to Inventory site 62 for stocking and recording. Inventory Site 62 oversees transporting the products to Orders-Ship-Bill site 64 where the products are prepared for shipment at a Shipping site 66 for Customer Inventory 68.

The supply chain process 20 generally serves as an exemplary transactional execution system, whereby demand is acknowledged by the system and the system employs a method for proactively managing the manufacture of products in demand. Demand for products is expressed as a plurality of customer orders 26. Generally, the plurality of customer orders 26 are transacted by placing, forwarding, or receiving customer orders 26 at a Customer Orders site 28. A customer, a distributor, or a point of sale entity places the customer order, or even the business planning system, or supply chain process 20 itself, can internally generate the order by using forecasted orders based upon monitoring the customer's inventory. A single enterprise, branch of an enterprise, distributor, factory, manufacturing entity, and the like, can typically
receive at least approximately one thousand customer orders 26 or more, in a day. Moreover, when applying the method and system on a global scale, an overseas branch of the manufacturing entity can receive the customer orders and forward it to a central location, e.g. a Customer Orders site 28 in the United States, that can coordinate or supply the demand. The customer orders comprise information such as the customer name, product types, product stockkeeping unit (hereinafter referred to as "SKU"), number of units ordered, invoice number, grade of container for shipment purposes, request date, delivery information such as date, time, and location, and top level critical-to-quality (hereinafter referred to as "CTQ") characteristics.

Top Level CTQs are key Critical-To-Quality characteristics are set by customers. Based on those CTQs, internal measurements and specifications are developed in orders to quantify quality performance. Quality improvement programs, such as Six Sigma, are developed whenever there is a gap between the customer CTQs and the current performance level. Typically, the first step in a quality improvement program is defining the real problem by identifying the CTQs and related measurable performance that is not meeting customer's expectations. In the instant application, the top level CTQs are identified through an initial Six Sigma analysis of the customer's expectations, or by referring to previous orders placed by the customer, or even by previously identified top level CTQs being implemented by the supply chain process 20.

Transmitting data, information, and the like, throughout the supply chain process 20, and the entire business planning system as well, can be accomplished using an electronic data interchange (hereinafter referred to as "EDI"), or other software that performs the same or similar function, which provides a data specification format and external communication interface for the transactional execution system. A computer system having a plurality of various platforms, desktop terminals, or personal computers, or terminals connected by a network to a central server, and combinations thereof, and the like. The central server can comprise an internet server, intranet server or private internet server, a data transfer connection, as well as other software, hardware, peripherals, and combinations
thereof, and the like. The terminals are equipped with software permitting each
terminal to communicate with the server via the Internet. The terminals or personal
computers require readily available Internet browser software such as Microsoft
Internet Explorer or Netscape Navigator. The local terminals also have a
5 microprocessor for executing common software programs used by the computer
system and mass memory for storing data obtained from within or outside the
computer system. Data is imported/exported between the local terminals and
computer system via a data transfer connection, which can be a WAN or LAN
network, an e-mail or file transfer connection, or physical exchange of data storage
media. An individual at a local terminal, or several individuals or groups of persons
can access the computer system across a global array of web-enabled platforms.

The customer orders 26 received from the customer or generated by the supply
chain process 20, are transmitted as a demand signal 30 from Customer Orders site 28
to Demand Data site 32. Demand Data site 32 comprises a method and system for
15 performing demand and output variability analysis. A demand and output variability
analysis is a macro of a database program such as Access®, Oracle®, or any
Windows® based database program. The demand and output variability analysis
macro is programmed to formulate calculations and chart transferred, downloaded, or
keyed-in data. The macro is opened when needed or placed in an Access® start
directory, Oracle® start directory, or any Windows® based database program directory
so that it will read each time the program is started. Likewise, the demand and output
variability analysis macro is used on any Windows® based PC or any instrumentation
or hardware the user may use, such as a network, intranet, or internet, to perform the
demand and output variability analysis.

20 The demand and output variability analysis identifies potential minimum
orders quantities, examines historical demand patterns, and reviews appropriate
stocking policies. The analysis is conducted according to the grade container and/or
by machine. All pertinent information with regard to the customer orders is
coordinated and organized at Demand data site 32. Such data includes, but is not
limited too, fiscal periods, scheduling protocols, orders acceptance policies and

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selling days, and the like. The demand and output analysis analyzes the above-mentioned data and identify orders patterns and predict demand trends for products, family of products, etc. At the same time the analysis examines the trends to determine which are more or less stable so that an accurate lead-time is established.

Figure 2 is an exemplary embodiment of a plot of demand variability data shown in histogram form. The x-axis represents the year/fiscal week when the customer orders were placed. The left hand y-axis represents the quantity of products ordered. The right hand y-axis represents the customer lead time in calendar days. The customer lead time is generally the amount of notice the customer gave the enterprise, branch of the enterprise, or manufacturing entity, and the like, to supply the product, or the difference between the date the customer order 18 was received and the date the customer wants the product delivered. From the data in Figure 2, a demand and output stability relationship to Product-Sales-Inventory ("PSI") is analyzed (See Figure 3).

Figure 3 is an exemplary embodiment of a plot of demand/output stability and relationship to PSI. The x-axis represents the fiscal week. The y-axis represents the weekly demand for products. The y-axis can also represent a product family or all products for a demand/output stability analysis on a larger scale. The output of products and/or product families can be adjusted quarterly using PSI to generate new potential output or establish minimum order quantities. The new potential output or minimum order quantities can typically be consumed on a weekly basis while stable demand patterns and supply trends can be generated on a monthly basis.

As shown in Figures 2-3, the demand and output variability analysis analyzes the demand trend and predict new potential output or minimum orders quantities using historical demand data. A potential minimum orders quantity can be suggested to meet the apparent demand fluctuations so that the customer maintains an appropriate stocking policy. For example, the demand data may indicate that a customer orders five units of a specific product once every two weeks. The demand and output variability analysis can examine the products and determine whether it costs less to manufacture ten units of products once a month or five units of products.
every two weeks. If cost savings are generated by manufacturing ten units of products a month rather than five units every two weeks, then the suggestion will be made to the customer and the orders will be adjusted. As a result, the company can reduce carrying costs associated with maintaining an inventory surplus.

Generally, Demand Data site 32 in Figure 1 transmits the demand and output variability analysis data, historical demand data, and the like to a Scheduler Tools site 38. When operating on a global scale, a multi-site system can be structured to meet the demand and supply the products. Multi-site structuring permits the setup of a network whereby any branch can supply any other branch with any and all items. In that situation, no hierarchical branch supply relationship is required and demand can flow in all directions. Applying this concept to the instant application, Demand Data site 32 can be located at a United States branch that receives a customer orders 26 from Customer Orders site 28 at a Pacific Rim branch. Demand Data site 32 can identify top-level CTQs by accessing prior customer orders received by the Pacific Rim. The method and system disclosed herein can define the supply/demand relationships between different branches within a locale, city, county, state, country, and global community at the item level, planning family or plant level to optimally determine which branch should best supply specific data, items, commodities, or services to another branch and the customer.

Demand Data site 32 also transmits the demand and output variability analysis data, etc., to a Finished Goods Services site 44 (hereinafter referred to as “FGS 44”). FGS 44, a ProdMgr Roll site 46, a Sales Track site 48, a PSI Adjustment site 50, and a Finished Goods Services Interface site 54 comprises the Planning Feedback Process 22. The Planning Feedback Process 22 facilitates communication between the sales and manufacturing departments. Those skilled in the art who are familiar with forecast development and modeling, and multi-dimensional forecast planning are aware that reports generated on a weekly, monthly, quarterly, and annual basis to accurately predict supply/demand can become unmanageable. More importantly, each report must be examined to determine future supply/demand of a customer(s), or particular product(s), or raw material(s). Typically, due to these unmanageable
conditions, customers notify the supplier when a problem arises which creates a reactionary supply and demand system whereby manufacturing becomes dictated by overcoming inventory shortages and/or dealing with costly inventory surplus. In the instant application, Six Sigma statistical analysis is utilized with conventional statistical forecasting methods to alleviate these problems by utilizing the proactive performance feedback process described herein.

Figure 4 illustrates an exemplary embodiment of the statistical forecasting module 70 of FGS 44. Statistical forecasting module is a macro of a database program such as Access®, Oracle®, or any Windows® based database program. In addition, the statistical forecasting module includes any database program that can be programmed to employ Six Sigma statistical analysis in formulating calculations and charting transferred, downloaded, or keyed-in data. The module is opened when needed or placed in an Access® start directory, Oracle® start directory, or any Windows® based database program directory so that it will read each time the program is started. Likewise, the statistical forecasting module is used on any Windows based PC or any instrumentation or hardware the user may use to perform statistical analysis in accordance with Six Sigma.

The line item detail is summarized by SKU and fiscal month, and/or prioritized by information indicated by the enumerated headings such as order numbers, item number, invoice number, request date, and shipping date (See Figure 4). The statistical forecasting analyzes the demand history and the demand and output variability analysis data, to predict future demand patterns for a specific customer based on conventional forecasting algorithms. The forecasting algorithms generate forecasting information dealing with levels, trends, seasonality and end of quarter pushes for specific product types. Any regular demand pattern can be and is forecasted (See Figure 5).

The statistical forecasting lays the baseline for determining future demand; Six Sigma statistical analysis identifies where non-random patterns occur, that is, demand fluctuations, and develop that invalidate the statistics. For instance, a normal
distribution, often characterized by a bell-shaped Gaussian curve (See Figure 6), indicates which data points fall within and outside the 6σ range, i.e., μ-3σ to μ+3σ, that is predicated upon the top level CTQs mentioned earlier. Those data points falling within the acceptable 6σ range comprise a random pattern which is consistent with the 6σ standard of defect free products. Those data points falling outside the acceptable 6σ range indicate a non-random pattern which signals a “red flag” to those interpreting the data. Six Sigma analysis indicates when a demand fluctuation occurs in a demand trend for a particular product, for a particular customer’s order of a particular product, etc. (See Figure 7).

Integrating Six Sigma statistical analysis with conventional statistical forecasting algorithms creates a proactive method for managing by exception. Both the sales department and products managers at a Sales Track site 48 and ProdMgr Roll site 46, respectively, can independently review the statistical data to find the demand fluctuations and then meet to discuss their findings (See Figure 1). Typical supply chain processes fail to integrate the sales department’s activities with the overall manufacturing process. To overcome this obstacle the method and system disclosed herein proactively manages by exception.

The analyzed data is examined at a products level. The products level indicates all sales for specific products. The sales figures for those specific products can be divided amongst each specific customer account. The customer accounts are divided amongst the sales department. The sales department reviews the statistical data generated by the six sigma statistical forecasting module, and locates non-random patterns in the supply/demand patterns for a product, a family of products, a customer, a group of customers, and the like. Based upon the forecasted supply/demand patterns, the sales department and products managers determine whether to classify products as Make-To-Order or Make-To-Stock using a method and system for classifying products types.

The method and system for classifying product types comprises applying a Make-To-Order/Make-To-Stock Classification Data Matrix 72 to product information reviewed by both the sales department and products managers (See Figure 8).
Make-To-Order (hereinafter referred to as "MTO") classification indicates a product that is manufactured on demand. For example, the product may be ordered infrequently or once a fiscal period, i.e. a quarter. Rather than manufacturing excess product and driving up inventory costs, the product receives a Make-To-Order classification, thus indicating the product is manufactured per customer orders. Meanwhile, the Make-to-Stock (hereinafter referred to as "MTS") classification indicates a specific product that is manufactured in excess and held in inventory. For example, a product ordered on a regular basis can be held in inventory. The high turnover rate resulting from frequent sales can prevent high inventory costs so that it becomes affordable to stock those Make-To-Stock products. In addition, forecasting can indicate that a product's sales are concentrated during a specific time period such as fall/winter. In response to this information, the products are classified as Make-To-Stock so that, in this example, the products are manufactured during the summer to meet the fall/winter demand.

More specifically, the MTO/MTS Classification Data Matrix 72 comprises a macro spreadsheet program that organizes information according to product data, statistical forecasting data, and historical demand data (See Figure 8). The MTO/MTS Classification Data Matrix 72 is a macro of a spreadsheet program such as Excel®, Lotus®, or any Windows® based spreadsheet program. In addition, the MTO/MTS Classification Data Matrix 72 includes any spreadsheet program that can be programmed to formulate calculations and chart transferred, downloaded, or keyed-in data. The macro for the MTO/MTS Classification Data Matrix 72 is opened when needed or placed in an Excel® start directory, Lotus® start directory, or any Windows® based spreadsheet program directory so that it will read each time the program is started. Likewise, the macro for the MTO/MTS Classification Data Matrix 72 is used on any Windows® based PC or any instrumentation or hardware the user may use, such as a network, intranet, or internet.

Referring now to Figure 8, the exemplary product information is correlated according to Group ("GRP"), Grade Container ("Grade Container"), ABC Code ("ABC"), Make-To-Batch ("MTB"), Recommended ABC Code ("Suggestion"),
Reason Code ("Reason"), Number of Customers ordering the grade within the last year ("Customers"), and Number of Orders ("n"). The GRP represents a particular area of products that can be organized according to a number of exemplary characteristics. The importance of the product(s) within the group assists in determining whether the product is classified as MTO or MTS. The Grade Container is the basic stock-keeping-unit. The ABC is the current MTO/MTS Classification being considered for potential change. MTB represents a previous customer sensitive classification scheme. The Suggestion represents the suggested ABC codes A, B, C, X, which stand for the recommendation criteria that influence a MTO or MTS product classification. The Reason indicates which three recommendation criteria lead to the MTO/MTS classification determination. The Customers indicates the number of customers ordering the product. The “n” represents the number of orders for the product.

The exemplary statistical forecast data is incorporated into the MTO/MTS Classification Data Matrix 72 as the Average Customer Requested Lead Time ("Ave CLT"), Standard Deviation of Customer Lead Time ("StDev CLT"), Average Quantity Ordered Over The Past Year ("Avgas Qty"), and Standard Deviation of Quantity Ordered ("StDev Qty"). The Ave CLT indicates how much notice the customer typically gives when in need of the product. If the average customer requested lead time for a product is longer in duration than the manufacturing lead time for the product, then an incentive exists to classify the product as MTO. The StDev CLT represents a measurement of how consistently the customers give more notice than the manufacturing lead time. If the measurement is or becomes variable, then an incentive exists to classify the product as MTS. The Avgas Qty and StDev Qty indicate the average quantity of product ordered, and its statistical quantification to the typical batch size of product. If the average quantity significantly differentiates from the typical batch size, then an incentive exists to classify the product as MTS.

The exemplary historical demand data is also correlated and incorporated into the MTO/MTS Classification Data Matrix 72 as the Total Quantity Ordered Over The Last Year ("Quantity"), Total Pounds Orders Over The Last Year ("Pounds"), Total
Dollar Value of Orders Over the Last Year ("Dollars"), Percent That The Grade Container Orders Contribute To Total Orders Dollars In The Past Year For That Group ("Cumulative %"), Most Recent Stock Orders Request Date ("Latest Request"), Amount of Safety Stock Required If The Grade Container Is Classified As Make-To-Stock ("Safety Stock Cost"), Promise Lead Time Quoted To The Customer ("PLT"), Gap Between PLT and Ave CLT ("LT Gap"), and Sum of 1/Customer Rank, Based On The Customers Who Purchase That Grade Container ("USA Rank Wt").

The Quantity indicates how much product, e.g. units of a particular product according to a particular SKU, has been ordered over the previous year. If the particular product is shipped using a container, such as a drum, then multiplying the total quantity of product by the weight of the container equals the pound volume of the product ordered over the previous year. A large number provides incentive to classify the product as MTS. The Pounds indicates the pound volume of product ordered. A large volume provides incentive to classify the product as MTS. An exception can arise when the product is shipped in bulk, in which case; the container is filled on order and the volume reflects this difference. The Dollars represents the total dollar value of orders placed over the last year. A high dollar amount provides incentive to classify the product as MTS. The Cumulative % represents a measure of how important the product is within the product group. The Latest Request indicates the general importance of the product to the company. If there are no recent orders within about, e.g. the last three to six months, then there exists an incentive to classify the product as MTO, or even classifying the product as obsolete. The Safety Stock Cost indicates the cost to the company to stock this product as MTS. The PLT represents the manufacturing lead time against which the customer lead time is compared. The LT Gap represents a comparison of the customer lead time and the manufacturing lead time. The USA Rank Wt represents a method for normalizing the measure of the customer base. The largest customer typically receives a customer rank of 1, while the lowest ranked customer, for instance, receives a rank of 500. Utilizing the USA Rank Wt allows the company to identify smaller products that can be important in aggregate but not obvious individually.
The exemplary embodiment of the MTO/MTS Classification Data Matrix 72 filters products through certain recommendation criteria to determine whether a Product-Sales-Inventory Adjustment 50 (hereinafter referred to as a “PSI Adjustment”) is necessary. Three different criteria can inform the sales department and products managers whether or not to categorize the products as MTO or MTS. If the products are classified as MTS products, then the sales department and products managers can determine the necessary PSI adjustment in response to this classification. If the products fall under one of the three criteria, then the products are classified as MTO products. In this exemplary embodiment of the method and described herein, the products are classified as an MTO products when (1) the Revenues for the Grade Container are under fifty-thousand dollars ($50,000.00) for one year; and/or (2) there are less than 13 orders placed a year (or one orders placed per month); and/or (3) the Average Requested Lead Time is greater than Promise Lead Time.

Other criteria can be evaluated to determine whether an MTO or MTS classification is appropriate. For instance, a significant customer lead time variation can mean that the average requested lead time may not be an accurate indicator for classifying that particular product. Customer rank can also influence the MTO classification. A customer rank closer to “1” can indicate a customer that places a few orders at a high volume. The Cumulative % can identify the highest volume grade containers for a specific group. In addition, the latest request, or customer order, for that product can identify the potential obsolescence of the product and/or the statistical forecast data. For example, a product can be new, or a replacement, or even a one-customer product that may be ordered several time a week or only once a year. As marketing intelligence and demand data for products is updated, the sales team and product managers can observe which products are becoming obsolete or “dead” products. Products typically become dead products when the products are not ordered for a period of six months or longer. In that situation, the latest request date can indicate this fact. The sales department and product managers can then adjust the product’s forecast accordingly so that erroneous data is omitted from consideration.
While the MTO/MTS classification is being made at Sales Track site 48 in Figure 1, the analyzed product data is also transmitted from FGS site 44 to ProdMgr Roll site 46. The product managers independently review the data generated by the statistical forecasting module 70 at ProdMgrRoll site 46. The Business Planning System compiles all of the accumulated information and format it in an understandable format for the product managers. In the instant application, the term “product manager” refers to an exemplary employee of a company, enterprise, branch of an enterprise, distributor, factory, manufacturing entity, who is responsible for overseeing and/or having knowledge associated with a product, a family of products, a product line, including the research and development of such product, and other information associated with such product. Each product manager typically oversees a product, a specific family of products or several families of products, and reviews the statistical forecast data and search for non-random patterns. The product manager makes an individual determination based upon his/her knowledge of the products and/or product families, and customer(s), to assess whether or not the non-random pattern requires an adjustment. The product managers examine or “roll” the information from a customer level to a products level, then back to the customer level. At this point the product managers can modify the information at the customer level. Afterwards, the product manager rolls the information back to the products level where further modifications and adjustments can be made to the information at either the products level or family level. For instance, the product manager may personally know that a particular customer will begin ordering a lesser or greater quantity of products within his/her family. The statistical forecast data, and non-random pattern as well, may overlook this specific customer need because it comprises information not found in the historical data. Consequently, the product manager assesses the statistical forecast data and determine whether the demand fluctuations present reasons for making adjustments.

The analysis performed by the MTO/MTS Classification Data Matrix 72 is compiled by the sales department at Sales Track site 48 and presented to the products manager at the PSI Adjustment site 50 (See Figure 1). Likewise, the product managers compiles their respective analysis of the statistical forecast data and
presents it to the sales team personnel. The product managers and sales department present their interpretations of the statistical forecast data to each other, and share additional knowledge as well. Each demand fluctuation discovered by the product managers and sales team personnel are discussed and evaluated. Although the product managers typically make the final determination, e.g., as to whether a product is classified as MTO or MTS, the product managers can reach that decision by a consensus with the sales department.

The Marketing Intelligence site 52 of Figure 1 further enables forecast adjustments by providing information that will affect future demand but is not found in the historical data. The Marketing Intelligence site 52 updates its information on a weekly basis within the Business Planning System. New data from market intelligence or about planned products promotions, or events, as well as information on new products, for example, is implemented to adjust the statistical forecast. This piece of the Planning Feedback Process 22 disclosed herein also permits incorporating marketing intelligence into a forecast to determine its effect on demand. Information can be organized by product lines, geographic areas, units of measure, or other groupings. Marketing Intelligence site 52 also informs both the product managers and sales team personnel when promotional products shipments are scheduled. Special promotions can often times create fluctuations in the demand/supply pattern for a product, a product family, a customer, or a group of customers, and the like. The method and system disclosed herein can adjust the forecast in recognition of a promotional event that is considered unusual for a given products, without impacting the statistical forecast for future analysis.

Referring again to Figure 1, the Planning Feedback Process 22 of the method and system disclosed herein further includes compiling the adjustments made to the products information and statistical forecast data by the marketing intelligence data at a Finished Goods Services Interface site 54 (hereinafter referred to as “FGS Interface site 54”). FGS Interface site 54 represents the convergence of the sales and manufacturing branches, which typically does not take place in conventional supply chain processes. Once final adjustments are made at FGS Interface site 54, the final
product figures are transmitted to a Master Production Schedule Site 56 (hereinafter referred to as "MPS site 56").

The Production Feedback Process 24 comprises MPS site 56, Scheduling Tools site 38, and Purchasing System site 58, which creates a second performance feedback process within supply chain process 20. Master production scheduling concerns the ability to schedule production while maintaining inventory levels between the maximum and minimum levels determined by inventory planning. Based on current inventory and the demand forecast, master production scheduling projects the level of inventory into the future. Whenever inventory is projected to decrease to the minimum level, the manufacturing facility is advised to produce more products. Whenever inventory is projected to exceed the maximum level, the manufacturing facility is advised to produce fewer products or even no products. Supply chain process 20 provides a more accurate master production schedule implementation due to the integrated proactive performance feedback process, which ensures an accurate inventory count so that MPS site 56 can determine a cost effective schedule.

MPS site 56 of Figure 1 can generate scheduling scenarios, provide optimum solutions based on existing constraints and apply least cost analysis. Several scheduling scenarios can be generated and compared based on factors such as total cost and net profit of the various options. In addition, existing business constraints can be identified and optimized around through advanced planning. Likewise, schedules can be automatically adjusted based on new exceptions to the existing constraints. Those constructing the schedules can exercise control over the relative priority of the optimization objectives for different constraints. Prioritizing optimization objects can result in simultaneously satisfying all of the constraints identified.

The MPS site 56 disclosed herein can also incorporate and consider high level objectives indicated by the Business Planning System. Specific business objectives can include improving inventory turnover, increasing manufacturing efficiencies, and improving customer service. At the same time, the relative priority of business objectives can be adjusted by, for instance, scaling the importance of the business
objectives from zero to critical during each optimization run. When planning the scheduling scenarios in this manner, the costs and profits associated with the different scheduling options can be examined and their impact evaluated before implementation. MPS site 56 can also generate schedules within a holistic view of all plants and facilities involved with the manufacturing and production. For example, when considering the manufacturing scheme in a global perspective, the MPS site 56 can determine which facilities in a town, city, county, state, country, or global community can be best equipped to supply raw materials, pre-fabricated components, or even implement the entire master planning schedule from start to finish.

MPS site 56 maintains direct communication with Scheduler Tools site 38 and a Purchasing System site 58. MPS site 56 structures production schedules for MTO and MTS products while linking multiple work orders, schedules and purchase orders together for rework, rush orders, etc. The production schedule considers demands, statistical forecast data, products family schedules, and other production schedules. In addition, the production schedule can process work orders in groups, like families or product groups. Production schedules can also be consolidated to pull in or push out and/or combine schedules. MPS site 56 can make these and other scheduling determinations related to formulating a production schedule by working cooperatively with Scheduling Tools site 38 and Purchasing System 58.

Scheduling Tools site 38 can receive information from both MPS site 56 and Demand Data site 32. Scheduler Tools site 38 generates scheduling scenarios using a macro of a database program such as Access®, Oracle®, or any Windows® based database program. The macro is opened when needed or placed in an Access® start directory, Oracle® start directory, or any Windows® based database program directory so that it will read each time the program is started. Likewise, the macro for Scheduling Tools site 38 is used on any Windows® based PC or any instrumentation or hardware the user may use, such as a network, intranet, or internet.

Scheduling Tools site 38 acts as an exception based reporting mechanism that can provide a line of sight measurement and reporting for a production department.
within Supply Chain process 20. In a conventional BRP/MRP/DRP system, the Production department manufactures product having little knowledge behind the decision making process for manufacturing one product type over another. The scheduling tools macro of Scheduling Tools site 38 provides that knowledge. The scheduling tools concurrently examine the production schedule transmitted by MPS site 56, and also examine the safety stock levels, and the like, at Inventory site 66. The scheduling tools indicates if a product is being manufactured, for example, too early or too late, or if the proposed quantity for product is insufficient or too much. Since these exceptions arise on a daily basis, scheduling tools site 28 provide daily, weekly, quarterly and annular updates and the like, to the Production site via MPS site 56. As result, the Production department can fully appreciate and understand the importance behind each instruction it receives. The Scheduling Tools site 38 can also be implemented within a holistic view of all plants and facilities involved with the Production Feedback Process 24. For example, when considering the Production Feedback Process 24 in a global perspective, the Scheduling Tools site 38 can determine which facilities in a town, city, county, state, country, or global community can be best equipped to supply raw materials, pre-fabricated components, or even implement the entire master planning schedule from start to finish.

Scheduling Tools site 38 reports the identified exceptions to MPS site 56 where it is reviewed and adjusted if necessary. Once the proposed production schedule is approved, the Scheduler Tools site 38 transmits the schedule to Purchasing System site 58. The Purchasing System site 58 confirms the availability of raw materials and pre-fabricated components as well as indicate which materials must be purchased. Estimates for the purchase of raw materials and consumption of existing inventory are then made according to the scheduling scenario. Purchasing System site 58 transmits this information to MPS site 56 for review, adjustment and approval, before transmitting the final raw material and inventory consumption data to Inventory site 62.

MPS site 56 transmits the final production schedule to Production site 52.

Production site 60 oversees the actual manufacture of the MTO/MTS products. The
finished products are stored at Inventory site 62. Inventory site 62 monitors existing stock quantities for all products so that safety stock quantities are maintained to meet existing and forecasted demand. Inventory site 62 reviews the information transmitted by Purchasing System site 58 and MPS site 56 to assure the finished products from Production site 60 meet the customer’s specifications. At that time Inventory site 62 forwards the finished products to an Orders-Ship-Bill site 64 (hereinafter referred to as “OSB site 64”) to fulfill the customer orders.

OSB site 64 oversees the fulfillment of the customer orders. OSB site 64 generates a shipment’s bill of lading, including, but not limited too, itemized shipping instructions, notes, quantities, item descriptions, dates, and the like. OSB site 64 reviews the customer’s requirements and CTQs such as shipping instructions, quantities, delivery dates, delivery locations, etc., that are transmitted from Customer Orders site 28. A typical selection process includes selecting a carrier based on, for example, cost, load capacities, service level, transportation mode, etc., and track the carrier’s performance based on, for example, the number of loads accepted, volume given, number of loads rejected and costs of each rejected. To meet the customer’s expectations and CTQs, OSB site 64 implements a method and system for the capture and analysis of product delivery dates. The capture and analysis of product delivery dates method and system disclosed herein selects a carrier best suited to meet the customer’s CTQs based upon a Six Sigma statistical analysis of the carrier’s historical performance.

The capture and analysis of product delivery dates is implemented by linking all carriers with OSB site 64. The carriers are linked to the OSB site 64 using EDI, or other software, or digital medium to exchange information via a telephone, email, WAN, LAN, internet or intranet connection so that direct bi-directional communication takes place between each carrier and OSB site 64. OSB site 64 transmits the shipping and implementation guidelines to the carriers. OSB site 64 follows up with the carrier within a time frame such as, for example, one week to confirm receipt and revisit the implementation guidelines. OSB site 64 receives daily updates with regard to scheduled shipments and report such updates to the Business
Planning System. The reporting and tracking is accomplished using a ramp-up forecast (See Figures 9-10) that is generated using a macro of a database program such as Access®, Oracle®, or any Windows® based database program. The macro is opened when needed or placed in an Access® start directory, Oracle® start directory, or any Windows® based database program directory so that it will read each time the program is started. Likewise, the macro for the capture and analysis of product delivery date data is used on any Windows® based PC or any instrumentation or hardware the user may use, such as a network, intranet, or internet.

Figure 9 is an exemplary embodiment of a ramp up carrier forecast, or actual delivery date data for the carriers A-NN, in histogram form. The x-axis represents the carrier used by the enterprise. The left hand y-axis represents the Fiscal Week of the calendar year. The right hand y-axis represents the actual delivery date percent completion. The ramp-up forecast indicates the top performing carriers according to the percentage of shipments completed on time within the implementation guidelines.

According to Six Sigma, a delivery made on the date specified by the implementation guidelines receives a score of 0 σ (See Figure 6). Deliveries made a day before or a day after the specified date can fall within the $\mu-1\sigma$ to $\mu+1\sigma$ range of the 6σ curve, or within a wider range depending upon the implementation guidelines' specifications.

Figure 10 is an exemplary embodiment of a plot of the EDI implementation percentage by each carrier. The x-axis represents the carrier, such as carriers A-S from Figure 9. The left hand y-axis represents the Fiscal Week of the calendar year. The right hand y-axis represents the EDI implementation percentage of the respective carrier week by week. Each EDI implemented carrier reports their actual delivery progress on a daily basis. OSB site 56 therefore immediately determines which carriers are performing at a six sigma efficiency standard rather than a typical optimum level or best solution level associated with conventional methods such as BRP, DRP, and MRP.

The OSB site 64 monitors the carrier's performance so that customer orders are shipped from Shipping site 66. The Supply Chain Process Overview of the Business Planning System also monitor inventory held by the customer at Customer
Inventory site 68. As orders are placed and fulfilled, the product types and quantities can be monitored to determine when the customer may require additional products. Orders can be confirmed with the customer and automatically placed internally within the method and system disclosed herein.

The method and system disclosed herein provides several advantages over the existing methods and systems for managing manufacturing a supply chain. The method and system disclosed herein incorporates a planning feedback process that promotes communication and cooperation between Product Managers and Sales personnel within a manufacturing scheme for a supply chain process. Existing conventional management schemes allow the Sales department and Product Managers to operate independently from one another. As a result, Product Managers operate unaware that potential customer inventory shortages and/or inventory surplus, and the like, may be approaching which will spur a dramatic change in existing production schedules. Likewise, the Sales Department will forecast demand patterns and supply trends unaware what current safety stock levels are for specific products or products families due to inconsistencies in the manufacturing scheme. The method and system disclosed herein can allow Product Managers and Sales personnel to independently review the statistical forecast data and then meet to determine by a consensus the appropriate steps to take in order to meet demand/supply.

Another recognized advantage is implementing Six Sigma statistical analysis to more accurately forecast demand patterns and supply trends. Six Sigma can facilitate the “managing by exception” principle within both proactive performance feedback process. Managing by exception can allow the Product Managers and Sales personnel to proactively evaluate a potential fluctuation in the demand/supply pattern for a product, a family of products, or series of customer orders, etc. These demand/supply fluctuations can readily appear as non-random patterns in the Six Sigma statistical analysis that is performed in conjunction with the statistical forecasting module. Rather than reacting to a problem after it occurs, the Product Managers and Sales personnel can evaluate the potential obstacles indicated by the non-random patterns and determine an appropriate course of action. The obstacles
can be avoided prior to expending time, energy, and labor for manufacturing, or consuming existing inventory and endangering safety stock levels.

Another recognized advantage of the method and system disclosed herein involves inventory planning. Carrying too much inventory increases costs through the inventory carrying charge, while carrying too little inventory causes orders to be missed or placed in backlog; both situations decrease the quality of service level to the customer. Since the time available between when a customer places an orders and when the customer expects to receive the products is never considered, the traditional techniques tend to advise carrying higher than necessary inventory levels. Both proactive integrated performance feedback processes ensures that the sales and manufacturing branches, and the production department, communicate so that inventory, including safety stock, remains at cost effective levels. In addition, the method and system for demand and output variability analysis can generate cost effective strategies for restructuring customer orders in response to customer demand patterns and manufacturing costs. Consequently, the manufacturer can reduce inventory carrying charges while improving business relations with customers by responding to their needs rather than their complaints.

The present invention can be embodied in the form of computer-implemented processes and apparatuses for practicing those processes. The present invention can also be embodied in the form of computer program code containing instructions, embodied in tangible media, such as floppy diskettes, CD-ROMs, hard drives, or any other computer-readable storage medium, wherein, when the computer program code is loaded into and executed by a computer or a network of computers, the computer(s) becomes an apparatus for practicing the invention. The present invention can also be embodied in the form of computer program code, for example, whether stored in a storage medium, loaded into and/or executed by a computer, or transmitted over some transmission medium, such as over electrical wiring or cabling, through fiber optics, or via electromagnetic radiation, wherein, when the computer program code is loaded into and executed by a computer, the computer becomes an apparatus for practicing the invention. When the implementation on a general-purpose microprocessor, the
computer program code segments configure the microprocessor to create specific logic circuits.

While the invention has been described with reference to a preferred embodiment, it will be understood by those skilled in the art that various changes may be made and equivalents may be substituted for elements thereof without departing from the scope of the invention. In addition, many modifications may be made to adapt a particular situation or material to the teachings of the invention without departing from the essential scope thereof. Therefore, it is intended that the invention not be limited to the particular embodiment disclosed as the best mode contemplated for carrying out this invention, but that the invention will include all embodiments falling within the scope of the appended claims.
WHAT IS CLAIMED IS:

1. A method for managing manufacturing a supply chain process, the method comprising:
   receiving a customer order for a product;
   determining the availability of said product;
   initiating the manufacturing of said product;
   compiling a plurality of demand data for said product based on said customer order;
   calculating a demand pattern and a supply trend using said plurality of demand data for said product;
   forecasting the future demand of said product using a first integrated performance feedback process;
   generating a master production schedule using a second integrated performance feedback process;
   producing said product using said master production schedule;
   placing said product in an inventory; and
   delivering said product to the customer.

2. The method of claim 1 wherein said calculating said demand pattern and said supply trend includes:
   applying a demand and output variability analysis method to said demand data of said product; and
   transmitting said analysis for said product to said first integrated performance feedback process and to a production scheduler.
3. The method of Claim 1, wherein said initiating further comprises receiving a demand signal.

4. The method of Claim 1, wherein said determining availability further comprises checking an inventory site for said product.

5. The method of Claim 1, wherein said compiling further comprises:

   identifying a plurality of critical-to-quality characteristics for said product;

   comparing said critical-to-quality characteristics with a plurality of historical critical-to-quality characteristics and/or a plurality of previous customer orders for said products; and

   comparing said plurality of demand data to a plurality of historical demand data.

6. The method of Claim 1, wherein said second integrated performance feedback process further comprises a production feedback process.

7. The method of Claim 6 wherein said second performance feedback process further comprises:

   reviewing said future demand at said master production scheduler;

   forwarding said future demand from said master production scheduler to a production scheduler;

   reviewing said future demand by said production scheduler;

   reviewing said demand pattern and said supply trend for said product using a plurality of scheduler tools;

   generating a production schedule;

   forwarding said production schedule to said master production scheduler and to a purchasing system;
compiling a list of materials for said production schedule at said purchasing system;

forwarding said list of materials to said master production scheduler and to an inventory department; and

transmitting said production schedule to a production department.

8. The method of claim 1 wherein shipping said product includes:

selecting a carrier by applying a capture and analysis of product delivery date method; and

shipping said product using said carrier.

9. The method of Claim 1, wherein said first integrated performance feedback process further comprises a planning feedback process.

10. The method of Claim 9 wherein said planning feedback process includes:

performing a statistical analysis of said plurality of demand data for said product using a statistical forecasting module;

classifying said product;

adjusting said plurality of demand data for said product; and

forwarding said plurality of demand data for said product to said second integrated performance feedback process.

11. The method of claim 10 wherein said classifying includes applying an MTO/MTS classification method to said statistically analyzed demand data.

12. The method of claim 10 wherein said adjusting includes applying a product-sales-inventory adjustment to said statistically analyzed demand data by a product manager.
13. The method of Claim 10 wherein said performing further comprises combining and utilizing a six sigma statistical analysis with said statistical forecasting program.

14. The method of Claim 13 wherein said six sigma statistical forecasting module further comprises implementing said module using a macro of a database program.

15. The method of Claim 14 wherein said six sigma statistical forecasting module further comprises identifying a demand fluctuation in said plurality of demand data.

16. An apparatus for managing manufacturing a supply chain, comprising:

a storage device; and

a processor connected to the storage device,

the storage device storing a program for controlling the processor; and

the processor operative with the program to manage the manufacturing of a supply chain to receiving a demand for a product supplied by the system;

analyze said demand for said product;

determine a demand pattern and a supply trend for said product;

analyze statistically said demand pattern;

forecast a future demand for said product;

adjust said demand pattern;

generate a master production schedule based on said future demand for said product;

produce said product;
stock said product; and

ship and supplying said product in response to said demand.
ANALYZE DEMAND VARIABILITY OVER TIME TO DETERMINE APPROPRIATE STOCKING POLICY, DEMAND FLUCTUATIONS, AND POTENTIAL MINIMUM ORDER QUANTITY

FIG. 2
ANALYZE DEMAND/OUTPUT STABILITY AND RELATIONSHIP TO PSI

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FIG. 3
### Table 1

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### Table 2

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**FIG. 8**