



Manufacturing Forum

Center for the Management of Technological and Organizational Change (CMTOC)
The Mary Jean and Frank P. Smeal College of Business Administration

January 1999

405 Beam Business Administration Bldg., University Park, PA 16802

(814) 865-1789

The Strategic Use of Computerized Production and Process Planning Systems October 26-27, 1998

Re-engineering for Breakthrough Performance At CVI

Joe Wisniewski, CV Industries

A Journey for the Strong of Heart

CV Industries is the parent of four wholly owned companies based in Hickory, NC. CV Industries employs a total of 2,400 people, and has 2,300,000-sq. ft. of manufacturing space. The Century Furniture division has been in existence for 50 years, and is the world's largest crafter of medium to high-end wood and upholstered furniture. Century Furniture is an OEM company with contract and hospitality customers. The Valdese Weavers division is a Jacquard mill and was formed in 1935. They produce medium and high-end furniture fabrics, contract office fabrics, and specialty fabrics marketed to furniture makers. Computers scan in fabric patterns for production on CNC looms with equipment sized for 54 inches to 120 inches wide materials running at up to 700 picks per inch. This division is considered a cash cow running at 16% to 18% operating profit for the past six years. The Expressions company was recently acquired in 1997, and is one of the nation's top 50 furniture retail chains. CV Industries has sales integrated through the full goods-to-customer cycle including everything from retail to final trucking.

Several issues faced Century Furniture in 1995 before the company's re-engineering process was implemented. Century Furniture was running at industry standards of 3% to 4% operating profit. Typical standards include 3 turns of inventory, low profits, and high asset levels with very low returns. The previous owners desired to "cash out" and retire. The company had diminishing financial returns since 1988, and product lines were outdated and in need of replacement. Factory methods were

methods were "select fit" and "revise to fit" where a master cabinetmaker would assemble pieces through a trial and error method until matches were made. The lay out of production equipment placed common machines in the same areas, resulting in multi-directional material flow. Some products traveled up to 13 miles inside the plant until complete. Spaghetti diagrams were created as part of the re-engineering effort to analyze production flows. Labor intensive operations determined and set the slow paced production. The factory floor was cluttered with partially completed product, and housekeeping was poor. There were OSHA requests to clean-up the factory.

Product returns due to defects were 5% of all products shipped. The company was disconnected from customer demands resulting in 3% of product being obsoleted. Fifty percent of the SKU's provided 95% of total sales volume. Pricing models were designed on a low profit based, cost-plus system. Product costs were based on overhead plus labor. Average profits were reduced from 4% to 2% when materials were imported from foreign factories. A 20% transfer of labor resulted in only a 10% reduction in labor. All factories were operating on one shift only, with an employee turnover rate of 21%. Production employee accident rate was at an OSHA level of 28 points with a one in four chance of getting harmed. The service cycle was 15 weeks resulting in customers waiting long periods of time for products. Proposals were in place to purchase additional CNC equipment even though plant equipment was only being utilized on one shift. There were seven separate order entry systems, and each brand name had its own autonomous division. It would take five purchase orders for one customer to place an order for a single room of furniture. The market distribution involved 3,700 retailers, which caused erosion of opportunity for large retail stores. Competition was even in worse condition.

large retail stores. Competition was even in worse condition.

The Y2K problem was not addressed in the industry, nor was it fully understood. The company lacked the ability and source code to correct the problems, but tweaked older, obsolete systems to make them work. Poor operating and business conditions included 3 turns of inventory, 15 week lead times, accounts receivable of 65 days, average SKU volume of only 50 piece per year, and 1.3 billion possible upholstery combinations. (1998 results improved significantly to 4 turns of inventory, 6 week lead times, 45 days in accounts receivables, and cost per SKU reduced) To grow \$1,000,000 in sales in 1995, a negative \$250,000 in incremental working capital cash was required. The cost for the same level of growth in 1998 has been reduced to \$50,000.

Century Furniture developed a strategy to simplify plants, centralize operations, achieve greater return on assets, reduce working capital requirement, create value-added in products, and fix the Y2K problem. Using computer modeling, the plants were organized into unidirectional flow and manufacturing cells resulting in reduced set-up costs. A tolerance and precision fit environment was created using Unigraphics, and a full engineering system was integrated with simulation of CNC machines. Off-line programming of CNC machines was implemented with CAD/CAM, and product development, which caused weeklong shutdowns twice a year, was removed from plants and into a tech center. Multiple shift operations were implemented.

The Century Furniture plant was cleaned up and displayed as a flagship operation to customers. Morale and pride increased. Labor incentives were put into place providing $\frac{1}{2}$ of each 1% team productivity gain above standards back to employees. Two conditional provisions stated that (1) If out-of-tolerance parts were moved on to the next station, they would be reworked at out-of-incentive hours, and (2) If anybody recorded an OSHA level injury, all team members would lose their incentive pay for the day. This provision resulted in major reductions in injuries. A \$1.50 per hour premium for second shift operations was implemented to attract experienced workers. Consolidation of engineering resulted in a two week gain in production. The customer service departments were consolidated and made dependent on information systems. The company consolidated three plants and three rough mills by adding people in bottleneck areas and shutting

down three plants. The information system was integrated for an ERP including all customer service, order entry, and multiple model production schedules. The company implemented new manufacturing systems involving JIT, continuous and discrete flow manufacturing, and make to stock products.

The cost to solve the Y2K problem was estimated at \$13,000,000 with an investment of \$17,000,000 in SAP to improve information systems. The main portions of these costs were from training and consulting. The company implemented upgrades in various computer systems including e-mail, workstations, GUI interfaces, Ethernet standard protocol, web site, and a variant configurator for price configurations and BOM's. This permitted customers to successfully access databases for information exchanges and inquires. The company implemented ESOP plans to move tax-free cash to owners of the company. Employees participate in ownership, and receive matching contributions of stock equivalent to six to nine percent of their pay. Stock re-purchases created \$75 million dollars in debt, but were made possible through the re-engineering plans.

Implementation of an ERP involves five major points: (1) Re-engineer the business before implementation of ERP. Implement re-engineering changes, freeze the organization, and free the best people to run the implementation. (2) The top management, CEO or COO, must run the plan; lower level management will not be able to successfully complete the process. (3) Create a functional specification of the business identifying the "best of breed" processes. Assemble core group of middle management to determine business conditions and objectives. Use software like "Buy Smart" that asks key questions and parameters related to a specific business. The software then analyzes responses using its internal database of 400 top ERP systems, matches them to the company, and formulates a recommended functional specification. (4) Create a committee made up of core employees below the corporate sponsors. The committee should study, select, and implement the processes. The ownership of the plan creates employee "buy in" for the project. (5) Choose an integrated consultant after careful interviews with the actual people who will be working with your company. Select a team out of your best business managers to work full time implementing the new "to be" process.

The implementation of an ERP project requires four general phases, and should include an

incentive bonus paid to the employees for completing each phase: (1) Create detailed process flow mapping of the current "as is" and future "to be" business processes. (2) Configure the software to the "to be" process. (3) Test the conference room pilot and integration of system. Century Furniture completed 55,000 transactions per day that resulted in a system failure. A new system was re-implemented in two weeks to process the transactions. (4) Create a conversion plan and implement the process.

Seventy percent of companies that implement an ERP fail on their first attempt. It is important to remember to select the proper corporate sponsor, complete the ready-aim-fire process, thoroughly analyze the "as is" and "to be" conditions, know where you're going, and plan before execution.

Enterprise Resource Planning at Corning Incorporated

Rick Beers, Corning Incorporated

A Work in Progress

Enterprise Resource Planning has been in process at Corning for four years. ERP is good for a company, but it is difficult to implement. The difficulties of ERP systems result in 70% of all initiatives failing. There are four basic drivers to account for the high failure rate. (1) The Nature of the Beast: Companies remove core systems and replace with new systems. (2) Conspiracy of Best Intentions: Software vendors promise more benefits than can actually be realized. Company representatives know that all vendor promises can't be true, but pass along information believing that they can do better, and hoping that optimistic projections will result in project approval. (3) Dual Expectations: There are two groups of people in companies who are in natural conflict. They are the functional groups who are concerned with deliverables, and the enterprise groups who are concerned with overall company well being. (4) Be Careful What You Wish For: Information systems that are integrated together can "talk" with each other, but the information flow impacts other manufacturing processes. These systems can not be adjusted locally because everybody impacts everybody else.

Enterprise systems are primarily driven by three factors. (1) Groups want integrated information systems. (2) The Y2K issue. (3) Business Value. These three factors combine to create a new infrastructure within a company, but the ERP

initiative must be justified for overall value. There are five areas of business value in the supply chain world. (1) Order Promising: The degree of confidence, accuracy, and quickness that a company representative can promise a delivery date to a customer. (2) Asset Utilization: Availability of information necessary to manufacturing most needed products at the time they are needed. (3) Electronic Linkages with Customers: The customer's usage rate of products are automatically transferred to the vendor company systems for inventory replenishment. (4) Collaborative Demand Planning: Customer demands flow directly into the supplier company and are routed to the required personnel. (5) Improved Decision Making: New and improved sources of information lead to better decisions. These five improvements in business value are not possible without the investment of an ERP system.

Corning is a very diversified corporation with ten operating divisions producing a wide variety of products. Corning's products include fiber optic cable, fiber optic components, specialty components, environmental products, laboratory products, optical products, and television/computer components. Corning moved to a broad based ERP program in 1994 as an outcome of corporate reengineering, and an initiative to bring together the information systems of the ten different divisions. The ERP program has been managed and led by Corning since the beginning of the project. The ERP program is viewed as a long-term investment in business critical capabilities with diversity, decentralization, flexibility, and a shared business and information technology leadership. PeopleSoft was selected as the ERP vendor with the initial emphasis in finance and HR, and long-term requirements in supply chain capabilities. The ERP project is overseen by an executive level steering committee, and directed by a program office. The program office manages the four functional areas of Finance, Procurement, Supply Chain, and H/R. Each functional area has its own steering team.

There are many ERP difficulty issues and they are referred to as "speed bumps". The first issue is process diversity. Planning processes of discrete, continuous and hybrid functions are compared to market profiles of OEM and finished goods. The second ERP issue is business structure. Corning operates a three-tier structure with different types of organization interests at each level. At the corporate level the main concerns are finance, procurement, science and technology, and H/R. The main concerns at the division level are

The main concerns at the division level are sales/marketing, order management, inventory management, and capacity planning. The business unit levels of plants and sales offices are mainly concerned with planning, scheduling, and manufacturing execution systems. The third ERP issue involves system design. A centralized application is required at the corporate level, and it must function with a decentralized system at the divisional levels to permit flexibility for diverse products. The fourth ERP issue is software functionality. Functional breadth is critical for applications to the different manufacturing process types of continuous, batch, repetitive, assembly, and engineered to order. Functional depth is the range of configurability within each product, and is also critical within each of the manufacturing types. The fifth ERP issue is modifications. Some modifications are made to the processes, not the software. There are three types of processes. (A) Work Practices: Processes that are routine and repetitive, and relatively simple to change. (B) Business Policies: These are at a higher level and more difficult to change. (C) External Processes: These are forces that occur outside of company control. The dynamics of these three types of processes indicate that the closer an application is to the manufacturing floor or the customer, the more inflexible the process becomes. The sixth ERP issue is ERP/MES linkages: The link between ERP and MES systems occurs at four different locations. (A) Procurement / Equipment Management. (B) Planning and Scheduling / Plant Floor Scheduling. (C) Inventory Management / Product Tracking and Genealogy. (D) Bills of Materials and Routings / Process Monitoring and Closed Loop Control. The seventh and final ERP issue is change management. A critical component of managing change is to prepare people for the changes by informing them of all system impacts, and the reasoning behind the change. The improvements are not readily apparent to all of the employees working within the new systems, therefore the benefits should be fully explained. ERP implementation may be difficult, but it adds long term value to both external and internal customers. The availability of information changes the way people act and feel within the company.

The ERP lifecycle is managed for the long term by determining requirements for future growth, and the ability to upgrade systems easily. Program lifecycle has four categories. (1) Release Management: Reviewing software upgrades and controlling releases. (2) Configuration: The

configuration of new releases to company objectives. (3) Deployment: Taking new releases and deploying them within the company (4) Enterprise Systems Support: A group that supports the ongoing operations of systems. . Supply chain strategy is planned in three steps. (1) High level strategy: Determine what the company needs to accomplish. (2) Detailed Strategy: Identification of process redesign steps. (3) Detailed Project Planning: Determine how to accomplish goals.

Corning decided on taking a hybrid approach to operating the ERP system. One portion operates in a centralized mode for finance, procurement, and H/R functions. The other portion is developed with a common build of functions, but maintains enough flexibility to function at the diverse divisional levels. The current status of the Corning ERP model is as follows: The PeopleSoft system has been deployed with both centralized and decentralized functions. Centralized functions are in place for all finance, and H/R operations, with procurement operations being planned for the near future on a corporate basis. Supply chain issues require decentralized strategies, and are being implemented on a division by division basis. Decentralized functions have been deployed for the Photonics and Science divisions. The television division plans on implementation in the first quarter of 1999. Two other divisions are in the project-planning phase. With five other divisions yet to deploy decentralized systems, a five-year implementation strategy is planned. Implementation of the ERP systems is difficult, but going well. The benefits of the system to the company will be great.

Meeting Customer Expectations with Planning, Scheduling, and Organizational Innovations

Bill Frye, Titleist and Foot-Joy World

Titleist and Foot-Joy World manufactures golf balls, shoes, golf clubs, and a diverse array of other products. In 1997 Titleist manufactured 288 million golf balls. All divisions combined had sales in 1997 of over \$700 million with over 3600 employees. Titleist has a strong industry position that is critical to success. The company's marketing strategy is based on a pyramid of influence where top golf tour players work with the products thereby influencing other consumers. Seventy percent of golf tour players use Titleist products.

Golf ball technology is advancing in several areas, but the actual performance is limited by USGA specifications. Manufacturers have developed and perfected techniques to produce golf balls right at the specification limits with minimal variation. Design and manufacturing goals are now evolving to maximize performance to a specific individual. Golf ball design is being conducted to match a certain set of conditions, including the player's physical characteristics and golf equipment. These changes result in a large increase of SKU's within the company.

Customized golf balls have logos or images printed on the surface. The images can be single colored or multicolored, and can also include pictures. Many corporations and institutions purchase customized golf balls for promotions. Titleist is licensed to produce a variety of corporate, and college & professional athletics logos. Customized production is expected to exceed 84 million golf balls this year. Domestic shipments are now comprised of 40% customized golf balls. Customized golf ball manufacturing is highly seasonal, and produced on an assembled-to-order basis. The seasonal nature of sales results in large swings of production quantities and manpower.

Two primary factors are driving changes in customized golf ball production. (1) An increase in the number of different types of products: The variety of products result in different types of product packaging and distribution channels. (2) Corporations using customized golf balls as promotional items: Corporations are requiring the golf balls to be bundled with their other products. These two factors in customized golf ball production create a large increase in the number of SKU's to track. There are also other changes taking place within the industry. Corporate customers are demanding more customer service than the traditional country club customer. There are new forms of creative promotional packaging. Intermediate companies have emerged that specialize in various customized products. The customers are also developing buyer power that did not previously exist. Titleist growth is doubling every four to five years. Growth in the customized golf ball segment has resulted in the following increases at Titleist during the past eight years. (1) The number of finished goods SKU's has increased from 52 to over 700. (2) Logos kept on file have increased from 20,000 to over 100,000. (3) The number of manufacturing machines that decorate balls has increased from two to seven. (4) The

number of manufacturing plants has increased from one to three. Other Titleist growth changes include consolidation of company services, and lead time reduction from ten weeks to three to five days. Quality color prints on golf balls have become more difficult as logos get more complicated.

During the time period from 1992 through 1995, improvement factors were identified, documented, and implemented. Capacity management was studied in the custom production division. Manufacturing capabilities were determined using statistical analysis and learning curves for capacity ramp-ups. Flowcharts were developed to help streamline the ordering process and associated paperwork. Logo creation was changed from an outside contractor to an in-house graphics function. The consolidation of custom operations, customer service, and shipping groups into a single organization was implemented. Lead-times were initially reduced from 10 weeks to 10 to 15 days.

In 1995 the objectives for improvement actions were as follows: (1) Support growth of 15% per year. (2) Achieve industry leadership. (3) Contain overhead costs. (4) Reduce processing errors. The customer service, shipping, and graphics departments were consolidated into one organization. The SynQuest synchronizer MES system was installed permitting further reductions in lead-times. Additional opportunities were reviewed, and the order entry screen was changed to include specific details of custom ball production. The MES system was tied to the AS-400 computer for scheduling purposes. Re-engineering also was implemented in the packing and warehouse areas, which enabled matching of quantities and shipment types. Team concepts were also introduced at this time. The piece-rate pay system was eliminated and replaced with a skill-based pay system. Bonus opportunities were also implemented for a several manufacturing objectives. SynQuest MES software was selected because of its focused product capability that met the needs of Titleist. SynQuest was able to maintain cost economy constraints, and a short implementation horizon. The system streamlined the ordering process, provided guidance for shop floor personnel, and permitted real time visibility. The system provides information pertaining to projected orders that are going to be late, backlog hours, past due hours, and other key items. A 24-hour around-the-clock scheduling plan was implemented to feed orders to the manufacturing department. The system also

resulted in the unexpected benefit of a morale boost with the manufacturing personnel, and increased communications between shifts.

In 1998 the lead-times have been reduced to three to five days. An option of guaranteed two-day service is available for premium fee. The shop floor has been reorganized, and all information is now printed on the paperwork instead of handwritten. It is now possible to sequence group orders, and to track individual orders. Accurate information is provided for order status inquiries. The facility has been renovated with improved housekeeping and centralized processing. Market share is up 10%, with Titleist holding 70% of the market share in the custom ball segment. Sales and production volumes are up 15% in 1998. Team focus concentrates on machine utilization and changeovers. On time delivery is at a consistent 98% with lead-times in a 3 to 5 day window. Over-runs and returns are less than 1%. An advanced graphics technology system was implemented that stores digital images of all logos. Customer service personnel and manufacturing operators can verify order logos.

Titleist is now moving towards a PeopleSoft ERP system. Major goals are to streamline the forecasting process from a seven-day cycle to a single day, and implement constraint-based scheduling. Purchasing is still in part manual, and will be completely integrated into the PeopleSoft system. In addition, a job order costing system is planned. The timeline to implement the PeopleSoft ERP system is in the first quarter of 1999. There are separate teams to implement the manufacturing, financial, and HR portions of the PeopleSoft ERP system.

There are several factors that have been key to success with the implementation of the MES system, and will continue to be critical as the ERP system is introduced. A full week was dedicated by all teams to establish project requirement definitions. Project focus was concentrated on business objectives combining operations management strategies, HR strategies, and technology. Resources were focused during the implementation phase to ensure a smooth rollout. In addition, open communications were established between all personnel.

Drum-Buffer-Rope: An Implementation Case Study at Brenco, Incorporated

Ralph Carrell, Brenco Incorporated

Brenco was founded in 1949, and its main facility is located in Petersburg, Virginia. The company manufactures and reconditions tapered roller bearings, locomotive journal boxes, forging and machining products for the automotive industry, and seals for the railroad industry. The Petersburg facility consists of five manufacturing plants with 275,000 square feet of manufacturing space. The facility has 650 employees including 80 manufacturing work centers. Brenco will have an estimated \$130 Million in sales this year. Brenco also has plants located in Louisville, Kentucky, Sparks, Nevada, and Little Rock, Arkansas, with approximately 200 additional employees. These facilities remanufacture Brenco bearings. The name Brenco is an acronym for Bronze Engineering Company. In 1962 the first plant at the Petersburg, Virginia location was built, followed by additional facility construction during the 1960's and 1970's. Brenco holds approximately two-thirds of the domestic market share, and sees its main growth in the future as exporting product to foreign markets. Eighty percent of sales volume is concentrated in large bearings products, with smaller bearings beginning to increase in numbers. Basic product flow begins with the input of raw materials, processing through forging, machining, heat treatment, grinding, and assembly, then shipment to customer.

Brenco manually scheduled factory manufacturing processes prior to September 1992. There was not an integrated ERP system at that time, and it was difficult to schedule all required items. Brenco's automated scheduling system is based on theory of constraints. The first theory of constraint scheduler went on-line in September 1992. There were initial problems and gaps that made it difficult to use the software on the manufacturing floor. Software support from the vendor was minimal, and improvements to the program had to be made by Brenco employees. The company decided to change software and search for a different vendor. Brenco selected Resonance as its new vendor and purchased the software in June 1996. The new theory of constraint-based software went on-line at Brenco in November 1996.

Brenco has approximately 750 product parts with about 30% of them active at a given time. Parts are tracked through the manufacturing process via part numbers. All data is tracked and resides on the AS400 computer and JD Edwards software, flowing to and from the scheduler. Programs are run, and data is compiled into a file format that is compatible with the Resonance software. The files for work centers, part masters, bills of materials, routings orders inventory, and purchase orders are created and run through a data base utility. The data is run through the scheduler software, which produces a schedule. The schedule is then uploaded back to the JD Edwards software. The manufacturing schedule is based on weekly increments, and is accessible to company employees via access through any computer terminal.

Brenco completed time studies and determined manufacturing standards in preparation for the implementation of a theory of constraint-based scheduling system. There are five objectives and steps to follow for the implementation of a theory of constraint system: (1) Identify the constraint (2) Exploit the constraint (3) Subordinate to the constraint. (4) Elevate the constraint, and (5) Repeat the steps when the constraint is broken.

The first step is to identify the constraint in the process. Constraints are process steps running at maximum which limit throughput. One to three work centers that are process constraints should be selected. The Resonance software that Brenco uses indicates constraints by identifying resources running at over 100% of capacity.

The second step is to exploit the constraint. The process constraints should be operated as much as possible including through lunch and break periods, and other times when the machines are not running. The quantity of changeovers should be minimized, and machines need to be kept full of raw materials to process. The scheduling software identifies orders that will be either on time or late. Manual adjustment is made by either moving process batches or due dates. Savings can be achieved through set-up trade-offs. At this point in time a finite schedule is established with known start and finish dates, including times and quantities.

The third step is to subordinate to the constraint. Determine if the other processes can support the constraint, and how to maintain that support.

Establish a steady and constant flow of product both to the constraint and after the constraint, including processing through final assembly. Buffers are set (in hours) in the scheduling software to account for fluctuations in the process. Fluctuations include product movements, breakdowns, and other factors that will inherently happen in the process. Process times are determined through the shipping buffer and established constraints. Resource buffers in front of the constraint need to be set so the constraint doesn't run out of materials to process. Product should be released into process as necessary to buffer the constraint. Assembly buffers are where constraint parts meet non-constraint assembly processes. The process should be established such that the high priority products do not sit idle on the manufacturing floor at any time. When a constraint part enters thenext process area it should not need to wait. Protect and maximize the constraint, and make sure other product parts meet the constraint parts on time.

The fourth step is to elevate the constraint. Capacity should be added to the constraint and output should be maximized. Product scrap and changeover times should be minimized. Determine how to make the process quicker, and how to reduce the time required to complete tasks. A collaborative effort between manufacturing and engineering is required. Stock machine replacement parts that are critical to the operation of the constraint machinery. Establish expected machine efficiencies, and enter them into the system. Schedule preventive maintenance, and replace key components before the machines actually break down. Other methods to increase constraint output include refurbishment of old equipment, installation of new equipment, and outsourcing product if confidence of quality is at an acceptable level.

The fifth and final step is to repeat the process. When the constraint is broken and throughput is increased, the process that is actually the constraint may change. New constraints must then be identified. The entire process should be repeated when this occurs.

There were obstacles to implementation of the new scheduling system at Brenco. People were the largest obstacle to change in the scheduling system. Many difficulties arose when attempting to change the culture, behavior, and activities of

personnel. The delivery of the original system was not very smooth. The company personnel did not explain the system well enough to manufacturing personnel, and the vendor did not provide enough support. Manufacturing personnel were resistant to performing multiple lengthy changeovers and set-ups. The manufacturing personnel frequently requested to pull in the next week's orders to reduce changeovers, but were not permitted in most cases because that would have delayed the current week's commitments. Buffer management created additional difficulties. The buffer levels had to be maintained through identification and correction of process problems. Assembly buffers also had to be at sufficient levels to maintain the assembly process. Operating efficiency of constraint processes were established to minimize downtime and number of defective parts. Maintenance of machines and equipment was critical to back-up constraints. In addition, the implementation of the scheduling system also affected financial statements through lower inventory levels and costs to manufacturing.

There were many benefits to Breco from the implementation of the new scheduling system. The main benefit was synchronization of processes. Manufacturing products came together on time. On-time delivery was increased from 95% to 98% with the new scheduling software. There was a work-in-process reduction of 29% in 19 months. The work-in-process turnovers increased approximately 90% in the same time period from 13 turns to over 25 turns. Product cycle time decreased, and product now makes it through the factory quicker. Customer demand for the product increased 40% during the implementation period and was able to be met through the use of the new scheduling system.