While the title of this article is “100+ Inventory Turns,” the real story is of one company’s lean manufacturing journey. Because inventory is touched by so many activities in the business, you can’t reach this new standard of performance (100+ turns) without looking at your business as a whole. You can cycle count, set business rules, create locked stockrooms, and make any number of other inventory-related changes and still not reach this level of performance. The only way that I’ve seen to achieve this is through the type of company-wide change that is inherent in lean manufacturing. Collins & Aikman, in Port Huron, Michigan, is an automotive manufacturer that has made a very successful move to a lean manufacturing environment. Inventory turns is just one of several key metrics that they have used to measure their progress. We’ll talk about where they started, where they are today, and how they got there.

COMPANY BACKGROUND—WHO IS COLLINS & AIKMAN?
Collins & Aikman Corporation (C&A) is a global leader in automotive cockpit modules, floor and acoustic systems, instrument panels, automotive fabric, plastic-based trim, and convertible top systems. C&A has the number one or two market share positions in North America in seven out of 10 automotive interior product categories. The company's high-quality products combine superior design, styling, and manufacturing capabilities with noise, vibration, and harshness (NVH) "quiet" technologies that are among the most effective in the industry.

Collins & Aikman started in 1843 as a window shade shop on New York's Lower East Side. From its inception, the company was a leader in innovation, becoming the first U.S. weaver of satin damask and the first U.S. producer of jacquard velvet, innovating new technologies, and expanding into the furniture, automotive, and home fabric industries. Even through the stock market crash of 1929 and the Great Depression, C&A was profitable for all but one year. Through acquisition and innovation, the company has grown and increased its commitment to the automotive industry. By 1994, automotive products were the dominant segment of C&A's business, accounting for 59 percent of annual sales. Since 1994, Collins & Aikman has undergone a series of strategic acquisitions and divestitures in order to position itself as a leading automotive supplier with a broad range of product offerings. Acquisitions included companies that produced convertible top fabric, automotive plastic trim parts, automotive floor coverings, acoustic technologies and product lines, and one of the world's largest suppliers of fully integrated automotive cockpits. Through this process, C&A's automotive sales have grown to 96 percent of the company's total business.

C&A's Port Huron, Michigan plant opened in 1991 as a tier-one supplier of door panels and other interiors, primarily to Daimler-Chrysler. This division's focus has always been to be the best of the best. Their processes include injection molding, vacuum forming, adhesive and paint, heat staking, compression bonding, and assembly.

THE STARTING POINT – C&A PORT HURON “PRE-LEAN”
As a supplier to the automotive industry, C&A Port Huron has always been under pressure to minimize costs, increase quality, and provide 100 percent on-time delivery. That’s the reality of the automotive industry. Each year, these challenges increase. For its first several years of production, Port Huron tried to meet these challenges using traditional manufacturing methods. The shop floor was a traditional, functional layout. There were multiple schedulers managing five points of scheduling using traditional “push” scheduling methods (material requirements planning (MRP), etc.) Decision making was done at the executive level and pushed down to the shop floor. Using this model, Port Huron was able to be competitive in most areas. Some of the plants key metrics in the mid 1990s were
- inventory turns – 80
- PPM (defective parts per million produced) – 1,369
- scrap (as a percent of sales) – 0.78 percent
- manufacturing cycle time – 2.43 days
- customer lead time – 11 hours
• injection mold tool change time (last good part to first good part) – 42 minutes.

COLLINS & AIKMAN PORT HURON TODAY

While the “pre-lean” Port Huron was certainly not a failure, contrast where Port Huron was to where the plant is today—the key metrics for the company have improved dramatically, to

- inventory turns – 120+ (a 50+ percent improvement); inventory value has dropped by 78 percent, and C&A’s corporate office has recognized Port Huron as the best plant in inventory management in the entire corporate total quality management (TQM) program
- PPM – 17 (a 99+ percent improvement); Daimler-Chrysler, the Port Huron plant’s major customer, has awarded them with the highest quality award possible for the last 4 consecutive years
- scrap (as a percent of sales) – 0.58 percent (a 26 percent improvement)
- manufacturing cycle time – 1.63 days (a 33 percent reduction)
- customer lead time – 5.75 hours (a 48 percent reduction)
- plant productivity improved by 28 percent
- injection mold tool change time – 19 minutes (reduced by over 50 percent).

The improvement at Port Huron impacted more than just metrics:

- In 2000, Port Huron became the first lean role model supplier in their division of C&A.
- Port Huron was an IndustryWeek magazine “Top 10 Best Plant” for 2001 and 2002.
- C&A Port Huron was a finalist for the 2003 Shingo award.

Each month, the Port Huron plant ships more than 170,000 end items Just-in-Time (JIT)—and 100 percent on time. Over-shipment and under-shipment scores are at zero for the year. The plant manufactures and ships 6,000 products daily within a four-hour ship forecast. Finished parts are produced four to six hours before they are shipped to the customer. There is one scheduling point based directly on customer demand. This year’s mold change time target is 15 minutes—a 21 percent improvement over last year’s world-class mold change time of 19 minutes. Color changes in the paint lines are done in 60 seconds.

These dramatic improvements are the result of a very effective implementation of lean manufacturing. That lean journey is what the remainder of this article will focus on.

THE JOURNEY TO LEAN

Change Starts At The Top

For C&A Port Huron, it took failure to reach success. Attempts were made in 1995 and again in 1997 to establish teams and empower the workforce. In both cases, the desired goals were not achieved. What happened? After careful review, C&A determined that the weakness was in their own leadership. A key manager did not believe in teams on the shop floor and, in response, put up roadblocks to the lean implementation. Training was planned for the workforce, but a change in schedules resulted in reduction and/or elimination of the training time. In order for Port Huron to succeed, change had to start at the top, with the plant’s own management team. They needed the right players in the right positions and a commitment to lean manufacturing concepts from all management. In response, qualified candidates, both internal and external, who were committed to the lean philosophy and to C&A’s operating philosophy, were sought to replace those who were blocking the company’s goals. By fall of 1998, C&A had reorganized its leadership team and was ready to move forward.

Value Stream Mapping

In 1999, C&A’s corporate continuous improvement office directed the plant managers to read Learning to See. Once the plant manager at Port Huron read the book, she required her entire management staff to read it. A facilitator was then hired, value stream mapping was introduced, a strategic direction was determined, and the plant was on its way.

Port Huron’s first value stream map (VSM) was developed in May of 1999. Within two years, the plant had transformed their value stream from shipping all the way through to receiving. Today, this tool provides strategic direction to all of Port Huron’s continuous improvement activities. They keep their dynamic VSM written on a dry erase board that is on wheels and has traveled the plant in order to show everyone where C&A Port Huron has been and where they are going. The VSM opened their eyes to the true sources of their waste and the impact these wastes played in how they managed their business. It also plays a strategic role in planning for new programs. Using VSM, they plan the best possible dock-to-dock time, starting with a “clean slate.” This helps drive the entire planning process for new programs. Based on this map, Port Huron has a clear direction for developing their processes and production control systems. Even the plant layout is an extension of this tool.
Based on the VSM, Port Huron targets breakthrough kaizen events to facilitate the business process changes needed to implement the “future state” map. These workshops are held at least monthly with nearly all hourly associates, and they have led to dramatic improvements on the shop floor. As a result of these workshops, C&A Port Huron has reduced more than 100 operations, resulting in a plant-wide productivity improvement of 28 percent. In addition, more than 25,000 square feet of floor space has been freed up for other uses. Actual numbers from one production line were:

- labor productivity (pieces/person-hour) – up 35 percent
- work in progress (WIP) inventory – down 71 percent
- lead time (minutes thru line) – down 88 percent
- part travel distance – down 58 percent
- floor space required – down 23 percent
- walk distance – down 73 percent.

Equipment and Facility Changes

Once the VSMs were developed, C&A had a choice to make: Were they going to manage the business based on this tool, or were they going to allow existing equipment and its location to become monuments and process around them for the foreseeable future? C&A Port Huron made the conscious choice that there would be no monuments at the plant. They have moved or will be moving nearly all of their existing machinery to fit with their lean philosophy. This involves multiple injection molding machines, thermo-formers, and secondary machines.

Employee Involvement and Investment

Once management commitment was gained, the plant needed to enable teams to be full contributors to the organization. This included training workshops for more than 200 hourly associates and building trust between management and employees. Port Huron’s belief is that unless you build trust between management and the employees, lean manufacturing will never reach its full potential. In order to build this trust, Port Huron has committed that “no employee should have reason to perceive their livelihood to be in jeopardy by participating in continuous improvement efforts.” Management at Port Huron went so far as to publish this commitment as a formal policy, signed by the entire leadership team. This commitment to team building and employee trust was truly tested in 2001, as sales in the automotive industry decreased and downtime was unavoidable. The plant had to choose between a layoff of employees during the resulting downtime or reinvesting in them. Port Huron chose to reinvest. The company went through a “team rejuvenation” process, re-organizing the production teams and providing a consistent structure from which to operate. This team structure served as a guide in identifying the vision, goals strategy, roles, and accountability for all to abide by.

Early attempts at fostering and developing an empowered workforce had taught the management at Port Huron that teams will not develop unless you release control to them. However, you must first invest and place trust in the employees. This means:

1. Adequate training resources are provided to the employees, and paid employee training time is made available.
2. Training is scheduled, records kept, and training effectiveness measured.
3. Employees are required to meet continuous, advancing training standards.
4. Training and team facilities are available on site.
5. Open communication.
6. Team accountability and authority is clearly defined.
7. Rewards and recognition systems are in place.

This requires active involvement of the leadership team so that the strategic needs of the company are incorporated. Both internal resources and professional, external resources are used. In 2001-2002, Port Huron provided 1600+ hours of paid training to 200+ hourly employees. Training was done in relational skills, team leadership, problem solving, decision-making, communication, and conflict management. Training and team facilities are available on site for all teams to use. There is an on-site library containing a wide variety of resources where employees can sign out a book, video, or tape using the honor system. Two computer-learning stations have been set up so employees can take self-administered courses for professional development.

All of these training dollars would be wasted if the training wasn’t effective. In order to ensure that the training is effective, Port Huron performs evaluations of all trainees and all training sessions, and they maintain a binder of evidence. In evaluating training, C&A Port Huron focuses on three things:

1. Reaction—did the trainees like it?
2. Learning—did the trainees demonstrate that they learned anything?
3. Transfer—did the employees apply the learning? Employees are required to meet continuous, advancing training standards.
Policy deployment also involves the whole team. The senior executives provide initial direction and focus regarding vital strategic objectives, and then each subsequent level of the team aligns their goals with their supervisor’s goals. This requires staff and team meetings to ensure that the necessary resources are available and are also committed to these goals. Management is responsible for supporting these team decisions and activities with the necessary resources. Policy deployment is one component of team accountability and authority, another key concept in Port Huron’s implementation of lean manufacturing. Team accountability and authority is closely tied to team development. As managers release decision-making control, Port Huron is giving the production teams increasing responsibilities.

Kaizen events all involve training; it is critical that all associates understand why the plant is choosing to implement lean manufacturing as well as how. All workshops are five days in length and have a similar format:

- Day 1, training on lean basics: Time-based management/dock-to-dock time reduction, waste identification, line balancing, 1-piece flow, pull systems (kanban), leveling systems (heijunka), 5S, and total productive maintenance.
- Day 2, observation: Participants study the target area looking for waste and documenting the current condition.
- Day 3: Teams are challenged to develop improvement proposals for the target area, and they are coached on how to measure improvement and sell their ideas.
- Days 4 & 5: Teams do any preparatory work that is needed, including updating work instructions, visual aids, and training, and then work with the appropriate groups to implement the identified changes.

Job training, in addition to lean training, is an essential part of success. Each job position has a training checklist that was developed by the team to cover all aspects of the job. Items covered include machine operation, component installation techniques, safety, and ergonomics. Each position goes through three levels of training:

1. All aspects of the job are demonstrated, but line speed is not maintained.
2. Line speed is maintained for at least one hour.
3. Line speed is maintained for the shift, and the associate teaches the task to others.

Port Huron’s management team recognizes the efforts of teams and individuals for their work. Rewards and recognition provide feedback to the teams and individuals that the company values these efforts. In addition, the plant has formal methods for rewarding and recognizing accomplishments including service awards, perfect attendance awards, employee of the month awards, housekeeping awards, and gain-share payouts.

Eliminating Waste
Waste identification and elimination is another key at C&A Port Huron. To accomplish this, the Toyota Production System is followed. They utilize a central planning document, the plant lean implementation plan (PLIP). This requires that continuous progress in implementing lean operating methods is the organization’s primary tool in pursuing its strategic objectives. With the aggressive price targets that are inherent in the automotive industry, C&A Port Huron had to find less expensive processes. Working with their technology group, they benchmarked other products and literally tore them apart to see what construction and process they used. Port Huron has patented an idea for modular machines that uses less space, provides greater flexibility, and reduces the tooling cost to their customer. In addition, C&A Port Huron has no “sacred cows”—even very successful products can be reengineered for dramatic improvements.

These efforts have helped Port Huron reach tough target prices and win two new programs for the plant. By adding 21 percent to their current manufacturing floor space, Port Huron plans to double its sales volume. This is a result of a combination of their waste elimination programs, process, and product innovation.

One of the most noticeable changes at C&A Port Huron is their application of the 5S’s for workplace organization and discipline, which helped expose the hidden waste that existed in their plant. 5S workshops were provided to all teams in the plant with the goal to provide each team with an understanding of the process and the resources needed to implement them properly. The workshops involved classroom training, hands-on training, and time to apply what they’ve learned in their work areas. The results have been dramatic. Time to complete tasks has improved as much as 75 to 90 percent.

Total Productive Maintenance (TPM)
TPM has also been critical to the success of lean manufacturing and the resulting increase in inventory turns at C&A Port Huron. TPM is a comprehensive approach to minimizing productivity losses associated with equipment. These losses cause unplanned overtime and added pressures to meet customer demands, which plays havoc with the everyday lives of everyone in the plant. The characteristics of the
plant. The characteristics of the TPM system at Port Huron are:

- Operators are trained to perform preventive maintenance functions that do not require the capabilities of a skilled tradesman.
- Skilled maintenance personnel develop “one-point lessons” and provide training.
- Maintenance department moves from “fire-fighting” mode to prevention mode.

TPM builds on five points:

- Get the most efficient use of all equipment.
- Build a comprehensive preventive and predictive maintenance system.
- Engage people from all departments who are concerned with equipment.
- Require the support and cooperation of all organizational levels.
- Promote and implement PM activities based on small group activities.

Quick Changeover

A major key to flexibility in manufacturing (and therefore minimum inventories) is the ability to quickly change over production processes. This ability is crucial to supporting heijunka as the pace quickly change over production processes. This therefore minimum inventories) is the ability to run every product every hour enables Port Huron to keep only one hour of painted (WIP) inventory as opposed to more than eight hours of painted product two years ago. The result is nearly an 88 percent reduction in painted inventory. The same levels of reduction were achieved in the carpet adhesive area.

Quick Changeover has also been implemented in the paint and carpet areas of C&A Port Huron. Their automated paint line can, and often does, change product every 13 parts and perform four color changes every hour. So, 36 different parts might run on the paint line every hour. Changeover time is currently 40 to 80 seconds, as opposed to 180 to 300 seconds two years ago. This ability to run every product every hour enables Port Huron to keep only one hour of painted (WIP) inventory as opposed to more than eight hours of painted product two years ago. The result is nearly an 88 percent reduction in painted inventory. The same levels of reduction were achieved in the carpet adhesive area.

Mistake Proofing

Mistake proofing (poka-yoke) is also critical at C&A Port Huron. As with many areas, Port Huron uses hands-on workshops to evaluate their designs and suggest improvements. To facilitate mistake proofing, Port Huron must identify sources of mistakes, provide immediate feedback for root cause resolution, and prevent future mistakes. To implement mistake proofing, Port Huron uses an internal facilitator who trains, guides, and sets objectives. A risk assessment checklist is used to evaluate the level of mistake proofing for each operation. This assessment covers virtually all elements where mistakes are likely. Using this methodology, one interior door trim’s PPM went from 240 to 11.

This process is not limited to new programs. Plant engineering and maintenance groups designed and built a new piece of equipment to replace an older assembly station in response to one of the plant’s high-risk processes involving a complex door panel assembly. By locking the doors into the new machine and tying together the torque control and counting the number of screws secured to the specified torque, the machine will only release a door that meets pre-defined specifications. This reduces the plant’s risk by reducing the chance for mistakes during the assembly operation.

Visual Systems

To maximize their implementation of lean manufacturing—and to minimize inventories—C&A Port Huron needed to develop a system that could not only accommodate a high level of variety and volume of items produced but that would also provide visual controls. With a cross-functional team, they developed a heijunka system that would complement the organizational goals and objectives. This eliminates waste, streamlines up-stream processes, and provides a simple visual system, which enables associates to quickly “see” current status and allows them to make decisions very quickly.

Daily customer release requirements continue to be received and processed electronically—only now, these requirements are demonstrated within the heijunka kanban cards. The kanban cards are delivered to heijunka boxes located at the end of each assembly line and inserted into their designated slots. At each pitch, a specified number of cards are pulled from each heijunka box and delivered to the paint area. Paint will hang the door panels according to the kanban card instructions and complete the set of kanban cards within the pitch. Once the product is painted and placed in its specified rack, this rack and the appropriate kanban card is moved into the WIP sequencing area. The material handlers confirm the order and complete the insertion of remaining components to complete the assembly area sequence rack. The sequenced rack and the kanban card are moved...
into the assembly area for final build. The kanban card follows the product throughout the assembly process to final pack. When the entire quantity has been assembled and packed, the kanban cards are returned to the bottom row of the heijunka box to signify completion. The finished product is moved to its designated ship lane for shipment preparation and then shipped to the customer.

C&A Port Huron uses heijunka to avoid excessive batching of product. By utilizing a paced withdrawal, as well as leveling demand by part number, it makes it easier to identify problems and ensure efficient use of all resources. This keeps the focus on customer requirements. By synchronizing the pace of production to the pace of sales, units are made only in response to demand. This has led to a reduction of WIP and finished good inventories.

Color coding is used throughout the plant for many purposes, including support of first-in-first-out (FIFO) inventory control. In the receiving area, all containers have a color-coded date code sticker with the receipt date stamped on it. This color-coded sticker identifies the receipts date of the product. Each day of the week has a different color to easily identify which product is to be consumed first. The face of the shelves used to hold the product is color-coded, identifying the product's supplier and the last four digits of the C&A part number. All color-coding schemes are identified on charts located at the end of the shelving unit for ease of location identification.

Vendor Relationship Changes
Teamwork at Port Huron’s includes more than internal associates—it extends to the plant's relationships with its customers and its suppliers. Annual supplier meetings are conducted to expand communications while clarifying C&A's goals and objectives as they relate to the volatile automotive environment. These supplier meetings are built around key elements from C&A's Global Supplier Development & Guidelines Manual and encourage open discussion and supplier participation. Another goal of the supplier meetings is to share experiences across company boundaries to help identify and implement improvement opportunities.

Port Huron shares its knowledge of lean manufacturing with its suppliers by offering and conducting lean workshops at the suppliers' facilities and by inviting suppliers to participate in internal lean workshops at C&A Port Huron. The company also includes suppliers in company functions such as open house festivities and award ceremonies. Suppliers are even included in product development at Port Huron. Suppliers are co-located at C&A’s design facilities and work with C&A’s engineers and designers to ensure feasibility for tool construction and manufacturing of their future products that will be used within the C&A final assemblies. All of these things help promote a true sense of partnership between C&A and its suppliers.

Supplier satisfaction performance measurements are communicated electronically from C&A to their suppliers. These metrics match the metrics Port Huron’s customers use to evaluate them, and they help maintain a continuous flow of communication while identifying and eliminating non-value added activities from the material supply processes. C&A’s supplier performance calculation is divided into three categories:

- Performance rating, based on PPM and delivery (right time, right quantity, proper bar code labeling, and correct packaging).
- Assessment rating, based on assessments performed by the supplier development group evaluating cost reduction, mistake-proofing, and diversity content.
- Quality system rating, based on third party quality systems registration using QS, ISO, TS or other appropriate standards.

Use of Technology
Any operating system will fail unless feedback is provided. Part of this feedback is plant performance, which is tracked and reported as part of the plant’s business operating system (BOS). The purpose of the BOS is to institutionalize a systematic, disciplined approach to continuous improvement of all key metrics. The total set of all metrics, which are common across all C&A plastics plants, is monitored and driven at the plant level. A selected set of 12 metrics is displayed at Port Huron in the employee entrance. Some of these key metrics are PPM by part category, scrap as a percent of net sales, average mold changeover time, overall equipment effectiveness (OEE), employee turnover, inventory turns, inventory accuracy, and cost of quality.

The timeliness and accuracy of information is critical to providing feedback for management and operators to assess their performance to their goals. Port Huron utilizes a production labeling, data collection, and management reporting system called “Transport,” from Blackhawk Systems, Inc. The Transport system is comprised of 55 networked personal computers with touch-screen monitors, label printers, card readers, and bar code scanners. All shop floor activity is tracked by this system:

- scanned receipt of supplier materials
- movement of materials
- recording of production, scrap, and machine uptime and downtime
• component lot control
• racking of components
• loading of trucks
• shipment of finished products.

Since everything is processed through the system, all this activity is available for reporting and analysis at any time. There is also a real-time monitor that enables key players to see at any instant what is currently being produced, by whom, and on what machine, as well as the uptime and downtime status of all machinery. This monitor is built on a Web browser so it can be viewed from anywhere in the world via the Internet. The reporting capabilities are not limited to management—each operator’s workstation has the ability to run detailed production reports to see how they are performing to the minute. It’s all about results—putting up-to-the-minute information in the hands of the people who can make the changes and improve the process immediately. Port Huron’s staff doesn’t have to wait to review reports—results are available immediately. In addition, this system can track and individually identify items from the beginning to the end of the manufacturing process. The user interface consists of touch screens and scanners, rather than a keyboard, simplifying operation for the user and reducing time and effort.

To facilitate and support TPM, C&A Port Huron uses a computerized maintenance system called MP2 in conjunction with their shop floor data management system (Transport) to measure and track measurables such as overall equipment effectiveness (OEE), percent of planned maintenance orders versus total maintenance orders, and percent of PM orders completed on time.

To help ensure 100 percent on-time deliveries, C&S Port Huron fully utilizes the MRP functionality within their enterprise resources planning (ERP) system (TRANS4M from BRAIN/Agilisys.) This system pulls in (via electronic data interchange (EDI)) and processes customer release requirements and translates these into supplier releases, which provide the supplier with two weeks of daily requirements and an additional 12 weeks of weekly forecasted requirements. By aligning the entire supply base partners with actual received customer orders, Port Huron is able to remove any “safety” or “buffer” inventories traditionally required to protect against unforeseen production or supply glitches. This is an important concept, because many proponents of lean manufacturing and/or the Toyota Production System claim that MRP is no longer needed. While MRP is no longer needed to actually initiate production, it is still a very valuable tool for planning and long-term visibility. Kanban and other pull systems work very well in environments where demand is relatively constant. However, large swings in demand (either up or down) can cause delivery problems in even the most well-executed lean manufacturing environment. MRP can provide an early warning that such demand swings are coming, enabling you to make adjustments to your heijunka pace, and/or your kanban pull quantities to meet these changes in demand.

SUMMARY

We started talking about inventory turns, but we ended up discussing a full lean manufacturing implementation. The truth is you can’t get to 100+ inventory turns by focusing strictly on inventory, no matter how hard you try. Inventory is affected by almost everything you do in a manufacturing environment and by a lot of things that you may not be doing. To achieve this level of performance, you have to look at inventory as one component of a complete business system and philosophy. As proved by C& and Port Huron, lean manufacturing is the business philosophy that can get you there.

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