START

DOING the
CARPET DANCE

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SPARKED BY ITS MISSION TO LEAD, WIN, AND HAVE FUN IS THE KEY REASON COLORWORKS IS ABLE TO CELEBRATE ITS SUCCESSES ON THE "DANCE FLOOR."

Working at the Carriage Carpet "ColorWorks" factory is a great deal more fun these days, thanks to an innovative information system that takes the guesswork out of the art of carpet dyeing.

Carriage Carpet, a subsidiary of the Dixie Group, Calhoun, Ga., produces carpet in any color for manufactured housing and recreation vehicle original-equipment manufacturers (OEMs) and exposition centers. Automation at the ColorWorks factory enabled Carriage Carpet to save thousands of dollars each month and improve product quality. However, the phenomenal increase in the factory's profitability has as much to do with the corporate culture as the implementation of information-based automation technology.

"'Lead, Win, and Have Fun' is our mission statement and it really does reflect our company values and the way we do business," says Francisco Campa, director of engineering. "We are always looking for a better way to do our job, which is fun in itself. Each time we develop a product, we discuss the best way to produce it. We have ongoing leadership training. We continuously look for new opportunities; we never stop improving our processes. We communicate everything to everybody. We believe when our staff has all the information they need to consistently produce quality products, they can relax and enjoy their job. Stress is reduced, and so is waste."

The staff at ColorWorks understands first hand how a lack of information can impact quality, morale, and even the environment.

"Before we automated the dyeing process, we didn't have standardized formula control and batch preparation procedures. We were dependent upon the experience of the plant operators for the end product rather than exact measurements," explains Campa. "Operators made subjective decisions based on their individual perception of sight and feel. Each operator had his own way of doing things, which resulted in a variation of processes and quality between shifts."

ColorWorks has two continuous dyeing lines, one for multicolor carpets and the other for solid colors and patterns. Each line can process more than one million square yards in one week.

The solid color dye line produces 20 different styles of carpet a day; each style represents a different carpet

weight, color, width, and protective treatment. It runs continuously, 24 hours a day. An operator has about 10 minutes to manually sew a new roll to the trailing edge of the carpet on the line. After the dyeing machine applies color, the steamer section of the line boils most of the water off allowing the dye to adhere to the fibers. A vacuum section then removes excess water. After the dye is fixed and the carpet is at the correct moisture content, chemical treatments such as Scotchgard are applied. The carpet then enters a drying oven to remove the remaining moisture.

The dye line features a seven-zone, 80-foot long drying oven. Prior to 1999, a panel board controlled the oven. Single loop temperature controllers modulated burner gas valves. Ineffective half-zone temperature controls often allowed one side of the carpet to overheat, changing color, while the other side remained wet. Operators had to be well experienced in manually overriding temperature and line speed set points, especially during style changes, to ensure proper drying across the carpet width without burning. Moisture content was measured by touch as the carpet left the dryers rather than by sensors. Operators also had to guess how much dye and chemicals were needed.

Over dependence on the experience of seasoned plant operators made Carriage Carpet vulnerable. "We were losing people who knew how to tweak machines to do things. When they left, they took that knowledge with them. In an area of low unemployment, recruiting and keeping people was a challenge," says Campa.

For a company that strives to be a rewarding place to work, morale was a big concern. Damaged carpet and uneven color application were even bigger problems. In 1999, damaged carpet from just one of the dryers represented more than $63,000 of waste. Thousands more dollars were lost to rework, excess dye and chemical usage, and fines.

Because there was no way to know exactly the amount of dye or chemicals needed, the carpets often left the dryers wet with unbonded dye or excess chemicals that were dumped into the sewer. The town was regularly assessing Carriage Carpets with fines, according Campa.

Carpet treatments such as Stainmaster and Scotchgard as well as dyes are expensive. With every operator having to go by experience rather than measurements, carpets were often over treated or under treated.

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"We produce 4,000 different product lines, which is a lot of complexity for a single plant," says Campa. "The processes we had in place, both equipment-based and people-based, were not designed to handle this level of flexibility. Without online data, differences could be seen from shift to shift. We wanted to repeat what the best operators did all the time. We needed to implement information-based processes that would enable us to increase our flexibility, while improving quality."

Carriage Carpet embarked on an ambitious quality-improvement project to tighten oven control, improve color consistency, reduce scrap and rework, boost line output, and reduce dye and chemical waste. The project goals for the first year were to eliminate 50% of water-damaged carpet, 25% of uneven dyeing, and 100% of carpet reprocessing.

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"We got the end users involved and excited in the quality-improvement project right from the beginning," explains Campa. "It was a real team effort with plant operators and management in constant communication. The plant operators decided how they wanted to interact with the controls."

As Campa remarks, the entire project was something the entire company was involved in from the beginning. It wasn't a matter of people down at the shop floor wanting better equipment; the front office needed it as well.

"Management wanted more data available from the production facility," says Randy Myers, vice president of manufacturing. "We wanted this data to make decisions involving production costs, scheduling, inventories, and further process improvements."

The foundation of the company's quality-control program is based on lean manufacturing concepts, which relies on visibility of problems as they happen. To be effective, problems must be viewed as treasures, creating a non-blaming, non-judgmental environment. One aspect of this program can be found in an area of the ColorWorks factory called the "dance floor."

"We called it the dance floor, because it is a shiny floor in a central location," says Campa. "We take everything there, good and bad, for the entire company to see. If the carpet is real nice, we celebrate. If it isn't, we have the opportunity to communicate and solve issues."

The dance floor is also where employees exchange information and preview new products. Relevant company information is posted on the walls surrounding the dance floor.

Displaying damaged carpet on the dance floor inspired a greater sense of urgency for the quality improvement project. As the project manager, Campa was provided a great deal of freedom in selecting the technology that would automate the factory. He wanted an easy-to-configure-and maintain system that could be used out of the box.

Automation of ColorWorks began with the drying oven used in the solid color line. The panel board was replaced with DeltaV, PlantWeb field-based technology from Emerson Process Management, Austin, Texas. A Windows NT control network links the workstations and oven controllers via Ethernet, and provides operators with the information they need to run the line efficiently. The system collects data for diagnosis. It also provides remote diagnostics capabilities.

The automation project, which has paid for itself in only four months, is proving to be quite efficient.

"Before, operators controlled the dyeing process using big panels with lots of buttons," says Campa. "Now everything that was on the panel is in the computer. Operators can see everything that was in the old system, and more. We kept the system as mouse-driven as possible, because many of the plant operators don't like to type."

For the initial settings, controller-tuning settings were entered from the old controllers into their equivalent DeltaV loops. Data visibility provided by the system allowed both operations and management to see where they were in the drying process in realtime. Analysis of the data enabled the team to determine where to relocate sensors for greater effectiveness. Soon after, control loops for the 200-point system were retuned and DeltaV fuzzy logic control was added to the first of seven dryer sections. DeltaV Tune software was used to make the tuning easier, quicker, and more accurate. Once a quarter, the software can also be used to identify under-performing control loops.

Moisture content now drives the drying process rather than temperature. The operator workstation displays moisture values received from special sensors. If moisture levels rise or fall excessively, the operator manually adjusts the temperature set point accordingly. If moisture content between the two sides of carpet begins to diverge, the operator can adjust temperatures on both sides of the oven to bring the moisture content back in balance.

After the dryer improvements were made, the dye application in the multicolor line was automated where it was switched from a process that maintained constant pressure to one of maintaining constant flow. Before automation of the line, operators manually controlled dye spray pressure according to the carpet style being processed. Unfortunately every operator controlled pressure a little differently, which resulted in variations in color density and dye consumption with every carpet. Even with the same operator, consistency was difficult. Variations in dye consumption were as high as 40%. By automating the dyeing application, variations in dye consumption were reduced 38% to 2%.

BECAUSE THE NEW SYSTEM IS EASY TO CONFIGURE AND MAINTAIN, ENGINEERING TIME WAS REDUCED 80%, FREEING UP DIRECTOR OF ENGINEERING FRANCISCO CAMPA'S TIME FOR NEW QUALITY IMPROVEMENT PROJECTS.

The large amount of trend information collected by the new plant-floor system enables ColorWorks to analyze temperature profiles, line speeds, and chemical application. OSI PI from OSIsoft, San Leandro, Calif., and Microsoft Access databases collect the data for later analysis. PI is a data collection and presentation package for process industries, and is a major component of enterprise systems. Access and Microsoft SQL 2000 are used to record and classify formula, quality, and production data. The company also uses Excel for analysis.

Information from the system is extremely valuable for process improvements. "We can now operate the dryer at higher temperatures without overheating the product because the automation is precise and the operator has more and better information for making decisions," Campa points out. "This enables us to increase line speed and consume less gas."

Information in the Access database resolved the issue of formula control and batch makeup inconsistencies. The color kitchen can now accurately determine how much dye to formulate for each lot, eliminating the need to formulate batches according to excessive worst-case consumption.

The system makes it possible for operators to see where they are in the dyeing process in realtime and make adjustments accordingly. They execute procedures based on standardized instructions, rather than experience. Pressure has moved from the plant floor to middle management who was responsible for ensuring data accuracy. Morale has improved significantly.

"Standardization makes it easier for plant personnel to do their jobs. There is no hesitation, doubts, or unknowns when operating equipment. Everyone knows what to do and how to do it; it is a documented process," says Myers.

Myers and Campa go on to say the systems the company has invested in are already returning dividends. Not only in terms of dollars, but the workers are now better equipped to do what they need to do, which in the end means better productivity and savings.

"People are the most important part of the process. When they have the information they need, they feel empowered to do their job. By developing people and processes, we've saved millions."
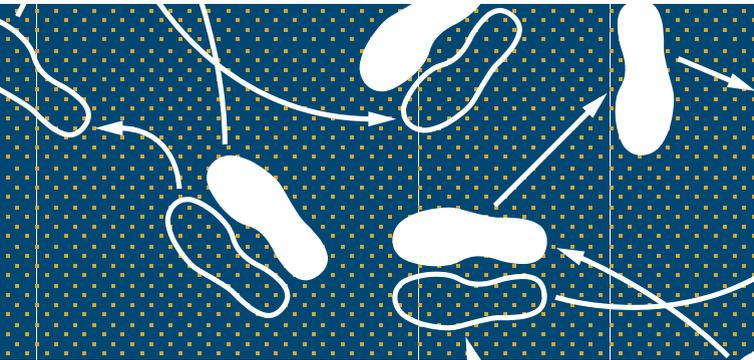
Adds Myers, "The cost savings as a result of the quality improvement project are reflected in our bottomline. We have more funds for further improvements and capital investment. The success of this project opened a whole new approach to improvements and investment. It allowed us to reinvest benefits to continuously improve the operation."

Within the first year of implementing the project, the information system more than paid for itself. The reduction of chemical and dye usage and rework saved the company nearly $1.4 million in 2000. The reduction of carpet waste alone saves the company more than $55,000 a year. A 20% gain in line speed resulted in $1 million per year in gained capacity. In addition, ColorWorks reduced scrap, rework, and outsourcing costs by 90% each month. Side-to-side color variation decreased by 94% and lot-to-lot color variation decreased by 96%.

Tighter controls and equipment modifications enabled Carriage Carpet to handle a wider range of carpet specifications. As a result, outsourcing dropped from as much as 30% to less than 3%. This allowed the company to save $50,000 per month in outside dyeing costs.

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Because the system is easy to configure and maintain, engineering time was reduced 80%, freeing up Campa's time to embark on new quality improvement projects. Currently, a second Windows 2000 network is being set up that will enable ColorWorks' staff to plan production, research formulas and equipment settings, and collect quality and process data to be used for further process improvements. All this information will be centralized on a Microsoft SQL 2000 server database that will receive and broadcast data via Internet Explorer.

As with previous quality projects everyone in the company, including management, is involved every step of the way. Campa credits the success of ColorWorks quality improvement projects to the teamwork shown by the ColorWorks management and plant operators. "They are open to new processes and not afraid to contribute ideas. Everyone embraces change. These are the qualities that make it possible to build a great team."

"Everyone was included and involved in the project, which allowed for better understanding and buy-in. This helped to eliminate the fear that can come with change," adds Myers.

The success at Carriage Carpet has helped the Dixie Group grow to become the fourth largest carpet maker in the United States. "Even with the economy down and sales slow, we are still working efficiently and have grown," says Campa with pride. "We are able to achieve way more with less capital equipment than our competitors. We are able to make efficient use of technology and resources. We can make changes in minutes rather than hours. We also have lower inventories."

"When a roll of carpet arrives at ColorWorks it is white, like a blank canvas. When it leaves here, it has color. We get to see the finished product on the dance floor, and almost everything we produce these days looks great. That is fun," declares Campa. •