ARC Client Case History

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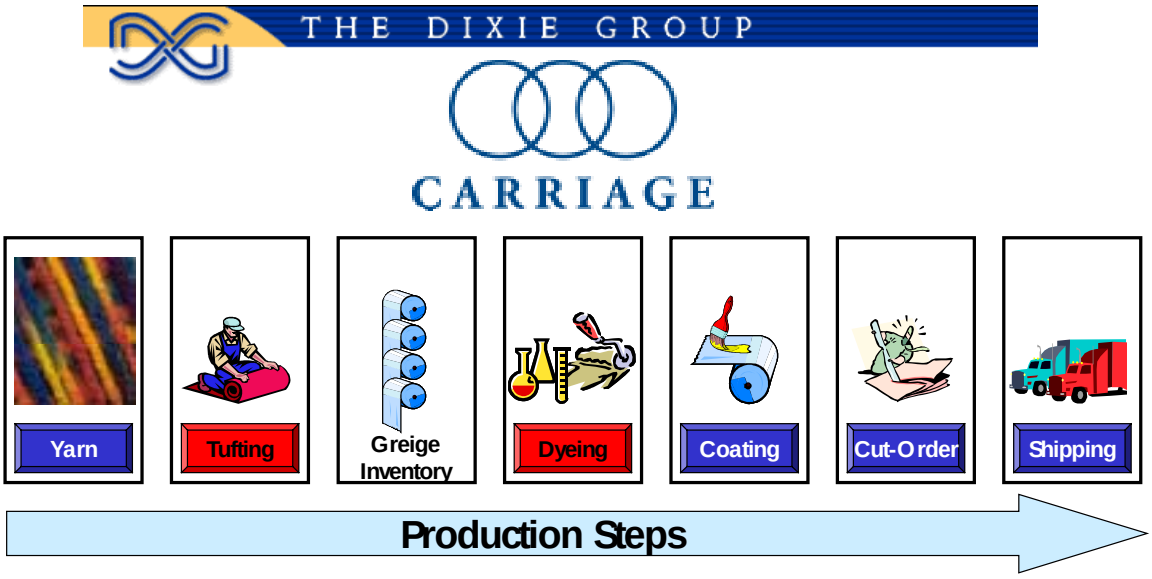
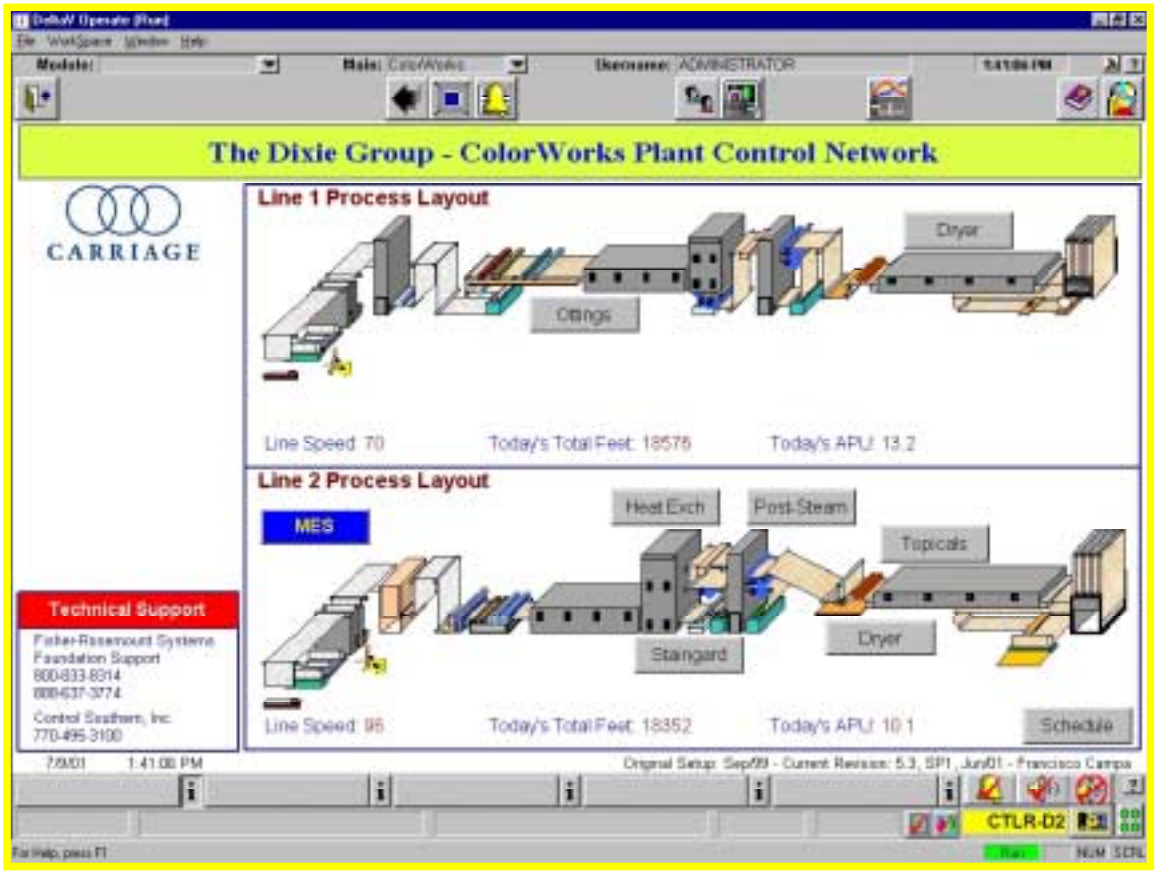
Carriage Carpets: Payback In 4 Months!



The ColorWorks Dyeing Operation is a Critical Step In Manufacturing



DeltaV Controls Both Lines At ColorWorks

Carriage Carpets' Challenges

The Dixie Group is the fourth largest carpet maker in the U.S. The Carriage Carpets division, located in Calhoun, Georgia, has had a lot to do with the group's recent success, despite the overall down turn in the carpet industry over the last several years. Gains in productivity at Carriage Carpets over the last couple of years have been due in large part to their implementation of a DeltaV™ system from Emerson Process Management. The DeltaV system is a key part of Emerson's PlantWeb® architecture.

Part of Carriage Carpets' business success is its ability to take orders for a wide variety of carpet styles. This business flexibility translates into the operational problems of managing 20 different carpet styles a day, each type with a different weight, color, width and protective treatment. The processes that were in place, both equipment-based and people-based, were not designed to handle this level of flexibility.

Opportunity at the Dyeing Facility

Carriage Carpets has three main processes: Tufting, Dyeing and Finishing. Tufting has no control layer, although PLCs are used to indicate whether the tufting machines are running or shut down. At the end of 1999, Finishing and Dyeing had panel-mounted controllers and PLCs that came with the OEM machines. The comparative complexity and variability of the Dyeing process made it the logical choice for improvement. The search for solutions began in 1999.

Most of the products from two other facilities were consolidated into ColorWorks. Despite the consolidation the lines at the ColorWorks facility were still not flexible. About 20 to 30 percent of their production was outsourced for a variety of reasons. For example, if the color requirement was too deep or the carpet order exceeded their range of 10 to 30 ounces then these orders were outsourced to contract manufacturers.

The two main problems at the Dyeing facility were damaged carpet and uneven color application. In 1999, damaged carpets from one of the dryers represented over $63,000 of waste. Management recognized that a Quality Improvement project needed to be launched.

Goals, Objectives and Justification

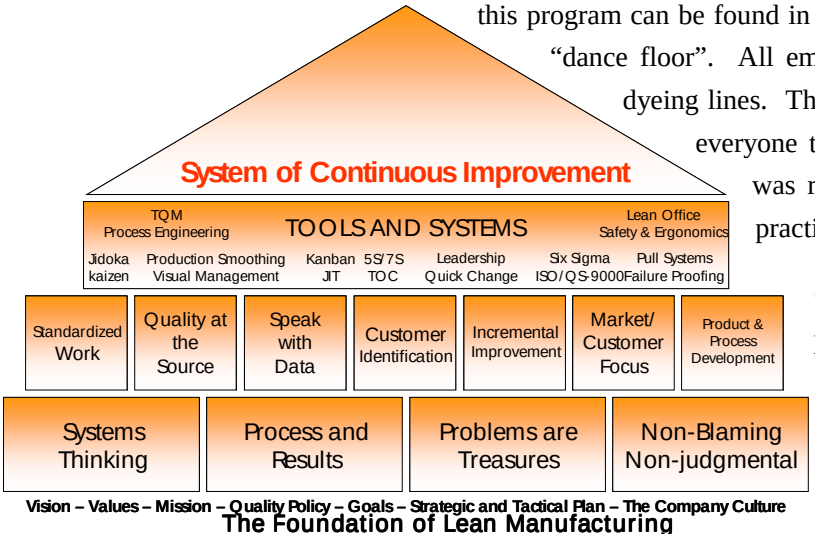
The initial justification for the Quality Improvement project had an expected payback of one year based on three primary improvements: elimination of 50 percent of the water-damaged carpets, elimination of 25 percent of the uneven dyeing, and elimination of 100 percent of the carpet reprocessing. None of the justification or the realized benefits was based on eliminating people.

Company Motto:
"Lead, Win and have Fun"

The justification to purchase of the DeltaV system was not based on tighter controls, but was intended to develop standards for operations to create repeatability. Even without on-line data, differences could be seen from shift to shift. The desire was to be able to repeat what the best operators did all the time.

Quality Control

As part of the overall objective to change the way the company operated, Carriage Carpets instituted a "Lean Manufacturing" quality program in 1998. One aspect of this program can be found in an area of the ColorWorks factory called the "dance floor". All employees pass this floor on the way into the dyeing lines. They put all reject or damaged product here for everyone to see. When the program began, this floor was regularly filled with bad product. Now it is practically empty all the time.



The goal of Carriage Carpet's Lean Manufacturing program is reducing cost by the elimination of waste and reduction of variability. It soon became apparent that to do this required visibility of problems as they happen. "Speak with Data", one of their underlying Lean Manufacturing concepts, was noticeably absent in 1998 when they began. The solution had to include real-time access to production data beyond the production floor. This is where the DeltaV system was a big help.

Color Works' Process

ColorWorks has two continuous dyeing ranges. Line #1 is for multicolor carpets. Prior to the improvements it was the biggest waste maker, typically running light

stock for manufactured housing market. Line #2 is for solid colors and patterns and runs continuously, 24 hours a day. Both lines have dyed over 1 million square yards in one week at their peak.

Line #1 is a batch process with each carpet run's dye being mixed in the "Color Kitchen" to a prescribed recipe. Excess dye after a run was a typical source for waste and error. Although industry standards allow color variations from lot to lot, sometimes the dye could not be remixed or saved.

Number 2 Line is the Number 1 Moneymaker

Rolls arriving from Tufting are about 500 feet long. The accumulator mechanism called a "J Box" provides the operator with about ten minutes to manually sew new roll to the trailing edge of the carpet in the machine, since stopping the line would be impossible.

Loose fibers and oils are removed prior to dye application. The dyeing machine from the German manufacturer Kusters is designed to switch colors quickly based on a command from the MES system directly to an embedded PLC. Although the dye switchover is very fast, when going from dark to light colors, a "header" is typically sewn between the rolls to avoid color transitions on the product. The header is actually reject carpet. Thanks to the success of the project, header material is in short supply.

The steamer section boils most of the water off allowing the dye to adhere to the fibers. The vacuum section then removes any excess water. With the dye fixed and the carpet at the correct moisture content, the correct chemical treatment such as Dupont's Stainmaster or 3M's Scotchgard can be applied. At this point automation plays a critical role in fine prevention by ensuring only clear water goes to the drain.

Finally, the seven-zone dryer must be able to remove the remaining moisture without burning the carpet. The transition of a new carpet into the first zone is extremely critical. Do it wrong and the trailing or leading edges of the carpets will be damaged. A control system that can handle this abrupt transition is critical to the Quality Improvement program.

DeltaV: "Speaking with Data"

Prior to joining Carriage Carpets, project leader Francisco Campa worked for Lear Corporation and John Deere. The process of making carpets was new to him. He

brought with him the experience and knowledge of how a Just-In-Time manufacturing process works.

He was given a lot of freedom in selecting the technology for the project. Of course, his budget was limited and his "team" consisted of one person – just him. This meant that what ever he selected had to be easily configured to do the job right out of the box.

Having familiarity with personal computers and PLCs made these technologies the obvious first choice. A preliminary selection of a PC-based software package had already been made when Francisco first heard about the DeltaV system. Once he talked to Emerson and reviewed a demonstration of a DeltaV system he was convinced that going with an integrated field device, control and communications approach was the answer.

Out of The Box Implementation

Francisco Campa is a mechanical and electrical engineer by training. He would be the first to admit that he was only slightly exposed to control theory in college. He found that all the practical knowledge needed to develop the DeltaV applications came from just one week of training at Austin, Texas. This allowed him to literally configure the system in his office.

The first control was commissioned in December 1999. For the initial settings, controller tuning settings from the old controllers were simply entered into their equivalent DeltaV loops. The first benefit of the DeltaV system was realized very early in the form of data visibility. This allowed both operations and management to "speak with data". For the first time they could actually see where they were in real-time.

Debugging applications occurred in early 2000. Once they could see what was going on, it was determined that sensors needed to be relocated to be effective. By summer of 2000, 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 DeltaV Inspect is run to identify under-performing control loops.

Foundation Fieldbus

The PlantWeb architecture provided Carriage Carpets additional information to

improve their process using FOUNDATION fieldbus technology. Each line has a DeltaV controller. Each controller has a single H1 Fieldbus card that supports two segments. This was used on both dryers to gather measurements from RTD temperature transmitters. The decision to use Fieldbus was primarily driven by the installation savings. Since Fieldbus was a single pair of wires it could be easily brought across the dryers and still meet code requirements. If conventional methods were used, it would have required installing conduit and pulling multiple wires – a time consuming and more expensive solution.

The 14 RTDs, two for each heater zone are on one of the H1 segments. The other H1 segment is used to connect a DVC (digital valve control), two additional temperature transmitters and two Emerson/MicroMotion flow transmitters. Although multiple measurements are available from the Coriolis transmitters, only volumetric flow is used for control. Occasionally, the density measurement is used by engineering.

The DVC has a PID capability that was successfully used at first. Currently, this feature is not used, since there is more than enough capacity for control in the DeltaV controller. This provides a sense of consolidation by having all the control in the same controller. Additionally, the DeltaV fuzzy logic control is not available in the DVC.

MES and DeltaV Interaction

MES functions such as defining the next carpet order to process, appears on the DeltaV screen as information for the operator to enter into the DeltaV system. This fulfills the objective of "standardizing" the method of operation as well as providing excellent visibility of the operation. When an operator overrides a target or setting provided by the MES, it is logged into the MES. Even defects that are detected at the end of the carpet line are logged into the MES system.

Architecture

The MES system is a recent addition to the overall automation architecture. A contractor is building the MES application on Microsoft SQL Server database based on Carriage Carpets' requirements. The programming of the MES system began in March 2001. The DeltaV server acts as an OPC server to exchange DeltaV/PI (process information system) and tag data with the MES SQL database. They have cleverly utilized the peer web services feature available in the DeltaV system to enable web pages generated in the MES server to be viewed within DeltaV screens.

The MES system stores all information such as run history, standards, and color keys for both dye lines. If detailed process information is needed, then the MES fetches data from the PI database using DeltaV/OPC Server.

Each forklift truck is equipped with a wireless system that provides instruction to the operator as to where to find the next carpet roll for dyeing. The bins have bar code tags, which are scanned directly into the MES system when rolls are received from tufting so the roll can be easily located.

The MES SQL server also acts as a gateway to the AS400 business system applications. Dixie Group is in the process of migrating to SAP to replace the in-house developed AS400 business applications.

Return On Investment

The initial investment in the DeltaV system and PlantWeb architecture was enough to sustain nearly two years of continued improvements. Although management gave the go-ahead for the project based on the projected one-year payback, they were actually sold on the increased visibility that the PlantWeb architecture would give them. This expected visibility into the performance of the factory was realized early on. It led to a payback in 4 months and benefits that far exceeded the standardizing of the processes.

Reprocessing Eliminated

Prior to the commissioning of the DeltaV system, at least one roll every day had to be reprocessed due to a variety of issues such as not enough chemicals applied. This resulted in about 14.6 hours per month lost production or $163,000 per year. This lost production has been totally eliminated.

DeltaV and PlantWeb gave them payback in 4 months and benefits that far exceeded the standardizing of the processes.

Line Speed Increase

A 20 percent gain in line speed resulted in $1,000,000 per year in gained capacity. Mechanical changes were made to the line as a result of gaining confidence in the ability to keep the line in control at higher speeds.

Handling Wider Variety Means Less Outsourced Manufacturing

The original dyeing lines were designed to handle up to a 30-ounce carpet. At the redesigned maximum of 70 ounces wet rolls are about 12,000 pounds. So not only

did the controls on the dryers have to be more precise, but also the equipment had to be able to pull it through the entire process.

With these improvements to control and equipment the contract manufacturing dropped from as much as 30 percent to less than 3 percent. This 90 percent reduction created a $50,000 savings per month in outside dyeing costs.

Reduced Chemical Waste and Usage

Before the DeltaV system was commissioned, the Dyeing process was losing thousands of dollars per month due to lack of formula control and batch preparation procedures. Since there was no way to know exactly the amount of dye or chemicals needed, often the carpets left the dryers wet with un-bonded dye or excess chemicals that was dumped to the sewer. The town was regularly assessing Carriage Carpets with fines.

Chemicals for carpet treatment such as Stainmaster or Scotchgard as well as the carpet dyes are very expensive. With every operator having to go by experience rather than measurements, the carpets were often over treated or under treated. Now those costs have been eliminated. Chemicals and dyes usage have been further reduced; all of this translating in an actual savings of $1,388,000 in the first year of full operation.

Description	Improvement
Dye Spots Defects	70 percent
Dye Streaks Defects	45 percent
Off Shade	38 percent
Uneven Dye Application	54 percent
Carpet Face Scorch	90 percent
Lot-to-Lot Variation	94 percent
Reprocessing	100 percent
Side-to-Side Temperature Variations	94 percent
Drying Capacity	20 percent

Reducing Waste Carpet

The 23,855 square yards of damaged carpets in 1999 was reduced to 19,000 square yards in 2000. A dramatic reduction to only 3,000 square yards is the forecast for 2001. At $2.65 per square yard this represents $55,265 in annual savings.

More Benefits Ahead

The ColorWorks' dyeing facility Quality Improvement project benefits have far exceeded the original expectations. The DeltaV system is performing well and has provided a platform for new, unforeseen benefits. Visibility was high on the list of initial objectives and now, by using standard features in the system, standard commercial off the shelf technology (COTS) can easily be deployed. For example, an iPAQ handheld PDA has been connected through a standard wireless connector that adds a mobility dimension to the visibility of operational data.

Delivery of an additional DeltaV system to the Finishing process is scheduled for early December 2001. The Finishing process, among other things, puts latex froth onto the dyed carpet for backing. Commissioning will be done in December and January. With continued confidence in ease of implementation, the task of configuring control application has been given to Finishing's maintenance manager. It will replace another supplier's standalone controller.

Scheduling has become the new challenge

Carriage Carpets has about 1,200 product changes per month passing through the dyeing facility. This is more than any other carpet manufacturer in the industry. The changes are for colors, widths and weight and typically take about 7 minutes. During this transition time, there is the largest window of opportunity for problems to arise. Dramatic color or weight changes cause the most problems for the process.

Now that visibility is available all the way up to the people doing the order planning, additional waste can be removed by proper scheduling. For example, scheduling can now be based on color key to avoid "dark to light" carpet transitions, which are most wasteful in terms of defects and time. Dramatic weight changes from one roll to the next can also be avoided by optimal scheduling.

The DeltaV system and PlantWeb architecture have provided the essential structure for a consistent dyeing operation. The foundation is laid for the MES system and the DeltaV system to work together flawlessly. By "speaking with data" and always being in control, Carriage Carpets can fulfill their motto - "Lead, Win and Have Fun".

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Acronym Reference: For a complete list of industry acronyms, refer to our web page at www.arcweb.com/arcweb/Community/terms/indterms.htm

AI	Artificial Intelligence
ANSI	American National Standards Institute
API	Application Program Interface
APS	Advanced Planning & Scheduling
B2B	Business-to-Business
B2C	Business-to-Consumer
BPR	Business Process Reengineering
CAGR	Compound Annual Growth Rate
CAN	Controller Area Network
COTS	Commercial Off The Shelf Technology
CMMS	Computerized Maintenance Management System
CNC	Computer Numeric Control
CPG	Consumer Packaged Goods
CPM	Collaborative Production Management
CRM	Customer Relationship Management
EAM	Enterprise Asset Management
EPM	Emerson Process Management
ERP	Enterprise Resource Planning
FF	Foundation Fieldbus
HMI	Human Machine Interface
IT	Information Technology
LAN	Local Area Network
MES	Manufacturing Execution System
MRP	Materials Resource Planning
OLE	Object Linking & Embedding
OPC	OLE for Process Control
PAS	Process Automation System
PDA	Personal Data Assistant
PID	Proportional Integral Derivative
PIMS	Process Information Management System
PLC	Programmable Logic Controller
ROI	Return on Investment
SPC	Statistical Process Control
TMS	Transportation Management System
WAH	Web Application Hosting
WMS	Warehouse Management System

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