Ford Team Uses Six Sigma to Reduce Costs While Improving Environmental Impact

by Janet Jacobsen

At a Glance . . .

- Performance metrics signaled increases in basecoat paint consumption at Ford's vehicle operations center in Saarlouis, Germany.
- A cross-functional Six Sigma team was chartered to solve the problem using a DMAIC approach.
- Using a variety of quality tools, the team identified root causes before developing and testing potential solutions.
- By reducing paint expenditures, the team achieved a $2 million annual savings.
- Ford entered this project in ASQ's 2011 International Team Excellence Award competition where it earned finalist honors.

Ford Motor Co.'s consumer-driven Six Sigma strategy involves regular analysis of scorecard metrics to detect performance trends. In the fall of 2009, during a routine metrics review, officials at the organization's Saarlouis, Germany, plant discovered an escalation in basecoat paint consumption. Not only was the upsurge driving production costs higher, but it also pointed toward increased solvent consumption, which in turn led to higher levels of volatile organic compound (VOC) emissions. A Six Sigma team addressed both cost and environmental issues and, at the same time, uncovered an unexpected solution that surprisingly led to a shift from a robotic to a manual process.

About Ford Motor Company

The Ford Motor Co., founded in 1903, designs, develops, manufactures, and services cars and trucks across six continents under the Ford and Lincoln brand names. The company also provides services and products in the areas of maintenance, collision, vehicle accessories, and extended service warranties under the Genuine Ford Parts, Ford Custom Accessories, and Motorcraft brand names. The organization, headquartered in Dearborn, MI, employs more than 166,000 people and operates 70 plants worldwide.

One of the organization's overseas sites is the vehicle operations center in Saarlouis, Germany. This facility, located in the southwestern region of the country, is the single-source plant for the 2011 Ford Focus in Europe, as well as a European model called the Kuga. The plant employs 6,500 people and produces 1,850 cars daily in three shifts.

Identifying Opportunities for Improvement

Ford's balanced scorecard system provides reporting tools that offer monthly values versus target figures, year-to-date/year-end values against target, and a prioritization system using red/green/yellow evaluations to pinpoint where improvement is needed. Using this evaluation system, the automaker classifies data as:

- **Green:** measures are on or over target.
- **Yellow:** metrics are under target, but better than last year.
- **Red:** results are under target.

In the fall of 2009, data for body paint consumption for the Focus and Kuga were classified as red, thus capturing the attention of plant officials. A quick review of historical data showed basecoat paint consumption stood at 3.74 kg/unit in 2007, while current consumption was 4.18 kg/unit.

When improvement opportunities like this are discovered, the organization typically turns to problem-resolution tools such as Six Sigma, if the following questions regarding the project result in affirmative answers:

- Does the project have recurring events?
- Is the scope of the project narrow?
- Do metrics exist? Can measurements be established in an appropriate amount of time?
- Do you have control of the processes?
- Does the project improve customer satisfaction?

Based on the affirmative answers, Ford officials selected this improvement opportunity as a Six Sigma Black Belt project, offering an ideal fit with the *One Ford* strategy that focuses on "working together effectively as one team."

Using the DMAIC Model to Improve Quality

The project began in October 2009 with team member selection. Of the plant's 7,000 employees, more than 50 are Six Sigma Black Belts and another 400 are trained as Green Belts, thus providing a pool of qualified team members to assist with the project. Team leader and Six Sigma Black Belt Martin Fischer based his selections on a candidate's responsibilities, subject-matter expertise and process ownership, and on relative need throughout project development, planning, implementation, and follow up. Other factors included communication skills and the candidate's ability to interact in a team-based structure. The 12 team members are listed in Table 1.

Define

Applying the define, measure, analyze, improve, and control (DMAIC) approach, the team began by defining project stakeholders using a suppliers, inputs, process, outputs, customers (SIPOC) analysis. This analysis led to three groups—internal, external, and a mixed group that contained both internal and external customers. The mixed group included not only customers who purchase the cars, but also internal customers such as the process owners, in this case the paint shop and the quality control group.

The goals of the project were threefold:

1. **Reduce costs:** Reduce paint consumption to lower production costs.
2. **Improve customer satisfaction:** Improve process capability to better meet customer needs.
3. **Lower environmental impact:** Reduce solvent consumption to achieve a better VOC balance.

Every Six Sigma Black Belt project at Ford starts with a standard project charter, which includes an evaluation rating on the estimated impact of the project's targets. The team predicted the degree of impact for each goal by measuring anticipated benefits against organizational goals and measures. They determined:

- The degree of impact for cost reduction was high, as $1.5 million could be saved annually.
- Customer satisfaction impact was medium with a target of 127.000 ppm (defective parts per million) reduction.
- Environmental impacts were also medium with a projected 50.000 kg annually in VOC savings.

***Table 1**—Team members and their roles in the project*

Team	Function	Team Role	Task and Involvement
M. Fischer	Engineer	Black Belt	Lead the project Data plan Tools and methods
A. Eisele	Master Black Belt	Master Black Belt	Input of experience Coaching by tools and methods
R. Höfner	Area manager	Project champion	Provide resources for project
R. Schmitt	Maintenance	Process owner	Provide resources for project
H. Nagel	Engineer	Production, subject-matter expert	Test trials from production side
W. Kretschmer	Engineer	Engineering, subject-matter expert	Consumption recording Research for automatic equipment
S. Schmidt	Foreman	Maintenance, subject-matter expert	Test trials and research
J. Buchholz	Foreman	Maintenance, subject-matter expert	Test trials and research
F. Scholtes	Foreman	Maintenance, subject-matter expert	Test trials and research
U. Michelbach	Foreman	Maintenance, subject-matter expert	Test trials and research
S. Bronder	Financial analyst	Financial analyst	Cost-benefit analysis
J. Pink	Superintendent (responsible manager) supplier	Product expert	Test trials Material properties

Table 2—Tools used in the measure phase

	Value-Stream Mapping	Brainstorming	Cause-and-Effect Diagrams	Statistical Data	Trend Analysis
How	Visualize the paint flow and application equipment	Free flow of ideas	Display all potential causes from the brainstorming	Collect data and analyze	Review consumption data to discover past events
Who	Customer Production Maintenance	All stakeholders	All stakeholders	Maintenance Buyer/controller Production	Supplier Final inspection Production
Why	To understand streamlining work processes using tools of lean manufacturing	To help a group create as many ideas as quickly as possible	To help the group consider all possible causes of the problem	To collect data and select appropriate analysis tools	To display historical data to determine the many attributes

Measure

Several tools were used early in the measurement phase, as listed in Table 2. For example, value-stream mapping served as a visual tool to help the team understand the flow of material and the paint application process. Statistical measures helped them filter, evaluate, and obtain strong data for the project. Cause-and-effect diagrams were useful for identifying the root causes of consumption and performance issues, and brainstorming sessions were used to rate all potential causes.

The next step was creating a data collection plan to help narrow the list of potential root causes by focusing on the following factors or critical Xs:

1. *Daily basecoat consumption.* Is there any dependency based on day or shift?
2. *Paint film thickness check.* Is there an increase, and if so, why?
3. *Consumption per robot (automated painter).* Are there differences, and if so, why?
4. *Consumption per manual painter.* Monitor consumption to check the process capability.
5. *First-time through rate versus consumption.* A low rate means more repairs, which translates to higher basecoat use.
6. *Application equipment.* Check for damages or technical problems.

Analyze

The Six Sigma team conducted a 5 Why analysis, as well as test trials on the six potential root causes. The results showed that factors one, two, four, and five were not significant. Factor three, consumption per robot, showed an increase for the liftgate robot. Through testing of factor six—application equipment—the team discovered a damaged solvent recovery valve that warranted further investigation. Additional testing uncovered that a defective solvent recovery valve was causing a direct paint flow from the color changer to the recycling tank, thus increasing consumption. Normally, the solvent recovery valve opens only for the cleaning program to bring the cleaning solvent back to a recycling tank.

Improve

The team used a variety of tools to develop solutions/improvement actions to address the two likely root causes. Value-stream mapping and benchmarking activities proved useful in the search for a manual solution to monitor the valve. On the other hand, while zeroing in on the robot issue, the team reviewed the value-stream map and discovered they could change the automatic process to a manual one for painting the liftgates. Also, through research and discussions with suppliers, they realized the plant could apply paint more efficiently by upgrading to an electrostatic paint application process.

When selecting final solutions, the team was cognizant of the overall project goals—improved customer satisfaction, reduced costs, and decreased VOCs.

Based on the outcome of the analyze phase, four potential improvement actions were identified for the defective solvent recovery valve factor:

1. Replace plastic valves with stainless steel valves.
2. Create an automatic recovery valve check system.
3. Check the valves weekly.
4. Eliminate the solvent recovery process.

The team used four primary methods to select the final improvement actions: test trials to evaluate stainless steel valves against plastic valves, technical research to develop an automatic recovery valve check system, brainstorming and value-stream mapping to determine the effectiveness of a weekly valve check, and the elimination of the solvent recovery process.

One of the test trials involved comparing the durability of the plastic versus stainless steel valves in the solvent recovery process. The test revealed a 48 percent higher mean durability by switching to a stainless steel valve. During a brainstorming event, analyzing the value-stream map of the critical areas of the process led to a decision to change the critical valves before the defect possibility rate reached 5 percent. Then with a durability test run, the team determined how long it would take to reach the 5 percent rate.

The test results revealed that a quick, inexpensive change from plastic to stainless steel valves would result in a 45 percent performance improvement. Testing also demonstrated that an automatic recovery valve check system would be cost effective and could offer an effective error-proofing device. The other two solutions were rejected because conducting weekly valve checks was too costly, and eliminating the solvent recovery process was not in line with the organization's environmental standards.

For the liftgate robot factor, three potential solutions were identified:

1. Develop a new cleaning program.
2. Change the robot process to a manual paint application.
3. Upgrade to an electrostatic paint application.

Testing focused on improving the existing cleaning program and then comparing the consumption data from the robot process to a manual process. The team also created a cost-benefit analysis for an upgrade to an electrostatic paint application. Tests showed there was no significant difference between the old and the new cleaning program. But, by simply changing to manual-only painting processes for interior painting, it was estimated that Ford could save 0.28 kg/unit. Finally, the team also determined that upgrading to an electrostatic paint application system would not be cost effective.

Once the solutions were finalized, the team created a three-step implementation plan that included the following steps:

- **Think:** Plan all necessary implementation activities.
- **Act:** Implement the solutions.
- **Control:** Check if solutions were correctly implemented.

Yet another critical element in the project was overcoming stakeholder resistance to the solutions. This was accomplished through effective relationship building as well as providing data, training, and opportunities to discuss the project solutions.

Reducing Consumption, Improving Satisfaction

Once the solutions were implemented, the team achieved every project goal and even exceeded the expected cost reduction by a half million dollars annually, as shown in Table 3. More specifically, in meeting these goals, the basecoat paint consumption dropped from 4.18 kg/unit to a mean consumption of 3.3 kg/unit.

***Table 3**—The team exceeded all project goals*

Goal	Target	Result
Reduce costs	$1.5 million annually	$2 million annually
Improve customer satisfaction	127.000 ppm reduction	129.000 ppm reduction
Reduce environmental impact	Lower VOCs by 50.000 kg annually	VOCs reduced 70.000 kg annually

Albert Eisele, Six Sigma Master Black Belt for the project, attributes the team's success to using Six Sigma methods, such as the DMAIC approach, as well as great teamwork.

In addition to the tangible benefits, the project also delivered impressive intangibles, including the implementation of a monitoring system that provides a full overview of processes and improved morale among maintenance workers because of job enrichment.

Control

The new monitoring system and standard operating procedures are vital to helping the Saarlouis plant sustain the results gained in this project. This system provides a real-time view of paint consumption in detail for each of the four paint booths. All of the plant's standard operating procedures are part of the plant's ISO 9001 compliant quality management system and are therefore included in routine audits. This helps assure that paint consumption will remain within specifications.

Sharing Lessons Learned

Because of the project's results, Ford's global Six Sigma organization nominated the team to compete in ASQ's International Team Excellence Awards (ITEA) process. The project earned finalist honors, and team members had the opportunity to present their project at the 2011 World Conference on Quality and Improvement.

Eisele says this project was a strong candidate for the competition because it was a cross-functional team that included members from production, maintenance, quality, manufacturing engineering, and the supplier: "They worked together as a team in an excellent way, proving the power of a team and the sum of competencies in a team."

For More Information

- To learn more about this project, contact Albert Eisele at aeisele@ford.com or Martin Fischer at mfisch31@ford.com.
- Complete details on ASQ's ITEA process are available at http://wcqi.asq.org/team-competition/.
- Visit http://asq.org/2011/09/design-of-experiments/ford-team-project-builds-relationships.html to read a case study from another Ford team that qualified as a finalist in the 2011 ITEA process.

About the Author

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