Automobile Manufacturing

The following is a problem that occurred at an automobile manufacturing company. You are hired as a consultant to help solve this problem.

For this exercise

1. Identify possible causes. From experience, what could have caused this deviation from what has worked before to what is currently happening?

2. Evaluate possible causes. How will we evaluate the possible causes proposed? Which possible cause best fits the known facts. Which possible cause has the fewest, simplest and most reasonable assumptions?

3. Confirm the true cause. What can we do to verify any assumptions made. How can this cause be observed at work? How can we demonstrate the cause-and-effect relationship? When corrective action is taken, how will results be checked?

A valued new customer received one of your EX25 automobiles one week late. Because the equipment was late, the customer missed some key pilot tests in an important project. Unfortunately, the late delivery was due to your internal production difficulties, which delayed the shipment date a week. This delay is not an isolated incident. Recently, a number of your EX25 customers have experienced delays of from three to nine days. Since many of your customers have guaranteed arrival dates, the consequences of these late deliveries are becoming serious in terms of both cost to your company and damage to its reputation.

The Manufacturing Manager has informed you that the recent production difficulties are no longer just an in-house problem. The excessive number of rejects that you've been experiencing during the last two weeks has begun to result in late delivery of EX25 automobiles. The difficulties are compounded by the fact that you are in the middle of your peak season, which is the time of year when increased demand requires the hiring of new people and the speeding up of production on both lines.

Interview with Manufacturing Manager

Since one of the major features of our automobiles is their durability, they are all encased in painted metal body. His analysis shows that the delivery delays have been due to an excessive number of paint rejects on the body of our EX25 autos. While this lack of paint adhesion does not affect the operation of the automobile, He cannot send out a unit with a substandard paint job. Stripping and repainting the rejected body is more cost-effective than scrapping them. However, this rework takes valuable time and lowers the output of acceptable units. This problem has caused the reject rate to rise from the normal 1.5% to over 6%, and it's still increasing.

The problem couldn't have come at a worse time. Since our customers tend to have similar budgeting cycles, orders for all three of our automobiles tend to peak during the same six-week period each year. We are currently half-way into this peak season. Two weeks before the peak season begins, we bring on new personnel to work with experienced employees on both of our assembly lines. Each week during the peak season, we increase the rate of production on both lines so that all three of your units--the EX25, the EX35 and the EX45--can be produced more quickly to meet the demand. Currently, the EX45 autos are being

produced at a rate of 40 units per hour, the EX35 autos at 70 units per hour, and the EX25 autos at 140 units per hour. The rate is scheduled to be increased again tomorrow.

Most frustrating to him is the fact that we experienced the same problem a year ago. After many days of investigation, we discovered that some employees, including employees who handle the body before painting, were using a silicone hand lotion which could prevent proper paint adhesion. A notice listing the acceptable hand creams was posted in the wash rooms. Within a week, the reject rate returned to normal.

Interview with Industrial Engineering Manager

The rejected units are the body for the EX25 automobiles. The EX35 and EX45 automobiles are experiencing the normal reject rate of 1 .5%. The EX25 reject rate has soared to over 6% and is still rising, due to periodic rejection of body with random gaps in the paint. While the automobile operation is not affected, the units cannot be sent to customers with a lack of uniform paint coverage on the body. The defects have been noticed by the quality control inspectors during their final visual inspection.

Since the rejected bodies are stripped and repainted, there has been no increase in scrap. However, this increase in rejects is beginning to have a significant impact on the number of satisfactory units that are sent to Shipping.

He mentally reviews the production process for the three units: the EX25, the EX35 and the EX45 automobiles. The basic process involves several assembly operations: component testing, body painting and inspection. Supplies of the various parts, such as instrument panels and trim, are kept at the points at which they are assembled in the automobile chassis. The new employees, hired just prior to peak season, work with more experienced assemblers on both lines. This was done to help with their on-job training and to prevent mishandling of the units.

The three autos are very similar in design, engineering and size. The EX35 is somewhat more sophisticated than the EX25. And the EX45 is the most advanced machine. Because more of the EX25 units are sold than the other two models combined, the EX25 is produced on its own assembly line. The EX35 and EX45 autos are produced on the other line. Last week, the output of Line 1 was increased to its current level of 140 units per hour of the EX25 autos, and output of Line 2 was increased to 70 units per hour of the EX35 autos and 40 units per hour of the EX45 autos. These rates have increased weekly during the peak period and will continue to accelerate until the end of the peak season three weeks from now.

Each line has its own supply of subcomponents and two simultaneous operations. While the engine and other components are being assembled, the metal body is going through wash, paint and dry operations. The wash involves a dipping operation in which the bodies are immersed in a cleaning solution that removes the contaminants and oils. The solution is changed every half hour. Because a continuous supply of body is required, each line has two wash tanks: one that being used and a second that is being drained and filled with fresh solution. The tanks on both lines are filled from a common, central supply tank.

After cleaning, the bodies are manually suspended on grounded hooks attached to the two conveyors, one of which is for EX25 body and the other for EX35 and EX45 body. The conveyors, which move at the same speed, take them through the booth in which paint is electro statically applied. After painting, the units enter the drying section.

After drying, the bodies go to the final assembly section of each assembly line and are attached to the rest of the unit. After this final assembly step, the units go to Quality Control and to Shipping.

Yesterday, when he checked the entire manufacturing process, everything was being done according to the standard procedures. However, he wouldn't necessarily have noticed employees who might have been mishandling the units in some minor way.

Interview with Manufacturing Supervisor

The EX25 units are being rejected because of defects in the paint that covers the metal external body. The body has random spots in which the bare metal is visible because the paint has not adhered properly. Since the EX25 is assembled on Line 1, his attention has focused on that line. The other units, the EX35 and EX45, are not experiencing the problem and are assembled on Line 2. The two lines are set up identically. Even though the more sophisticated EX35 and EX45 units involve assembling some different components, the assembly operations are essentially the same. On both lines, the instrument panels and other internal parts are assembled at a series of stations, each of which has its own supply of parts. While this assembly is occurring, the external metal body are washed, painted and dried.

The wash operation involves dipping the body, using a continuous conveyor, into a bath that removes contaminants and oils. The bath solution is changed every half hour. Because a continuous supply of body is needed, each line has two wash tanks, one that is being used and a second that is being drained and filled with fresh solution. The tanks on both lines are filled from a common, central supply tank.

The body are manually removed from the wash tank conveyor, carried the short distance to the painting area and hung on hooks suspended from one of the two moving conveyors. One of the conveyors carries EX25 body and the other carries EX35 and EX45 body. As both conveyors move at equal speeds through the walled booth, the electrostatic paint is applied to the grounded body by spray nozzles located on the sides, top and bottom. The paint is mixed in small batches in a "homogenizer" next to the paint booth to control its quality and consistency. The homogenizer must be cleaned after each batch to avoid contaminating the paint. After painting, the units enter the drying section where they are exposed to a fast, thorough heat-drying process.

After drying, the body goes to the final assembly section of each line to be attached to the rest of the unit. After this final assembly step, the units go to Quality control and from there to either the rework or shipping sections.

Five weeks ago, as part of the annual peak season preparation, we hired additional personnel to work in all areas of the assembly operation. To ensure effective on-the-job training, each of these inexperienced employees is paired with an experienced worker.

His frustration with the body paint deficiency is compounded by the fact that he experienced the same problem a year ago. After many days of investigation, he discovered that some employees were using a silicone hand lotion which could prevent proper paint adhesion. A notice listing the acceptable hand creams was posted in the washrooms. Within a week, the reject rate returned to normal.

Since the problem started two weeks ago, he has increased his time on the floor. He had not noticed any employees doing anything wrong. He can't help but recall that he warned everyone about a month ago that increasing the production rate can lead to all kinds of trouble.

Interview with Quality Control Supervisor

The automobiles come to his section after they have been completely assembled. The internal components have been attached to the chassis and hooked up, and the body have been washed, painted, dried and attached to the rest of the unit. While some component testing occurs during the assembly operation, the final testing is done in Quality Control. His section includes three inspection/test operations: electronic, operational and visual. Working in each of these three areas are quality control specialists who are qualified to test and evaluate all three of the automobiles, the EX25 units that are assembled on Line 1 and the EX35 and EX45 units that are assembled on Line 2.

The 4.5% increase in rejects of EX25 autos is due to periodic paint defects on the surface of the body. While these defects do not affect automobile operation, the standards require him to reject any unit in which the paint on the body does not uniformly cover the metal. During the last two weeks, his visual inspectors have rejected a significant number of the autos because of gaps in paint coverage that appear randomly on the surface of the body. The paint rejects solely are among the EX25 autos; the EX35 and EX45 units have not experienced an abnormal number of rejects.

When a unit fails to pass any of the inspections, it is sent to the rework area. Because of the disproportionate number of paint rejects, the rework group on Line 1 is dedicated almost exclusively to disassembly and paint stripping. While nearly all rejects can be converted into acceptable units, the rate of satisfactory units reaching the shipping area is not sufficient to meet promised customer delivery dates.

He has asked his inspectors to keep an eye out for anything irregular. So far, they have not reported anything back. However, a number of them believe that employees may be using inappropriate hand cream again.

AUTOMOBILE MANUFACTURING FLOW