

Problem Solving Exercise: Auto Manufacturing Case

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

For this exercise:

- 1. Produce a problem statement.** What is the problem you are solving?
- 2. Identify possible causes.** Based on the information provided, what might have caused this problem?
- 3. Evaluate possible causes.** Which of your proposed causes best fits the known facts and relies on the fewest assumptions? Why?
- 4. Confirm the true cause.** How can the cause be observed in action? What can we do to verify any assumptions that have been made? How can we demonstrate the cause-effect relationship? When corrective action is taken, how will results be checked?

The automobile company you have been hired to work for produces three automobile models: The EX25, the EX35 and the EX45. A valued new customer recently received one of the company's EX25 automobiles one week late. Because the equipment was late, the customer missed some key pilot tests for an important project.

Unfortunately, the late delivery was due to internal production difficulties, which delayed the shipment by a week. This delay is not an isolated incident. Recently, a number of EX25 customers have experienced delivery delays ranging from three to nine days. Since many customers have guaranteed arrival dates that are not being met, these late deliveries are costly and damaging to the company's reputation. The difficulties are compounded by the fact that it is currently the peak production season, which is the time of year when increased demand requires the hiring of new workers to support increased production.

Information from Manufacturing Manager

As durability is one of the main features of the company's automobiles, each is encased in a painted metal body. The manufacturing manager's analysis shows that the delivery delays have been due to an excessive number of paint rejects on the bodies of the EX25 autos. The reject rate has risen from the normal 1.5% to over 6%, and it's still increasing.

While lack of paint adhesion does not affect automobile operation, units with a substandard paint job cannot be distributed. Stripping and repainting the rejected bodies is more cost-effective than scrapping them. However, this reworking takes valuable time and lowers the overall output of acceptable units.

This problem couldn't have come at a worse time. Since customers tend to have similar budgeting cycles, orders for all three automobile models tend to peak during the same six week period each year. The company is currently halfway into its peak season. Two weeks before the peak season begins, new personnel are hired to work with experienced employees on both of the assembly lines. Each week during the peak season, the rate of production is increased on both lines so that all three automobiles (EX25, EX35, and 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 increase again tomorrow.

Most frustrating to the manufacturing manager is the fact that the company experienced the same problem a year ago. After days of investigation, he discovered that some employees were using a silicone hand lotion that could potentially prevent proper paint adhesion. A notice listing the unacceptable hand creams was posted in the washrooms. Within a week, the reject rate returned to normal.

Interview with Industrial Engineering Manager

The rejected units are the bodies of the EX25 automobiles. The EX35 and EX45 automobiles are experiencing the normal reject rate of 1.5%. The EX25 reject rate, however, has soared to over 6% and is still rising, due to periodic rejection of bodies 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, the increase in rejects is beginning to have a significant impact on the number of satisfactory units ready for shipping.

The basic production process for the automobiles 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 on the automobile chassis. The new employees, hired just prior to peak season, work under the supervision of the more experienced assemblers on both lines. This is to help prevent the 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 for the EX25 autos, and output of Line 2 was increased to 70 units per hour for 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 goes through the wash, paint and dry operations. The wash involves a dipping operation in which the bodies are immersed in a cleaning solution that removes contaminants and oils. The solution is changed every half hour. Because a continuous supply of bodies is required, 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.

After cleaning, the bodies are manually suspended on grounded hooks attached to the two conveyors, one for the EX25 bodies and the other for the EX35 and EX45 bodies. The conveyors, which move at the same speed, take them through the booth in which paint is electrostatically 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 finally to Shipping.

Yesterday, when the industrial engineering manager 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 on the metal external bodies. The bodies have random spots in which the bare metal is visible because the paint has not adhered properly. Since the EX25 is assembled on Line 1, the manufacturing supervisor's 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 bodies are washed, painted and dried.

The wash operation involves using a continuous conveyor to dip each body into a bath that removes contaminants and oils. The bath solution is changed every half hour. Because a continuous supply of bodies 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 bodies 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 the EX25 bodies and the other carries the EX35 and EX45 bodies. As both conveyors move at equal speeds through the walled booth, the electrostatic paint is applied to the bodies 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 the paint's 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, each 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, additional personnel were hired 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.

The manufacturing supervisor's frustration with the paint rejects 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 unacceptable hand lotions 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 and has 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

Each automobile goes to the quality control supervisor's section after it has been completely assembled. The internal components have been attached to the chassis and hooked up, and the body has 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. The quality control supervisor's 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 automobile models.

The 4.5% increase in rejects of EX25 autos is due to periodic paint defects on the surface of the bodies. While these defects do not affect automobile operation, the standards require the quality control supervisor 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 are solely 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.

The quality control supervisor has asked his inspectors to keep an eye out for anything irregular. So far, they have not reported anything out of the ordinary. However, a number of the inspectors believe that employees may be using inappropriate hand cream again.

AUTOMOBILE MANUFACTURING FLOW

