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Road Rescue Implements a Flexible Continuous Process Improvement Framework

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Abstract

Continuous improvement programs traditionally focus on making small incremental improvements to a system. Unfortunately, their success can be limited due to the rapid changing environment within which most small companies operate. Improvement efforts should be flexible enough to capitalize on incremental and radical changes to a system. This paper presents a case analysis of how Road Rescue, an ambulance manufacturer, uses a continuous improvement framework to capitalize on both radical and incremental improvement opportunities. Results include a 10% increase in throughput, reduced cycle time of 44%, increased customer satisfaction, and higher quality.

Keywords: continuous process improvement, simulation, statistical process control

Introduction

Why do some improvement programs fail and others succeed? There are many potential answers to this question, though we propose that the critical component of a continuous improvement program is flexibility. The need for flexibility is especially needed in small entrepreneurial-type companies where the management structure is usually flat. The reduced management heirachy gives managers and employees more authority and flexibility to make either radical or incremental changes to a product or process. In this paper, we highlight how Road Rescue has implemented a flexible continuous process improvement framework that allows them to benefit from all types of system improvements. We highlight both a radical and incremental project that they have implemented and describe the results after one year of implementation.

Producer, Process, and Problem Setting

Road Rescue, Inc. of St. Paul, Minnesota, is one of the country's leading producers of ambulances and rescue vehicles. The rescue vehicle market is highly competitive and consists of 38 manufactures that annually produce a total of five thousand to six thousand vehicles. The rescue vehicles market can be classified into three segments:

- Type I rescue vehicles are light to medium duty trucks that have a pickup cab and chassis. Type I rescue vehicles account for approximately 9% of the total market.
- Type II rescue vehicles are vans converted into ambulances. This type of vehicle accounts for approximately 55% of the total market.
- Type III rescue vehicles use a van chassis with a box-type module attached behind the cab. Type III vehicles account for 36% of the national market.

Road Rescue annually produces between 230 and 260 Type III vehicles per year. They do not currently produce any Type I or Type II vehicles.

One of the difficulties in producing rescue vehicles is that each vehicle is custom-designed based on customer specifications. For example, a rescue vehicle produced for Denver may be dramatically different than one produced for Miami, due to different city ordinances and state regulations. Vehicle orders are typically obtained through a competitive bidding process. A city or municipality will provide rescue vehicle manufacturers with a set of specifications, each manufacturer will submit a bid price, and the lowest bidder will (usually) receive the order. Due to the customization needed for each order, there is a limited amount of standardization a rescue vehicle manufacturer can place on their products.

The process of manufacturing a Type III rescue vehicle is not complicated. First, the rescue vehicle box-module (consisting of frame, flooring, walls, ceiling and compartments) is constructed using heavy-gauge aluminum. Second, the box-module is attached to a vehicle chassis that Road Rescue purchases from an external supplier and the vehicle is painted. Third, the vehicle flows though a series of 8 final assembly stations. At the first final assembly station, external fixtures such as lights and sirens are attached to the vehicle. At subsequent stations, the electrical systems, interior furnishings, cabinets, and decals are added. Due to the customization and complexity of these systems and associated liability issues with equipment failure, these assembly activities account for the majority of a vehicle's construction time. The last assembly station installs and tests the electrical control panels and the switches. The final task in the manufacturing process includes application of a rust proof coating and final inspection.

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Process Improvement Framework

Over the years, Road Rescue was perceived to be the leading innovator of rescue vehicles in their market. Unfortunately, their quality began to level off and they started to experience competitive pressure. In addition, industry trends indicated that that the demand for Type II vehicles was going to increase in coming years. To help guide the company, management formed a *Manufacturing Improvement Team* (MIT), which included one of us (Olson), to explore company operations and implement improvements efforts. Our team’s first task was to developed a continuous improvement framework to structure our team’s efforts. The framework consists of the following steps: (1) *project development* - management chooses a target area or process to explore, (2) *data exploration* – the team collects all relevant qualitative and quantitative data on the target area, (3) *data analysis* – the team defines specific projects in the target area, (4) *solution development and testing* - the MIT hypothesizes what solutions will be most effective in improving operations, (5) *analysis of results* – the team will evaluate the results from a pilot project or test, and (6) *implementation and standardization* – the team will direct full scale implementation. The key to our continuous improvement framework is that the specific projects are not determined until we, the improvement team, has collected data and surveyed the situation. Another component is that the plan is flexible and allows for small, incremental projects or dynamic, radical projects.

With a framework in place, Road Rescue management requested that we focus on the 8 assembly stations of the final assembly area. Our team spent 6 weeks gathering data on all facets of the assembly stations. Tools we used included employee interviews, cause and effect analysis, interrelationship diagrams, matrix comparison analysis, and activity sheets that define the process at each of the production stations. Our team presented an analysis to management and we both agreed to pursue a series of incremental projects and a radical project. One incremental project involved establishing a statistical process control (SPC) program and the radical project explored changing the manufacturing layout.

Statistical Process Control

During our review of the assembly stations, we determined that Road Rescue had few established quality measures. This was due to the variability resulting from the customization of vehicles. In addition, since Road Rescue produces only a limited number of vehicle types, each employee weekly perform a high number of assembly tasks, but has a low percentage of repeating a task. Our team believed that implementing a statistical process control (SPC) program would be an effective procedure to monitor the assembly process and provide an early warning of impending quality problems. In addition, the use of SPC methods to monitor critical manufacturing processes would, with continued use, allow our company to improve the consistency of quality and lower manufacturing costs[1].

We established process controls for warranty claims on vehicles and the flow time through the assembly stations. Effective SPC systems are balanced with a combination of attribute and variable data[1]. Warranty data are analyzed using attribute P-charts. The charts are used to determine the percentage of vehicles with warranty claims, by department, and indexed by month. This analysis is balanced with a variable measurement using an X-MR chart to track throughput time through the assembly stations. The X-MR charts are used to monitor the impact of individual vehicles on the process flow time. Our goal with the SPC program was to provide an objective understanding of the processes and begin the development of quantitative system measurements.

With the SPC program, warranty claims can now be tracked by numerical amounts, by type, and by department. Throughput time is recorded for all vehicles in the final assembly area. Using this data, reports are daily generated for different departments. For example, the materials department receives a report on part failures, the production department receives a report on workmanship quality, and marketing/sales receive a report on vehicle throughput time.

Plant Layout

Road Rescue's final assembly area was originally organized into 8 stations in a straight assembly line. Quite frequently, downstream assembly stations would be idle. The starving of the downstream processes was due to the varying levels of vehicle customization occurring at the upstream stations. Complicating the issue was that there was no consistency in which of the upstream stations was the bottleneck. Hence, since the variation was based on the vehicle being produced and was not a function of the station, our team concluded that a simple increase of workers at a specific assembly station was not a solution. We hypothesized that a different manufacturing layout might be appropriate.

To explore the final assembly area, we developed a simulation model of the existing 8 assembly station layout using ProModel[2], a visual-based simulation program. With the baseline simulation model, we explored how changes would impact manufacturing flow time and throughput. The first scenario we examined was to add a second assembly line through the assembly stations. That is, there are 8 assembly stations, but with two parallel lines passing through them. Advantages of such an approach include: (1) allowing workers to switch between the two lines when they complete a task on a vehicle, (2) a low cost associated with adding the additional line, (3) little, if any, lost production due to having to train workers, and (4) allowing vehicles to switch assembly lines if a downstream station becomes blocked. The simulation model estimated that adding a assembly line could potentially increase output by up to 40% and reduce the amount of idle time due to system blocking on average by 33%.

The second scenario involved completely scraping the 8 assembly station approach and replacing it with 8 independent manufacturing cells. Hence, a vehicle is placed into a cell and all of the final assembly tasks are performed at that cell. An advantage of this approach is that there are no blocking and starving problems. The manufacturing cells also minimize the impact customer variability and offers the potential for reducing cycle time since several tasks can simultaneous be performed on a vehicle (*e.g.,* installing interior carpet and exterior lights). Two major disadvantages of this scenario include: (1) the high cost to change the physical layout of the facility, and (2) lost production due to having to train workers to work in cells and on teams. The simulation model estaimted that the switch to manufacturing cells could potentially increase the output of the facility by 60% and reduce the amount of idle time due to system blocking by an average of 43%.

Management decided to implement the two assembly line system. Unfortantely, chainging to the this system took longer than anticipated due to an organizational restructuring and new company ownership. During the limited time period it has been in place, throughput has increased 10%. We belive that once the new system has stabilized for a few months, larger throughput gains can be expected.

Results

A company can choose to simply modify a system or make fundamental changes to its structure[3]. In either alternative, a business must be devoted to remaining competitive[3,4]. Through hard work and dedication, Road Rescue has been able to capitalize on both radical and incremental changes. By implementing an improvement framework that is flexible enough for identifying and implementing both types of changes, Road Rescue has positioned themselves to regain the status as the premiere manufacturer in the rescue vehicle industry.

In addition to the described SPC and plant layout projects, other incremental and radical changes that we have implemented or are exploring include: (1) dedicating a full-time staff for implementing improvement efforts, (2) improving the process of how employees report problems and/or recommend changes to processes, (3) expanding the SPC program to track customer service response times, (4) overhauling the customer service center to better process calls, (5) restructuring the engineering staff to better handle design changes, (6) improving the database for monitoring and analyzing warranty data, and (7) identifying a new system for scheduling resources.

One of the keys to our continuous improvement framework is its ability to capitalize on all type of changes to a system. Other factors we feel impacted our success included: (1) complete management support, (2) initial projects were quick and relatively easy - thus gaining the trust and acceptance of the employees, (3) team members were knowledgeable about process improvement technologies and the company processes, (4) solutions were verified and supported by production data, and (5) at every opportunity our team educated the employees in product and process improvement methodologies.

One year after these initial project efforts were implemented, Road Rescue has observed noticeable benefits. Results include a 10% increase in throughput, reduced cycle time of 44%, increased customer satisfaction, and higher quality. Though as noted before, it is anticipated that throughput will increase. Another positive result we have observed is that the flexible improvement framework has helped to nurture a company culture that accepts on-going improvement efforts and changes.

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