

INTRODUCTION

The focus on quality is one of the hallmarks of the lean production system. Quality is a major enabler of reduced costs, both directly through reductions in the quality assurance function and the cost of rework, and indirectly as it facilitates the reduction of inventory buffers. In this chapter, we discuss the critical role of quality in the lean system and report on efforts to improve quality at the companies that participated in this study. The full CCDR definition of quality control can be found in Appendix C.

FIRST-TIME QUALITY: A KEYSTONE OF LEAN

Quality assurance and manufacturing go hand in hand in lean manufacturing. First-time manufacture of quality products is one key to the efficiencies offered by lean production. This is not to say that traditional production did not consider quality important. Indeed, in any aircraft production, quality is *extremely* important. A quality problem that becomes evident while an airplane is in flight could have disastrous effects. Hence, a tremendous amount of time and effort is spent inspecting parts, subassemblies, and assemblies to make sure they were fabricated and built up properly. Those not meeting the rigid specifications are either scrapped or reworked to bring them into compliance. The catchphrase for this approach is that “quality is inspected in.”

By contrast, in lean manufacturing, quality is “built-in.” First-time quality receives tremendous emphasis, to avoid costly rework and scrapping of unsalvageable parts. Because poor production quality

is a major source of costs and waste, lean manufacturing aims to eliminate these problems by building quality directly into the production processes rather than dealing with quality at the end. This requires a consistent focus on quality throughout the design and production process and when dealing with suppliers.

First-time quality is linked to other aspects of lean manufacturing also. Without first-time quality, single-piece flow with continuous smooth part movement becomes untenable. Without a focus on quality, WIP inventories are required to maintain production flow while quality problems are resolved. At the same time, single-piece flow allows instantaneous recognition of quality problems so they can be resolved before more than one part with the problem is built. Hence, the “inverse” of quality in the factory is inventory. Without first-time quality, inventory is required to keep machines running and to make sure that the parts are produced in a timely fashion for delivery to customers. Bad quality thus results in higher costs from rework and scrap and also because of the extra inventory needed to make sure downstream processes run smoothly. Inventory is an expensive buffer against mistakes, and the principles of lean manufacturing call for the removal of such costly buffers that conceal the extent and costs of the mistakes.

Companies can use a number of tools to enhance quality in the production process. These range from tools that measure quality and make sure processes are standardized to statistical tools that analyze processes and practices to processes on the factory floor.

A critical aspect of the lean quality philosophy is a focus on perfecting processes rather than on inspecting parts. Under the traditional manufacturing system, parts would be inspected and problem parts would be reworked or scrapped. Lean manufacturing aims to find the root cause of the problem and fix it. A part with a flaw is a signal that a larger problem needs to be taken care of. Root cause analyses offer formal processes (such as the “five whys”¹) for discovering the causes of problems and addressing those.

¹This technique refers to a process of asking questions to get at the real originating cause of a problem. For example, the question of why a part is not within tolerance should not merely be answered by saying the machine is out of tolerance. The machine may be out of tolerance because it has not been properly maintained,

Powerful tools can help determine which processes are problematic and need to be fixed. Statistical techniques, including statistical process control (SPC), can be used to determine if problem parts are idiosyncratic exceptions (which still need to be studied and remedied) or part of a larger problem based on the process. Operators can inspect the parts and provide the data for statistical analyses and in some cases can perform the analyses. Charts containing the results of these analyses are often posted near the relevant machines to help provide early indication of trends.

There are standards that companies can follow to help make sure their processes are consistent. For example, ISO-9000 certification is performed by an independent agency that documents whether processes are known and followed, ensuring control over different processes.

SPC tools and ISO-9000 certification can help companies reach the often-repeated quality goal of “Six Sigma.” This refers to a normal distribution, with six sigma being six standard deviations from the mean, a very rare event. Six sigma quality translates to about 3.4 errors out of every million events. Essentially, to reach this demanding level of quality, each process has to be “error proofed”—that is, analyzed and reworked so that there is no room for a mistake in processing. Thus, process tolerances must be closely watched, in addition to having a design tolerance consistent with reasonable process tolerances.

Other practices, such as TPM, give workers a stake in how their machines are performing. Mechanics are trained to do simple machine maintenance and to monitor the performance of their machines on an ongoing basis. This should reduce quality problems caused by machines that are out of tolerance or break down because their care has been neglected.

because the responsible employees are overworked, because the operators do not have the authority to do simple maintenance, and so on and so on. When identified, the root cause can be fixed, which will prevent similar errors caused by that machine as well as errors caused by the same problem on other machines. The benefits of identifying and addressing the root cause of problems thus redound far beyond the original event.

REDUCTION IN COST OF QUALITY THROUGH LEAN PRACTICES

A number of promising policies were described at the participating companies. One company began a program of operator self-inspection in the early 1990s and has seen a resulting decrease in the number of factory quality control (QC) personnel. The project involved a systematic shift in responsibility for product quality from the traditional QC organization to the build teams and established “ownership” of product quality by those building the product. Low-risk QC inspections were eliminated and replaced with random inspections to make sure the self-verification processes were operating as planned. Critical inspections were maintained to safeguard the projects and the operators. The ratio of direct touch labor to QC labor increased from about 10:1 in 1992 to about 13:1 in 1998, representing an almost 25 percent net decrease in QC labor. With ownership in product quality, most business areas detect and report 98 to 99 percent of their own defects.

Another site offered a similar story of performance improvement, resulting in an expected 25 percent reduction of quality assurance (QA) personnel as a percentage of factory labor since 1992. This was the result of attempts to make quality a consideration at the beginning of the design process as well as formal programs to give production workers process ownership. They estimated that QA labor as a percentage of total factory labor declined from almost 23 percent in the early 1990s to about 19 percent in 1997, with an estimate of 17 percent in 1998.

Another company indicated that the trend in quality is for operator self-inspection, with QC people focused more on inspecting processes than inspecting individual parts. (This is something that the government had to agree to, however.) At that time, 11 percent of the touch labor at the company consisted of QC inspectors; their goal was to reduce QC to between 2 percent and 4 percent by using process auditing and worker self-inspection. A good audit plan was required to ensure quality is sustained. Workers had to be properly trained in inspection techniques, and acceptance by the union was required. To help win union support, QC workers (all of whom were experienced mechanics) would be guaranteed return rights to their former jobs as mechanics.

These initial forecast savings are encouraging and suggest that at least some defense aircraft manufacturers are paying attention to and trying to reduce the costs of quality. However, the costs of the QC function are often estimated and reported as some percentage of factory labor or manufacturing costs, rather than collected in their own right—most likely because of the difficulties of collecting dispersed information and applying it to specific work areas within a production area. (A subtle definition would incorporate the costs of direct QA personnel, the costs of scrapped parts leading to a worsening of the buy-to-fly material ratio, the costs of additional inventory buffers required when quality varies, and so forth.) As direct manufacturing labor is projected to be reduced through lean efforts, firms must decide whether the cost of QA will decline in proportion and keep the same estimating factor for the category or whether some other outcome is more likely. Full implementation of lean with attendant Six Sigma quality may mean that the cost of quality will decline at a greater rate than the costs of direct manufacturing. Although some companies have claimed this to be the case in their cost estimating, the evidence is still limited.