Little Lessons from the Big Boys

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Sometimes, even lean leaders suffer quality lapses.

Once a product leaves the assembly line, even the tiniest quality problem can quickly escalate into a big headache for manufacturing engineers. The key is to address quality issues on the plant floor and to build quality into every product. Unfortunately, that's often easier said than done, even at world-class manufacturers.

Recent quality glitches at Boeing Commercial Airplanes (Renton, WA) and Toyota Motor Corp. (Nagoya, Japan) have raised quite a few eyebrows in the manufacturing world. Both companies are considered to be lean leaders in their industries. Many of the problems that each manufacturer has encountered have involved snafus on the part of suppliers, but they have trickled down to wreak havoc on the final assembly line.

Boeing is currently building a revolutionary new airplane with new materials, new production processes and a nontraditional supply chain model. It is relying on a network of suppliers to assemble the bulk of its fuel-efficient 787 Dreamliner.

The first flight of the carbon-fiber aircraft has already been pushed back several times. Targeted delivery dates have also suffered due to missing links in the supply chain. Deliveries are now expected to begin in early 2009, rather than late this year.

"The fundamental design and technologies of the 787 remain sound," says Scott Carson, president and CEO of Boeing Commercial Airplanes. "However, we continue to be challenged by start-up issues in our factory and in our extended global supply chain."

Boeing outsourced a record amount of work to speed up its manufacturing cycle. Suppliers spread out around the world are building a bigger share of the 787 than on any previous Boeing jetliner. Approximately 80 percent of the Dreamliner, including its fuselage and wings, is being assembled by third parties vs. 50 percent for traditional Boeing aircraft.

The highly anticipated 787 has been plagued with a wide variety of production snags that are primarily due to suppliers that have been unable to meet critical deadlines. Boeing engineers have been scrambling to address problems associated with wiring, documentation, software programming and a shortage of fasteners. Unfinished parts and components from suppliers, known as “travel work,” have hampered final assembly and forced Boeing to push back its ambitious schedule.

According to Richard Aboulafia, senior aircraft analyst at the Teal Group Corp. (Fairfax, VA), most of the challenges facing the 787 program involve ramping up production rather than just poor quality parts. “There have been problems with wiring harnesses, fasteners, drilling and fuselage sections,” he points out. “But, it’s mostly an integration issue. The big challenge is getting the right parts in the right place at the right time.”

Aboulafia says Boeing’s woes have attracted widespread attention and have prompted some people to point fingers because the company has already sold more than 850 Dreamliners, making it the most successful airliner in history. To make matters worse, this is the first time that a new Boeing jet has ever been delayed by more than just a few months.

Boeing is exploring new territory and trying to solve many problems at once. “They’re pushing the envelope in terms of technology and outsourcing,” says Aboulafia. “They had a very aggressive schedule. Things appear to be going better on the second aircraft.”

Even more analysts and observers have been alarmed by recent developments at Toyota, which has long been synonymous with quality. Indeed, the company prides itself on zero defects. Its vehicles have an outstanding reputation for reliability and resale value.

However, the automaker’s envious record has been tarnished during the last three years. Toyota’s legendary reliability has slipped slightly in recent years, according to closely watched rankings conducted by Consumer Reports (Yonkers, NY) and J.D. Power and Associates (Westlake Village, CA).

In the United States, Toyota’s largest and most important market, the number of its vehicles recalled soared to more than 2 million in 2005. That was double the number of Toyota cars recalled in 2004 and more than 10 times the 200,000 vehicles recalled in 2003.

But, the number of Toyota recalls in the U.S. have steadily declined since 2005. According to the National Highway Traffic Safety Administration (Washington, DC), the automaker recalled 657,308 vehicles in 2006 and 573,554 in 2007.

At the same time, however, Toyota has recalled hundreds of thousands of vehicles in its home market of Japan. Last year alone, the automaker issued five different recalls in Japan to fix problems ranging from fuel pumps to steering gear.

Many of the problems have affected models that are more than five years old. But, quality glitches have also haunted Toyota's new state-of-the-art assembly plant in San Antonio, which assembles the Tundra pickup truck. Its V8 engine has encountered problems such as faulty camshafts.

According to industry observers and senior Toyota executives, the primary reason for the quality lapse is the company's aggressive expansion strategy. Toyota has grown so fast in recent years that its famous quality control system has failed to keep up.

Toyota's production in North America alone has increased 39 percent over the last five years. Toyota Motor Engineering & Manufacturing North America Inc. (Erlanger, KY) boosted vehicle and engine production to record levels at its 13 North American plants in 2007. Specifically, the automaker assembled 1,671,009 vehicles, an 8 percent increase, and 1,571,872 engines, a 10 percent increase.

While trying to keep up with that record-setting pace, Toyota's engineering staff has been overloaded. The automaker failed to hire enough engineers, despite its ambitious global expansion efforts.

An analysis conducted by the Goldman Sachs Group Inc. (New York) discovered that 68 percent of Toyota's recalls in 2006 could be blamed on design flaws. Problems included rubber parts not made thick enough to withstand engine heat and joints too weak to withstand stress.

Toyota is preparing to increase vehicle capacity in North America to approximately 2.2 million units by 2010, when its new plant in Mississippi opens. However, that growth may put additional stress on its ability to build-in quality on the assembly line. As Toyota continues to grow, some experts believe that its quality woes may get worse

before they get better.

“The company has grown an incredible amount,” says Art Smalley, president of the Art of Lean Inc. (Huntington Beach, CA) and a former Toyota engineer. “When I left, there were 70,000 people and most of them were in Japan in a circle with a radius of about 50 kilometers. Suppliers were very close by as well.

“Today, Toyota employs about 210,000 people and they are located all over the globe, as are key suppliers,” adds Smalley. The company operates plants in 27 countries and employs assemblers who speak Chinese, Russian, Spanish, Turkish and other languages. Next year, Toyota expects to sell more than 10 million cars worldwide, which is double what it sold in 2000.

“The sheer growth and difficulty in working in multiple languages and countries is part of the problem, I suspect,” Smalley points out. “From what I have read in a Japanese magazine article, the recent problems are evenly split between design problems, supplier quality issues and internal manufacturing issues.

“However, I also toured a Toyota engine plant that had a final assembly line operating at about 5 parts per million in terms of defects,” notes Smalley. “That is about 10 times better than when I worked there. Most companies would like to have Toyota’s quality ‘problems.’”

“It is possible that Toyota is not having worse quality,” adds Quarterman Lee, president of Strategos Inc. (Kansas City, MO. “It may just be that other companies are catching up. The standard for acceptable quality in the marketplace has risen significantly in the past 30 years or so.”

Addressing Quality

Manufacturing engineers must tackle quality issues on the plant floor head-on.

Both Boeing and Toyota are aggressively tackling their quality issues. In fact, the well-publicized incidents appear to be merely speed bumps on each company's lean journey. But, their recent problems show that no manufacturer is infallible when it comes to quality. "It underscores how difficult it is to maintain quality for any company," says Smalley.

Ideally, all manufacturers should strive to address quality before and during the assembly process, not after. Work instructions that teach operators major assembly steps, key quality check points and reasons why things are done a certain way are critical. Simple error proofing and use of measurement technology is also essential to ensure that quality problems don't get passed on. On top of that, supervisors and team leaders must possess good problem-solving skills.

In the case of Boeing and Toyota, both manufacturers encountered quality problems at the supplier level. Unfortunately, that's something that even the best plant-floor quality control system often can't avoid.

Boeing has sent scores of engineers to its suppliers' plants to find the source of snafus and resolve quality problems. The company is expected to reveal the full extent of the 787 delays and release a revised production schedule this month.

"Boeing has outsourced core competencies," says Rick Harris, president of Harris Lean Systems Inc. (Murrels Inlet, SC). "When you do that, you lose a certain degree of control over quality. It adds another degree of variability to the production process that needs to be carefully addressed."

Some of Boeing's suppliers are located in China, Italy and Japan. "When your suppliers are located further away from your final assembly line, it causes potential quality problems," warns Harris, who formerly served as manager of final vehicle assembly at Toyota Motor Manufacturing Kentucky Inc. (Georgetown, KY). "The feedback loop is much longer."

According to Harris, that's one of the reasons why all Toyota plants operate with a mini stamping facility attached. That way, the quality feedback loop is only two to three days, instead of seven to eight weeks for automakers that operate centralized stamping plants which supply all of their factories.

Toyota has refused to blame suppliers for its recent string of problems, despite the fact they have been the source of some quality lapses, such as the camshafts used in the Tundra. Instead, top management has urged all employees to carefully examine their own actions on the assembly line and not rely solely on the company's quality control processes.

Smalley believes that's a smart strategy. He says the best way to instill quality upstream is to have a good design for every component. Thorough communication of the requirements with the supplier through drawings, specs and quality control plans is important. Of course, it's also critical to pick suppliers that are capable of meeting the expected requirements.

"Even having done all this, as I assume Boeing and Toyota have, there will still be some degree of problems with some suppliers," warns Smalley. "On a regular basis, supplier performance needs to be reviewed. Problems in areas such as quality, cost or delivery need to be fed back to the responsible party for improvement.

"When problems are significant, Toyota will dispatch technical experts to the supplier to raise urgency and provide guidance as needed," explains Smalley. "Still, all this is difficult when you are dealing with hundreds of suppliers and tens of thousands of part numbers. Problems will unfortunately occur from suppliers. Some sort of system needs to be put in place to both proactively prevent problems and reactively deal with what does get through."

Toyota executives have publicly apologized to investors and they have vowed that the embarrassing quality problems will be addressed. During a speech at the North American International Auto Show in Detroit earlier this year, Katsuaki Watanabe, Toyota's president, urged all of his employees to take personal responsibility for the quality of the company's cars and trucks.

"Without improving quality, Toyota cannot expect to grow," says Watanabe. "I believe that quantitative growth is the result of improved quality."

During a two-month internal study of why there have been so many recalls and quality control issues, Toyota discovered that it may have outsourced too much engineering and that engineers may have rushed out some products without conducting enough quality checks or without building a sufficient amount of prototypes. The automaker has decided that it will build more physical prototypes in the future to address the issue.

To continually search for ways to streamline assembly processes and improve quality, Toyota operates large training centers at its plants in Georgetown, KY, and Motomachi, Japan. The Global Production Centers are important tools in the company's quality crusade. They teach employees the best way to apply various principles of the Toyota Production System. All Toyota managers are expected to be able to do the jobs of everyone they supervise and to teach their employees how to solve problems.

Toyota is also looking at how material handling can be fine-tuned to improve quality in its plants. For instance, the automaker is re-examining how parts are delivered to the assembly line. At its sprawling Tsutsumi plant in Toyota City, Japan, Toyota has removed traditional parts bins from the plant floor. Instead, bins are strategically placed inside car bodies. The company plans to implement the innovative technique at its new $1.3 billion plant in Blue Springs, MS, which is scheduled to ramp up in 2010.

Quality and Lean

Toyota is experimenting with new ways to deliver parts to the assembly line to reduce potential quality problems.

Continued quality problems for any company will eventually lead to problems with customers. "They may be willing to overlook a price increase every now and then, but a customer will rarely forgive a quality problem," notes Jamie Flinchbaugh, a partner in the Lean Learning Center (Novi, MI). "Quality is rarely seen as a competitive advantage by manufacturers. But, the absence of it is a serious disadvantage.

"The opportunity for bad quality is constantly creeping back into the organization," adds Flinchbaugh. "Quality isn't static. It's a moving target that's hard to sustain without constantly evolving and improving the process."

Both large and small manufacturers have discovered that quality control is something that is not isolated from lean manufacturing. “Quality was never meant to be separate from lean,” Flinchbaugh points out. “The two processes are integrated. Quality used to be something that was confined to data and analysis, in addition to test and inspection. Today, quality is more built into the overall production system.”

For assemblers to truly improve quality, they must go after the root causes of defects. “Most quality systems just contain the problem and protect the customer,” claims Flinchbaugh. “That’s not really a true improvement. It’s merely a safety net that screens things out.

“When you do that, quality-related problems often go right through the holes in the net,” adds Flinchbaugh. “You can’t do quality improvement as a kaizen event.”

Quality problems on the shop floor come in all shapes and sizes. Some are really design errors that get through to manufacturing. Some are inherent in the production process design, which may or may not have stringent quality gates. Others are supplier quality problems that are caught in final assembly. And, of course, there are manufacturing problems that are made in-house for whatever reason.

“Some problems are easy and some are hard to solve,” says Smalley. “It takes skill and discipline to solve problems. The plant floor is where all problems appear, but they may or may not have their root cause on the shop floor. Nonetheless, manufacturing often gets stuck with resolving the quality problem regardless of its source of origin.”

While many people like to talk about “mistake-proof assembly,” it’s hard to tell if it really exists. “There are designs that are harder to assemble wrong and easier to assemble right,” says Smalley. “But, there is no assembly that I have ever seen that can be done by a novice 100 percent right every time. For example, humans or machines still scratch things or put small dents in them even when they are assembled correctly.”

According to Lee, quality control has to do with corporate culture more than anything else. “For all the hoopla about Six Sigma, the fact is that the basic tools have been around since Walter Shewhart invented the control chart in 1924,” he points out. “Most managers view quality as either a technical problem or they see it as a bad attitude on the part of individual workers.

“However, corporate culture and the integration of people and processes play a huge role in quality,” claims Lee. “Of W. Edwards Deming’s famous 14 points, only the third [build quality into a product throughout production] even hints at technical solutions. All the others involve issues of strategy or corporate culture.”

Built-In Quality

All loops of a quality system should link and align to other loops. This includes feedback and feedforward of problems.

When lean manufacturing is correctly applied, quality is built into the assembly process. Jidoka is the lean tool often associated with quality control. It encourages assemblers to build 100 percent quality into the process so that a defect cannot be made.

Jidoka is one of the two pillars of the Toyota Production System (TPS). Sakichi Toyoda developed the concept more than 80 years ago for use on one of this early power looms. He refined jidoka on his automatic looms for about 20 years and was awarded many patents.

Jidoka requires manufacturing systems to be designed so that they can only make good products. Production of defective products must be impossible. The goal of jidoka is to detect problems immediately and facilitate visual control.

Specifically, jidoka enables machines and operators to detect when an abnormal condition occurs and immediately stop work. It highlights the causes of problems when they first occur. This leads to improvements in built-in quality by eliminating the root causes of defects.

“Jidoka is the mysterious Japanese word that has a couple of meanings,” says Smalley. “One is the notion of building in quality at the process. This is done in hundreds of small ways that involve subtle and simple uses of in-process technology. This is the least well understood part of TPS and the hardest to see.

“It is simple for an academic or a visitor to walk through a Toyota plant and see a standardized work chart or a kanban,” notes Smalley. “They are simple and visible. Jidoka, on the other hand, is inside the machine ‘under the hood.’ It is tough to show people and it varies machine by machine.

“As my former boss in engineering used to say, ‘there are just some things we are not going to show people,’” adds Smalley. “This is part of Toyota’s tradition. How machines are built is carefully specified in Toyota’s standards.”

According to Smalley, Toyota has volumes of these technical standards for processes such as casting, forging, machining, stamping, welding, painting, injection molding and assembly. “Not too many people get to see those unless you can read Japanese or work in the area issuing specifications to the machine builders,” Smalley points out. “This part of TPS is frankly just not understood by anyone writing about Toyota today. I call it the mystery pillar of TPS.

“I like to remind people that jidoka is a concept and not really a tool,” adds Smalley. “It has many ways of being applied, but it is always specific to the process in question.”

In addition to jidoka, manufacturing engineers can turn to other tools to help reduce or eliminate quality problems, such as design failure mode and effects analysis (FMEA), process FMEA, modeling, design of experiment, quality control plans and plan-do-check-act (PDCA) lists.

“The problem is not one of tools, but one of execution and capability,” argues Smalley. “For example, adding another tool in the bag will not help the average golfer. Their average score will not change. The same is true in manufacturing. Improvement only occurs when the root cause of the problem is discovered and fixed through hard work.”

One of the best ways to visualize the process is with quality loops. They have four sections: Workstation, zone, plant/process and customer. Communication flows from one loop into the other.

“Quality loops protect the customer and offer feedback for improvement,” says Flinchbaugh. “All loops of your quality system must link and align to other loops. This includes feedback and feedforward of problems.

“If, at the zone level, I start seeing a trend or uptick in a particular problem, I need to both feed forward and feedback,” explains Flinchbaugh. “Feedback is to the workstation, letting them know that they see the problem and that the operator needs to work on that problem at the workstation level.

“Feedforward is sending that same information downstream either to another zone or to the plant,” adds Flinchbaugh. “If I have an increase in problems within the zone, that makes my filter less capable of catching everything. So, you communicate that to other filters (the next zone or plant) so that they can increase their filtering, as it’s more likely during that period of time that something will slip through.”