From Craft to Lean: Raytheon Aircraft Takes Off

Robert W. Hall

Raytheon Aircraft in Wichita, KA is airplane country. Here Walter Beech built his first Beechcraft, the Model B17 flown in 1932, on display in the main building. The name Beechcraft is still painted on the roof. It’s a proud old place, a link from aviation pioneers to the latest in regional jet technology. A walk around is a historical review of civil aviation manufacturing, worthwhile because to appreciate the transformation under way, recognizing the long Beech tradition is essential.

The plants are huge, arranged in a mile square around a 9000-foot runway. Inside, Beechcrafters make almost everything in an airplane except engines and avionics. A tour through the plants is like a stroll through different ethnic neighborhoods in a major city. Old mixes with new, and each new neighborhood holds another surprise. Production technology ranges from 1930s drop hammers to 1990s mandrels to lay up composite fuselages for the newest regional jets. Raytheon Aircraft is home to a proud tradition, but it’s no longer your father’s Beechcraft.

The Craft Tradition

For decades, the old Beech company operated by craft and traditional factory management. The big challenge today: keeping the pride while weaning people from the craft culture, a transformation Raytheon Aircraft describes as “from Beechcraft to Flowcraft.” Raytheon Aircraft is a work in progress. Wichita is no small operation to turn. Last year, to accelerate this change, Paul Schumacher, whose lean manufacturing experience is from Martin Marietta, took over as VP of operations.

A Raytheon corporate program called R6σ, or Raytheon Six Sigma, guides the transformation. According to Raytheon’s CEO, Dan Burnham, R6σ should integrate the culture of far-flung, diverse operations that include a number of much more recent acquisitions than Beech. Because it combines quality and lean principles, R6σ can be described as “Lean Sigma.” In time Raytheon wants the company to have a consistent “language” of operations and process improvement by which everyone in the company can consistently communicate.

The depth of the Beech tradition dictated a slow start. Infrastructure for Flowcraft had to be built. For example, until 1997, industrial engineering was consumed with tracking labor hours. A base of professionals familiar with flow methods and layouts did not exist. It is still in development.

Until two years ago, mechanics in final assembly and elsewhere bought and used their own tools, an old craft tradition somewhat like auto repair mechanics owning their tools. Workers selected the tools they preferred, kept them in their own boxes, and seldom wanted others using them. Standardization of methods was difficult; 5S and visibility systems were hopeless.

As can be imagined, issuing Raytheon tools and having mechanics take their own tools home jolted the work culture. Teamwork for continuous improvement differs from individuals sharing their craft skills. Developing a flow of parts was also a major change. For example, before organizing a kanban system to supply final assembly,
**Raytheon Aircraft History**

Walter Beech, a legendary aviation pioneer, began building airplanes in the 1920s. In 1932, his fledgling company built the first Beechcraft, the bi-wing B17. His postwar design, the single-wing Beechcraft Bonanza, is still in production at Wichita, extending a production run longer by far than any aircraft in history.

Beech Field is a center for private aviation. Thousands of Beechcraft of all ages are still flying. Raytheon hosts periodic fly-ins of 50 or more old airplanes to this citadel of the civil airways. Owners swap lies and celebrate the adventures of flying.

Walter built them right. For decades, Beechcraft were handcrafted together, each airplane almost a work of art. Raytheon Aircraft workers still like to think of themselves as “Beechcrafters.”

In the 1970s, private aviation fell on hard times. Walter died in 1972. For ten more years, his wife Olive Ann hung on more on pride than money. With few funds to invest, Beechcrafters built quality airplanes by using ingenious tooling built in-house and by modifying old equipment.

In 1982, Olive Ann sold the company to Raytheon. However, the private aviation market did not start to turn up for another ten years, so plant investment continued to be cautious. In the interim, Raytheon Aircraft also lived on the Beech legend.

Recognizing that continuing in this mode would eventually run the fuel tank empty, in 1992, Raytheon became more aggressive. The product line needed a major lift, so Raytheon Aircraft bought the Mitsubishi Diamond Jet and entered the jet business. In 1994, it bought the Hawker 800. In 2001, three new aircraft are rolling out; the turboprop T6A Texan Trainer, the Raytheon Premier I composite jet, and the Hawker Horizon composite jet, a plane that enters Raytheon in the regional commercial jet market as well as the private market.

Raytheon is leaving the era in which customers would pay for small, private aircraft to be built mostly by craft. For the past four years it has been transforming to compete with the world’s most advanced aircraft manufacturers.

Total of about 10,500 employees on site; about 6500 direct labor.
Union: the International Association of Machinists and Aviation Workers.
Experienced, skilled workforce. Twenty percent of all employees have worked more than 20 years, while less than half have under five years longevity.
Vertical Integration: Raytheon purchases engines and avionics. Almost all the rest, about a third of the dollar cost, is fabricated and assembled on site.
Products are complex. The bill of material for a twin-turboprop King Air, the smallest aircraft built at Wichita, lists about 15,500 part numbers. Each plane consists of about 22,000 parts at assembly, with many of the parts also fabricated on site.

**Working Back From Final Assembly**

Raytheon Aircraft now has workable bills of material for manufacturing purposes, not just for engineering. Installation of SAP slowed the implementation of “lean” for 14 months, but it also required the cleansing of bills of material. Correction of data errors consumed 106,000 manhours. All that is now finished.

The cultural migration is the key to success. Changes strive to preserve the positives of the craft tradition. Most workers are highly skilled, and their work ethic fabulous. When something goes amiss, they figure it out and deal with it. For years, a loyal, enthusiastic workforce “built Cadillacs” on a shoe-string tooling budget.

Now new-generation aircraft models are ramping up. To efficiently build them, Raytheon Aircraft needs workers that can think on their own, plus expand their thinking to Flowcraft. Through Flowcraft, about the same number of people must build a lot more airplane using about the same space. That’s the overall goal of the process changes.

The number of suppliers has been
reduced. Projects to improve teamwork with key suppliers are under way. Once of those is a loft area dedicated to Allied Signal/Honeywell, an avionics systems supplier. Eighteen months ago, Raytheon experienced 4-5 avionics shortages per airplane built. Yammering back and forth about shortages and reasons for avionics not testing out consumed time. Almost every craft built was delayed.

Allied personnel on site, equipped with their own “hotbench” to test avionics, help resolve any problems marrying the avionics to the airplane much more quickly. If the avionics tests out, Raytheon knows that the problem is elsewhere in the airplane. Now only 0.5 shortages per airplane are reported. Avionics integration delays are minimal. A similar “hotbench” area for Rockwell Collins is under development.

Implementing R6º at Raytheon Aircraft has not been a simple matter of “rearranging furniture” and starting to work in cells. Such complex operations had too many big rocks in the river, like the problem with avionics, which could not be removed quickly or easily.

Every change is another warp of the craftwork system. People wonder what is happening, and with large plants spread around an airfield, communication is a big problem. A newsletter attempts to keep people informed of changes and progress. Key managers wear out a lot of shoe leather staying in touch and spreading the word.

Raytheon Aircraft introduced kaizen projects in 1999. In Fall 2000, they launched 15 kaizen projects at once. Too much too soon, these met great resistance from a workforce that still had difficulty grasping the vision. Kaizen projects now are more targeted. Raytheon needed demonstration projects to show people first hand what could be done and how Flowcraft could really work. Management decided to launch an intensive program to develop flow cells, starting with those to produce landing gear. The limit to conversion is the rate at which people can be trained and get into their new world of work.

**Subassembly Cells**

The landing gear cell program began on January 12, 2001, accompanied by lots of training and expert advice. Raytheon knows that they have “to get this program right.” A war room was established. A team of 40 people was assigned to the program, because it is not just a single cell, but 12 of them, and production has to supply the line during all the conversion and training. Shingajitsu and the Toyota Supplier Support Center were called in for advice. A consultant experienced in “aviation lean,” Mark Jamrog, checks and advises weekly.

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**Rudder Pedal Assembly Cell**

**Before**

**After**

*Figure 1.*
Cell Development

Since April 2001, the Wichita facility has been creating cells at the rate of one or two per week. Since the workers have never worked in cells, it was slow going at first. People are trained, material is built ahead for the cut over, and after a few weeks of trial, the cell is turned over to production. Those who support the cells with schedules, maintenance, and material handling are also part of the conversion. Figure 3 summarizes three months of intensive effort.

The conversion team initially designs the cells with input from the workers who will refine the design as they get into it. As expected, parts delivery to assembly quickly improved while work in process decreased.

A Cultural Journey

Raytheon Aircraft has a challenge in converting a very large, diverse manufacturing facility to lean manufacturing. A bigger one, and key to success, is converting the thinking from Beachcraft to Flowcraft. People are starting to “get it.” Many are very enthused, just as enthused as the proud owners of vintage Beechcraft flying machines.

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