# Lockheed Martin Aeronautics: The Joint Strike Fighter Goes Lean

How a large, complex program incorporates lean principles.

John H. Puckett

Most likely, no one associates lean manufacturing with building military aircraft. Government and lean just do not seem to fit together. However, the attendees at the recent AME workshop at Lockheed Martin's Ft. Worth, TX facility got the chance to see the implementation of the lean enterprise in a really unique setting. This Lockheed Martin plant is building the F-16 Fighter plane (see Figure 1) and is also participating in the production of the new F-22 Fighter.

The company was awarded the initial development contract for the new F-35 (Figure 2), Joint Strike Fighter (JSF), in October 2001, in a fly-off competition with Boeing Aircraft. Because of the new government initiatives to contain the costs for new weapons systems, Lockheed Martin has adopted a complete lean supply chain approach that includes engineering, program management, suppliers, and production. What we find in Lockheed Martin is a prime example that debunks two schools of thought on "Why lean will not work in my shop:" 1. I produce in very low volumes and have a high product mix.

2. I am a union shop and the union will not buy into lean.



*Figure 1.* The Lockheed Martin facility produces about one airplane (F-16) every 30 days; final assembly is shown.

## Update on Excellence



*Figure 2.* Lockheed Martin was awarded the initial development contract for the new F-35, Joint Strike Fighter (JSF), in October 2001.

For the past several years the Lockheed Martin facility has been producing about one airplane (F-16) every 30 days and they have a represented work force with the IAM being the principal union. They have indeed made lean work and are seeing the fruits of instituting lean as a company philosophy from top to bottom. The F-16 production rate is

#### **History and Folklore**

- Plant constructed in1942 to build the B24 bomber.
- Plant's main building is over one mile in length and contains over 1.5 million square feet.
- Peak production of B-24s in 1944 was one plane per hour!
- The facility is owned by the U.S. Air Force.

currently increasing to eight per month, due to new sales made possible, in part, by the relatively low cost on the world fighter market.

#### Lean History at Lockheed Martin

Lockheed Martin is not new to the adoption of lean manufacturing. Back in 1991, the production rate of the F-16 Fighter had plunged from the heydays of the mid 1980s, quality was slipping, and deliveries were behind schedule. As the military focused more on cost, quality, and delivery, plant management knew they needed to significantly improve their performance or risk losing critical business. By 1992, new performance improvements were under way, but there was much to be done. By 1995, a major benchmarking activity was started to determine "best practices" that could be brought into the plant.

In 1998 a new Lean Organization was put together under the direction of Larry Pike, Director of Lean Deployment. As the results of the benchmarking studies and the lean initiatives began to take effect, Lockheed Martin applied for and won the honor of being selected as one *IndustryWeek's* "Top 10 Plants" in 1998. Improvements from 1992 through 1997 included a 38 percent reduction in manufacturing costs, despite volume reductions; 50 percent inventory reduction; a defect rate of 3.4 defects per plane; and reduction in order to delivery time from 42 months to 21.5 months.

Despite these impressive improvements, Lockheed Martin was by no means finished with their continuous improvement program. Through the application of kaizen methodologies to further implement lean manufacturing, the plant challenged for and was awarded the Shingo Prize for Excellence in Manufacturing in 2000.

During this period, a kaizen project in material management reduced the time to move parts from receiving to stock from 30 days to four hours. Another major project undertaken with a major supplier on the F-16 Radar Rack resulted in a significant cost reduction on the follow-on contract. This project focused on the redundant handling and testing associated with a radar subsystem for the airplane. This application of the lean supply chain philosophy along with lean design, lean project management, and lean manufacturing were among reasons for Lockheed Martin Aeronautics winning the development contract for the new F-35 Joint Strike Fighter.

#### Lean Principles at Work

The principles of lean at Lockheed Martin Aeronautics include: *1) transparency* — when anyone can walk

into a workspace and visually understand the current situation; 2) Design for Manufacturing and Assembly (DFMA) — even the most elegant design is useless if you can't produce it affordably; 3) process focus - lean manufacturing effectively debunks the misguided belief that optimizing each operation also optimizes the entire process; 4) Just in Time (JIT) system — the factory will produce only what is needed, when it is needed, and only in the quantity needed; 5) process control — what can be more wasteful than not making something right the first time?; 6) standard work - standardizing work is the best way to get the job done in the amount of time available and how to get the job done right the first time, every time.

It was these major lean initiatives that prepared the way for Lockheed Martin to win the JSF competition. Because employee involvement is a basic pillar of lean, Lockheed Martin fully involved their unionized workforce in the necessity for and the principles of lean manufacturing. The future success of Lockheed Martin was going to be tied to the successful capture of the Joint Strike Fighter and a mutual effort of both the unionized and non-unionized workforce that would make this possible.

### Values and Culture

To survive in this competitive environment, it is important that the whole workforce share common values. Lockheed Martin settled on three key values that would drive the business: 1) collective accountability by team members; 2) employee engagement; and 3) business-based decision making. Through these shared values, the business would be conducted. These values set the cultural environment of the company. The four principles of this culture were:

- 1. We, not me
- 2. Customer first
- 3. People focus
- 4. Lead by example.

As the new corporate culture took hold and the lean manufacturing training was implemented, the foundation had now been laid for the company to capture the JSF program.

#### Management-Union Cooperation Paved the Way for Improvements

One of the first issues that came up that took advantage of the Lockheed Martin lean efforts over the past few years was to reduce the floor space occupied by the F-16 program by 60 percent for the JSF program. The cooperation between the company management and the union made this possible without loss of any F-16 production. Another example of this cooperation in the implementation of lean was the ALE-50 Pylon program. The product travel distance was reduced to 50 feet from 200 feet and the time to produce the product was reduced from 177 to 34 hours.

#### Front End Focus

As we move on now from the Lockheed Martin foundations of lean and the capture of the JSF (F-35) program, we look at the main focus of the workshop — the application of lean principles at the front end of a major weapons program like the F-35. Today, successful lean organizations have moved beyond the manufacturing floor into the front end of the business; and Lockheed Martin has done just that. We had the opportunity to hear from program management, design engineering, and supply chain management on how lean has transformed their organizations

and how its use makes the F-35 successful for both the customers and suppliers.

One aspect of the JSF program vision that was different from any previous weapons system was that it must be "affordable." When we go back and look at the vision of an affordable fighter, you might ask, "What does that really mean?" Here are some of the program objectives:

- 1. Reduce the overall acquisition costs of this plane by 60 percent compared to current aircraft of a similar mission capability
- 2. Reduce the logistical support costs by 50 percent compared to current systems
- 3. Reduce design time by 50 percent
- 4. Reduce manufacturing time by 66 percent
- 5. Reduce tooling required to produce the aircraft by 90 percent
- 6. Reduce spare parts required by 50 percent
- 7. Provide a total order-to-delivery time of less than one year.

All this will be accomplished using a worldwide supplier network, producing three major platforms in a mixed model production line with orders coming from governments from all over the world. Pretty ambitious!

# Integrated Product Teams and Suppliers

The whole program is run by a series of Integrated Product Teams (IPT) that have complete responsibility for a portion of the aircraft. A unique feature of this program and the management of it is the multicompany, worldwide manufacturing approach that has been taken. Although Lockheed Martin is the principal contractor, there are two other primes as well, Northrop Grumman, and BAE Systems of the UK. In order to assure the most competent people in leadership positions within the IPTs, team leaders were selected from among the three prime contractors, even though the team location was going to reside in Ft. Worth, TX at the Lockheed Martin facility.

In addition, many of the other key subcontractors are represented on the IPTs. With over 75 percent of the manufacturing costs coming through the international supply chain, having many of these key suppliers being part of the product teams will insure close communications throughout the design and product phases of the program.

The structure of these IPTs resembles a traditional company organization chart. The big difference is that this organization is strictly product-oriented. From the top level product team that has overall responsibility to the smallest subsystem product team, the interconnecting lines of communication are designed to insure the best possible performance of the product. This structure represents a new variation of the "virtual corporation" taken to a level unseen before. The loyalty of the executives, managers, and other team members is to the success of the F-35 program and not to their home companies. If the program is successful, each of the individual companies will also be successful.

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What we saw during this workshop was how the principles of lean, especially the concept of waste reduction, contributed to meeting cost and schedule goals during the development phase. The traditional government contract mentality that accepted cost overruns, schedule slips, and performance compromise is just not part of the vocabulary here. If a system team has a problem with cost, performance, or schedule, that phase of the program just does not proceed until the issue is resolved. If a problem involves two different IPTs, they get together to resolve the issue immediately. It may become necessary to involve the next level in the product structure to resolve the issue, but the problem gets resolved right there, at the lowest possible level.

All of these teams have been trained in the fundamentals of lean and how to identify and eliminate waste both in the development phase and in the manufacturing

process. One example we saw was how a common production tool could be used to produce several different, but similar parts, by just changing an inset. This reduced the tooling costs for producing these parts by 90 percent.

This workshop was an excellent example of how a large, complex program has incorporated the principles of lean to 1) win a major weapons program and 2) establish a cross-functional/cross-company environment dedicated to the success of the program. As this model proves successful on the new JSF program, it is likely to set the precedent for all future major weapons contracting by the U.S. government.

Editor's note: The really spectacular part of this model is that all of the key principles are being taught today through the AME Lean Series of seminars on Lean Program Management, Lean Design, Lean Supply Chain, and the Kaizen Blitz workshop, added John Puckett. AME and Lockheed Martin plan an additional workshop focusing on the manufacturing aspects of the JSF and how the lean design transforms into lean manufacturing. Watch for AME Lean workshops on the website (www.ame.org).

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