

# Best Practices in Aerospace Lean Manufacturing: The Migration to a Lean Enterprise

## WHITE PAPER

Cincom In-depth Analysis and Review



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Cincom Manufacturing Business Systems

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#### About the Author

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## Overview

Lean manufacturing's greatest benefit is in eliminating waste from the many processes aerospace manufacturers rely on to anticipate, respond to, fulfill, and serve customers.

The objectives of this white paper are to first provide you with insights into how aerospace manufacturers are tackling the task of transforming lean production lessons learned into lean enterprise strategies and instituting lasting change at the process level. This includes a discussion of the lessons learned and steps aerospace manufacturing companies are taking to overcome the challenges of making lean enterprise strategies last.

Second, this white paper provides a self-rating test to see how your company measures up. Included is a maturity model that shows specifically how your company measures up relative to others in aerospace manufacturing.

Finally, recommendations are made as to how aerospace manufacturers can attain lean transformation based on the collective insights gained from research cited from MIT's Lean Aerospace Initiative and a variation of AMR Research's Demand Driven Supply Chain Maturity Model applied to aerospace manufacturing lean production processes maturity.

## Executive Summary

In the many studies MIT has done on the impact of lean manufacturing within the aerospace industry, the top areas that emerge from the Lean Aerospace Initiative (LAI) research include the following key insights. All of these can specifically be crafted into recommendations for manufacturers interested in attaining higher levels of performance as a lean enterprise.

- **Integration of environmental protection, compliance, health, and safety systems corporate wide.** Clearly the need for mitigating the significant costs of compliance as they relate to the use and disposal of chemicals and raw materials used in the production of aerospace products are many manufacturers' most critical concern. This speaks to the need for a comprehensive strategy surrounding Enterprise Compliance and Quality Management (ECQM).
- **Greater system-level integration with downstream stakeholder values and greater visibility into customer demands.** This relates back to the discussion at the beginning of this paper regarding how the highest-performing aerospace manufacturers are able to produce assets that in turn enable their customers to be lean. This second priority for customers is at the beginning of the 18-key criteria as defined by MIT's LAI group, and forms the basis of the self-rating scale included in this paper.
- **Reward both process standardization and greater cross-functional communication.** In several of the case studies that MIT and others have cited as examples of best practices in lean enterprises, the senior management teams worked to tear down the silos between departments by actively encouraging and rewarding cross-department and cross-division collaboration.
- **Allow the customer to have a seat at the development table.** MIT found that the highest-performing lean enterprises re-define their product development processes to support the inclusion of customers in the actual development environment. This has increased customer satisfaction, reduced the number of reworked orders, and also led to the development of cross-functional teams that attacked the processes that got in the way of allowing divisions to be more responsive to customers.
- **Integrate and reward lean initiatives' success and include them in both strategic planning and production systems planning.** The companies gaining the greatest competitive advantage through their efforts to become lean enterprises have started first with smaller projects and then progressed to enterprise-wide projects once the payoff has become clear.

## Aerospace Manufacturing Best Practices Start With Lean

Attaining best practices in lean manufacturing begins with embracing a lean enterprise vision for the enterprise first. In attaining this vision of a lean enterprise, aerospace manufacturers are pursuing higher levels of supply chain visibility, greater levels of collaboration with customers, and increasingly greater levels of real-time integration throughout their sourcing, pricing, manufacturing, and service systems. A lean enterprise is one that aligns itself to the goal of being as responsive and as accurate as possible in all responses to customers. In the aerospace industry, the higher the level of product complexity, the greater the need for a lean enterprise vision to be a reality.

What makes the lean enterprise vision so difficult to turn into a lean manufacturing strategy are the conflicts that push and pull on the same resources, tasks, and processes that need to be optimized for a lean manufacturing strategy to be consistent. The biggest conflict is the push and pull of innovation on the one hand and the need for aggressive cost reduction on the other. Consider the Airbus strategy in manufacturing the A380 and the tremendous costs of innovation required to design and manufacture that aircraft. The Airbus A380 is for many the symbol of aerospace innovation. Counter to this is the Boeing e787, a commercial aircraft due to be launched in 2008 with a 40% greater range while delivering a significant fuel savings at the same time. The competitive conflicts between Airbus and Boeing serve as an excellent illustration of the conflict aerospace manufacturers have in balancing innovation and cost reduction within a lean manufacturing environment. For Airbus, innovation is all about driving their customers' top-line revenue growth by supporting long-haul flights with 580 passengers onboard. In the case of Boeing and its e787, they are delivering a commercial aircraft their customers can in turn use to develop and sustain their own lean service strategies. Adopting lean manufacturing to deliver top-line revenue growth forces a supply chain into entirely new areas of requirements, often with unforeseen and unpredictable results. The Airbus A380 is a case in point. But when a lean manufacturing strategy is combined with supply chain and for that matter, accountability chain visibility, the ability to deliver products that in turn deliver the potential for customers to adopt their own lean manufacturing or services strategies as well takes hold.

This is what best practices in lean manufacturing within aerospace manufacturing is all about. The focus on having a lean enterprise vision and from that, strategy, that makes it possible to harness innovation to deliver even greater levels of efficiency in the design, procurement, quality, production, and services processes of a company are a lasting and nearly unassailable competitive advantage. The reason: a manufacturer capable of producing products that in turn makes its customers capable of becoming lean, either in services or downstream manufacturing, delivers value every day the product is used, regardless of it being a satellite, commercial jet, or spare part on communication devices. The essence of lean manufacturing in aerospace centers on how to create products infused with enough innovation to have a dropping cost to manufacture yet is innovative enough to deliver the potential of end-customers adopting lean services strategies in the end.

Yet for this best-practices vision, there are many barriers and impediments to growth when it comes to aerospace manufacturers adopting and executing on a lean vision. The intent of this paper is to provide an overview of those barriers and discuss approaches that can be taken to overcome them to attain a strong and sustainable lean manufacturing strategy.

*A lean enterprise is one that aligns itself to the goal of being as responsive and as accurate as possible in all responses to customers.*

## Barriers to Becoming a Lean Enterprise

The greatest challenges to any aerospace manufacturer in implementing a lean manufacturing strategy have more to do with a sense that nothing needs to change and that the organizational islands that have been created through years of processes are being unchallenged. Yet when one considers the work completed by AMR Research, Gartner, and the Massachusetts Institute of Technology's Lean Aerospace Initiative (LAI), it becomes clear that the same barriers to change are more process- than customer-centric. From the accumulated work of the sources mentioned, here are the major barriers to aerospace companies being able to transform themselves into a lean enterprise:

- **Lack of ownership at the C-Level to force change to existing processes.** What is consistent across industry advisory firms is the fact that all three rank the lack of urgency and lack of support for lean initiatives at the C-level as the major reason why so many companies fail to become lean enterprises. As the self-scoring survey in this paper will show, the lack of support and vision at the top of an organization actually encourages more siloed-based approaches to managing lean initiatives at the lower levels of the organization.
- **Lack of appreciation for the statement "What a company measures, it becomes."** For those aerospace manufacturers who are attaining lean enterprise-level performance, the cultures of their companies have become incredibly focused on metrics, and in fact, the organizations themselves have become so metrically driven that the culture itself embraces the concept of measuring performance and improvement. Those organizations that lack urgency for accountability and results never attain lean enterprise performance, according to the work completed by MIT's LAI initiative.

- **Lean positioned purely as a cost-cutting strategy corporate-wide.** This is also a critical mistake many aerospace manufacturers make, and often becomes the main focus these companies continue to pursue as opportunities to better integrate their strategies with customers, suppliers, buyers, and service organizations present themselves.
- **Lack of commitment to lean enterprise initiatives as illustrated by no support for a Lean Programs Office.** In the intensive research and analysis as completed by MIT, the researcher found that without a consistently high level of support for lean initiatives to the point of creating a Lean Programs Office, the ability to reach a collaborative level of performance dropped off significantly. Those companies attaining best practices in lean enterprises create a Lean Programs Office and staff it with senior executives who have the authority to re-align processes if necessary to attain lean enterprise objectives.

*Overcoming these barriers to becoming a Lean Enterprise needs to be propelled by a passion to serve your customers better than any other supplier ever has before.*

## Evolution of the Lean Enterprise in Aerospace

Aerospace manufacturers have continually struggled to gain the advantages of lean manufacturing, starting first with manufacturing processes at the shop-floor level and progressing to a vision of implementing an entire lean enterprise. What's become essential in the pursuit of the lean enterprise is a very focused and well-managed migration away from cost reduction as the primary payoff for a lean strategy to one that is more focused on organization-wide efficiency and the resulting impact on financial metrics. Table 1, Characteristics of a Lean Production System, shows the specific lean production processes and accompanying system change initiatives.

What is most critical to keep in mind about the characteristics of how lean enterprises measure themselves are the five process areas as shown in the Performance Measurement System line of Table 1. Having a balanced set of strategic metrics, continually looking to improve cost accounting, working to support top-down communication, and most critically, focusing on turning an internal focus to an external one are all essential for any company to transform itself into a lean enterprise. Finally, the approach of process management and measures both from a customer and supplier standpoint, and the ability to both quantify and measure performance on this critical attribute, is essential for an organization to transform itself into a lean enterprise.

**Table 1: Characteristics of a Lean Production System**

	<b>Lean Production Process</b>	<b>System Change Initiative</b>
<b>Focus</b>	Production line (tasks, activities, and cells)	Single organization (departments, processes, suppliers, and customers)
<b>Practices</b>	Cellular manufacturing, quality circles, supplier relationship management, pull production, re-engineering setups	TQM, JIT, Six Sigma and, process re-engineering
<b>Measures</b>	Task time, on-time delivery, first time through, safety performance, production rate	Quality, delivery, process time, cost, flexibility, customer satisfaction
<b>Performance Measurement System</b>	<ul style="list-style-type: none"> <li>• Visibility – real-time reporting</li> <li>• Casual relationships (production tasks and activities)</li> <li>• Use of single version of the truth and single information</li> </ul>	<ul style="list-style-type: none"> <li>• Balanced set of strategic metrics (financial and non-financial)</li> <li>• New methods of cost accounting (ABC, target costing)</li> <li>• Top-down communication</li> <li>• Internal versus external focus (benchmarking and self-assessment)</li> <li>• Process management and measures (value delivery)</li> </ul>

Table 2, Comparing Lean Production and Lean Enterprise Characteristics, illustrates the many differences in focus, practices, metrics, and performance measurement systems. The shift required in aerospace companies to achieve this level of performance needs to start with the recommendations at the end of this paper and continually build upon insights gained from the survey contained within this paper.

**Table 2: Comparing Lean Production and Lean Enterprise Characteristics**

	<b>Lean Production Process</b>	<b>System Change Initiative</b>	<b>The Lean Enterprise</b>
<b>Focus</b>	Production line (tasks, activities, and cells)	Single organization (departments, processes, suppliers, and customers)	Extended enterprise (value streams and all stakeholders)
<b>Practices</b>	Cellular manufacturing, quality circles, supplier relationship management, pull production, re-engineering setups	TQM, JIT, Six Sigma and, process re-engineering	Seamless information flow, integrated product and process development, process capability and maturation, identify and optimize enterprise flow, maintain stability in changing environment, align and involve all stakeholders to achieve lean vision, relationship based on mutual trust and commitment across the extended enterprise, make decisions at the lowest levels, optimize capability and utilization of people, focus on external and internal environment, nurture a learning environment
<b>Metrics</b>	Task time, on-time delivery, first time through, safety performance, production rate	Quality, delivery, process time, cost, flexibility, customer satisfaction	Stakeholder value (effectiveness), overall efficiency, system availability, system level flexibility
<b>Performance Measurement System</b>	<ul style="list-style-type: none"> <li>• Visibility – real-time reporting</li> <li>• Casual relationships (production tasks and activities)</li> <li>• Use of single version of the truth and single information</li> </ul>	<ul style="list-style-type: none"> <li>• Balanced set of strategic metrics (financial and non-financial)</li> <li>• New methods of cost accounting (ABC, target costing)</li> <li>• Top-down communication</li> <li>• Internal versus external focus (benchmarking and self-assessment)</li> <li>• Process management and measures (value delivery)</li> </ul>	<ul style="list-style-type: none"> <li>• Stakeholder value measures</li> <li>• Uniform set of measures</li> <li>• Casual relationships between measures across all levels</li> </ul>

## How Does Your Company Rate?

Based on the collective work completed at the Lean Aerospace Initiative (LAI) at the Massachusetts Institute of Technology (MIT) specifically in the area of evaluating and benchmarking aerospace manufacturers' performance to lean initiatives, the following series of life-cycle processes were created. These form the foundation of the survey below where you can quantify the level of performance your organization has to the goal of being a lean enterprise.

The 18 life-cycle processes as defined by the LAI:

### Business Acquisition and Program Management

- Leverage lean capability for business growth
- Optimize the capability and utilization of assets
- Provide capability to manage risk, cost, schedule, and performance
- Resource and empower program development efforts

### Requirements Definition

- Establish a requirements definition process to optimize life-cycle value
- Utilize data from the extended enterprise to optimize future requirement definitions

### Develop Product and Process

- Incorporate customer value into design of products and processes
- Incorporate downstream stakeholder values into products and processes
- Integrate product and process development

### Supply Chain Management

- Define and develop supplier network
- Optimize network-wide performance
- Foster innovation and knowledge-sharing throughout the supplier network

### Produce Product

- Utilize production knowledge and capabilities competitive advantage
- Establish and maintain a lean production system

### Distribute and Service Product

- Align sales and marketing to production
- Distribute product in lean fashion
- Enhance value of delivered products and services to customers and the enterprise
- Provide post delivery service, support, and sustainability

In creating a questionnaire from these 18 factors, it's critical to take into account the maturity levels of each attribute as it relates to the performance of an entire organization. It is not enough to simply look at a binary, either/or condition for each factor. It is rather the level of maturity on each of these 18 attributes that determines a company's potential for attaining best practices in the lean enterprise.

Using a four-point scale applied to each of these factors yields a self-scoring questionnaire, which is shown in the following table. Giving just one answer for each of the 18 factors, calculate your company's score for lean enterprise performance.

### Benchmarking Your Company's Lean Enterprise Maturity

	Manually Done If at All (1)	Only within Departments (2)	Cross-department Collaboration (3)	Corporate-wide Collaboration (4)
<b>Business Acquisition and Program Management</b>				
Leverage lean capability for business growth				
Optimize the capability and utilization of assets				
Provide capability to manage risk, cost, schedule, and performance				
Resource and empower program development efforts				
<b>Requirements Definition</b>				
Establish a requirements definition process to optimize life-cycle value				
Utilize data from the extended enterprise to optimize future requirement definitions				
<b>Develop Product and Process</b>				
Incorporate customer value into design of products and processes				
Incorporate downstream stakeholder values into products and processes				
Integrate product and process development				
<b>Supply Chain Management</b>				
Define and develop supplier network				
Optimize network-wide performance				
Foster innovation and knowledge-sharing throughout the supplier network				
<b>Produce Product</b>				
Utilize production knowledge and capabilities competitive advantage				
Establish and maintain a lean production system				
<b>Distribute and Service Product</b>				
Align sales and marketing to production				
Distribute product in lean fashion				
Enhance value of delivered products and services to customers and the enterprise				
Provide post delivery service, support, and sustainability				
<b>TOTALS:</b>				

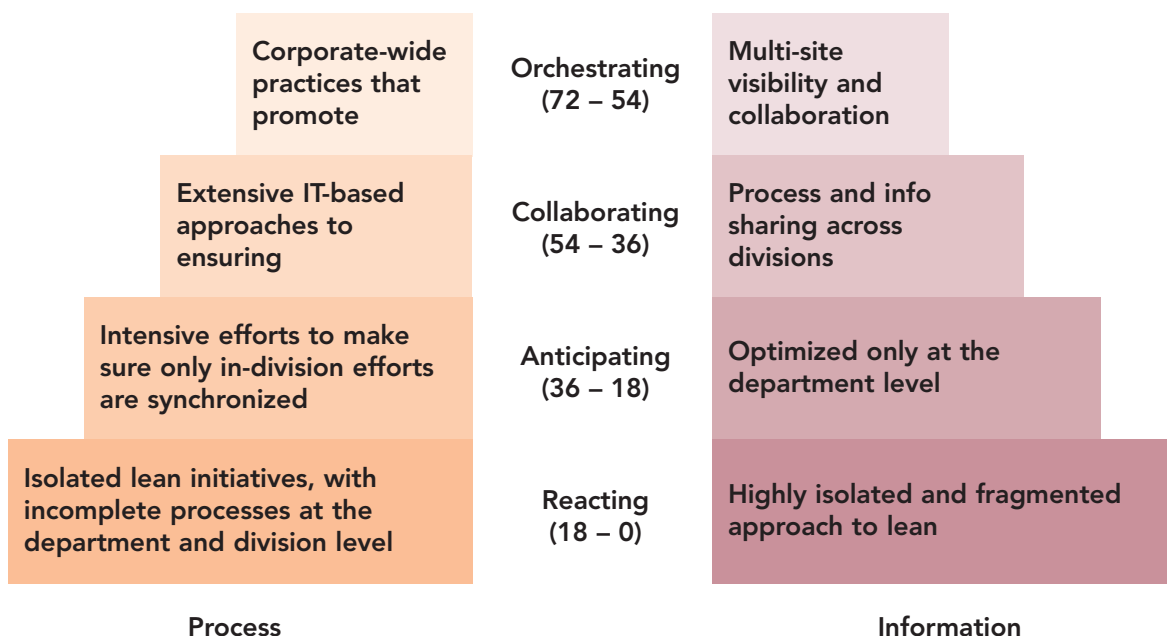
After having scored your organization on its lean initiatives, use the following table to define where your organization is on the Lean Enterprise Maturity Model:

Score	Level in the Lean Enterprise Maturity Model
72 – 54	Orchestrating – Where an organization has a very high level of cross-department and division collaboration and often has a corporate-wide edict that forces lean enterprise principles deep into the organization.
54 – 36	Collaborating – A series of process- and IT-based infrastructures exist to ensure cross-department and cross-divisional collaboration.
36 – 18	Anticipating level – Marked with in-division collaboration only.
18 – 0	Isolated approach to lean – Heavily influenced by silos of departments that do not communicate and collaborate with one another.

The following graphical representation of the Lean Enterprise Maturity Model illustrates how each level of maturity varies by Process Maturity and Information Maturity. This graphical concept of a maturity model was originally proposed by AMR Research in the definition of Demand Driven Supply Networks (DDSN) maturity levels, and has direct applicability to lean enterprises' levels of maturity.

### Introducing the Lean Enterprise Maturity Model

(Source: graphical concept from AMR Research)



## Recommendations for Attaining Lean Transformation

In the many studies MIT has done on the impact of lean manufacturing within the aerospace industry, the top areas that emerge from the Lean Aerospace Initiative (LAI) research include the following key insights. All of these can specifically be crafted into recommendations for manufacturers interested in attaining higher levels of performance as a lean enterprise.

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- **Greater system-level integration with downstream stakeholder values and greater visibility into customer demands.** This relates back to the discussion at the beginning of this paper regarding how the highest-performing aerospace manufacturers are able to produce assets that in turn enable their customers to be lean. This second priority for customers is at the beginning of the 18-key criteria as defined by MIT's LAI group, and forms the basis of the self-rating scale included in this paper.
- **Reward both process standardization and greater cross-functional communication.** In several of the case studies that MIT and others have cited as examples of best practices in lean enterprises, the senior management teams worked to tear down the silos between departments by actively encouraging and rewarding cross-department and cross-division collaboration.
- **Allow the customer to have a seat at the development table.** MIT found that the highest-performing lean enterprises re-define their product development processes to support the inclusion of customers in the actual development environment. This has increased customer satisfaction, reduced the number of reworked orders, and also led to the development of cross-functional teams that attacked the processes that got in the way of allowing divisions to be more responsive to customers.
- **Integrate and reward lean initiatives' success and include them in both strategic planning and production systems planning.** The companies gaining the greatest competitive advantage through their efforts to become lean enterprises have started first with smaller projects and then progressed to enterprise-wide projects once the payoff has become clear.



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