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# Implementing Lean in aerospace—challenging the assumptions and understanding the challenges

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**Abstract**

Lean manufacturing appears to hold considerable promise for addressing a range of simultaneous, competitive demands including high levels of process and product quality, low cost and reductions in lead times. These requirements have been recognised within the aerospace sector and efforts are now well established to implement Lean practices. Lean manufacturing was initiated within the automotive sector. However, since the publication of the influential book, *The Machine That Changed the World* (Womack et al., 1990) there has been a range of documented cases of Lean implementation in a variety of sectors. Despite this evidence, the perception remains that Lean manufacturing is to some degree, an 'automotive idea' and difficult to transfer to other sectors especially when there are major differences between them. In this paper we discuss the key drivers for Lean in aerospace and examine the assumption that cross-sector transfer may be difficult. A Lean implementation case comparison examines how difficulties that arise may have more to do with individual plant context and management than with sector specific factors.


*Keywords:* Lean; Aerospace, manufacturing strategy

## 1. Introduction

Manufacturing has undergone radical and fundamental changes over the past decade. The relatively 'static' nature of market conditions within the mass production era have now been replaced by market requirements that are profoundly different to mass production. The terms used to describe the current era include:

- *Mass Customization* (Pine et al., 1993)—reflecting the need for volume combined with recognition of customers' (or 'consumers') wishes.
- *Flexible Specialization* (Piore and Sabel, 1984)—related to the manufacturing strategy of firms (especially within small firms) to focus on parts of the value-adding process and to collaborate within networks in order to produce whole products.
- *Lean Production* (Womack et al., 1990)—developed from the massively successful Toyota Production System, focusing on the removal of all forms of waste from a system (some of which are difficult to see).
- *Agile* (Kidd, 1994) emphasising the need for an organisation to be able to switch frequently from one market-driven objective to another
- *Strategic* (Hill, 1995; Brown, 1996) in which the need for the operations to be framed in a strategy is brought to the fore.

Whatever term is employed, the paradigm for the current era is, as mass production was a hundred years ago, a major innovation process that makes the system it replaces, largely redundant. Time-to-market and product customization are now high on the strategic agenda (Clark and Fujimoto, 1991; Hart and Berger, 1993; Pine et al., 1993; Sasaki, 1991).

Perhaps the most popular term to describe the current era is that of Lean production. This developed from the book, *The Machine That Changed the World*, in which the authors examined the Toyota Production System and provided data on Lean and non-Lean plants within the automotive industry (Womack et al., 1990). Lean production describes the Japanese-style manufacturing process pioneered by Toyota, which uses a range of techniques including just-in-time inventory systems, continuous improvement, and quality circles (Krafcik, 1988). Lean is concerned not only with the firm's

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internal manufacturing capabilities, but is also heavily dependent upon supplier involvement within the supply network (Levy, 1997; Oliver et al., 1996). The essential characteristics of Lean production include the following factors:

- Integrated production, with low inventories throughout, using Just-in Time management;
- Emphasis on prevention, rather than detection in quality;
- Production is pulled in response to customers, rather than pushed to suit machine loading or other in-house ideas of scheduling;
- Work is organized in teams, using multi-skilled workforce problem solving to eliminate all non added value (Dankbaar, 1997);
- Close vertical relationships, integrating the complete supply chain from raw material to customer.

The claims of the authors of *The Machine That Changed the World* were both bold and clear. Ultimately, it is claimed, Lean practices will spread to all manufacturing:

> ....the adoption of Lean production, as it inevitably spreads beyond the auto industry, will change everything in almost every industry—choices for consumers, the nature of work, the fortune of companies, and, ultimately, the fate of nations (Womack et al., 1990:p. 12)

and

> ...we believe, Lean production will supplant both mass production and the remaining outposts of craft production in all areas of industrial endeavor to become the standard global production system of the twenty-first century (Womack et al., 1990, p. 278).

Undoubtedly, as Womack et al. (1990) predicted, Lean practices have crossed from the automotive sector into other industries. However, the Lean paradigm is not without its critiques. For example, Delbridge (1998) is very critical of supposed benefits of team working and empowerment promised by the adoption of Lean practices and argues that these are based on myth. These views have some support in the aerospace sector, as the following quote illustrates:

> "Lockheed's version of Lean manufacturing isn't with employee empowerment", says Terry Smith, a business representative with the International Association of Machinists and Aerospace Workers (LAM) at the Ft. Worth plant. "Their version of Lean manufacturing is more top down where they say, 'We want you to do it this way so we can figure out how to do it cheaper and with less people'"*Manufacturing News*. (April 10, 2000 p. 3)

Despite some criticism with Lean, the Aerospace sector has recognised the opportunity to eliminate huge amounts of waste within its value streams and the Lean 'revolution' within the industry is clearly underway, as the following indicates:

> The aerospace industry is in the grip of a revolution. Its name is 'Lean' and its guiding principle is the elimination of waste from the production cycle. The revolution is moving out of the prototyping shops and on to the assembly lines, with dramatic results—and none too soon. The automotive industry has been Lean for years. In aerospace, avionics and engine manufacturers embraced Lean thinking long before the airframe makers. Now airframers are moving fast to catch up. Their motivation is the promise of faster development, better quality and lower cost" *Flight International*. (Sept, 1999)

This is endorsed by Cook (1999) when he states:

> Lean aircraft designers consider that a new 'right first time' culture in aerospace manufacturing will do for aircraft what it did for the car industry a decade ago. Under the new regime, panels and components damaged in operation can be quickly replaced at the front line without special customization in much the same way that car parts are ordered up and fitted in the commercial world. Employees involved in all aspects of Eurofighter production—from the design stage through to logistic support—are grouped in integrated product teams (IPTs). Each IPT is responsible for its own budget and accountable for its particular section of the aircraft (Cook, 1999).

The adoption of Lean practices are evident in the US and UK. In the US, Lockheed Martin's Aeronautics Sector declared 1999 as the 'year of Lean and is rigorously applying Lean techniques to the F-16 and F-22 fighter programmes and the C-130J military transport aircraft. In the UK, BAE Systems' military aircraft plants have been heavily involved in employing Lean practices within their businesses in recent years. The Samlesbury site became the company's flagship manufacturing site, believing that Lean manufacturing was central to controlling costs on the Eurofighter programme. However, BAE Systems perceives that the aerospace industry is 10–15 years behind the automotive sector in implementing Lean ideas (Flight International, Aug–Sept, 1998).

Lean ideas are now being transferred throughout the UK aerospace industry, with major initiatives also underway in many manufacturing firms including Airbus