

**AEROSPACE MERGERS AND ACQUISITIONS
FROM A LEAN ENTERPRISE PERSPECTIVE**

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SUBMITTED TO THE SYSTEM DESIGN AND MANAGEMENT PROGRAM
IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE OF

MASTER OF SCIENCE IN ENGINEERING AND MANAGEMENT

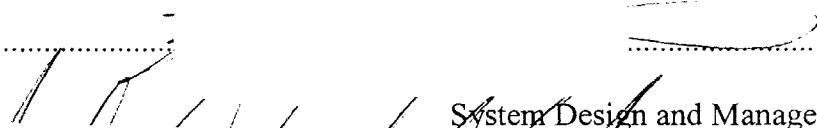
at the


MASSACHUSETTS INSTITUTE OF TECHNOLOGY

June 2004

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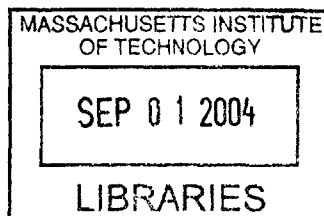
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Submitted to the System Design and Management Program
on March 01, 2004 in partial fulfillment of the requirements for the
Degree of Master of Science in Engineering and Management

ABSTRACT

In the past twenty years, companies in the aerospace industry experienced major transitions: mergers and acquisitions, and lean transformation initiatives. This thesis presents research about the relation of lean efforts and mergers and acquisitions. It is based on case studies of mergers and acquisitions undertaken by Boeing Company. In order to obtain supplementary research data, case studies were also developed regarding the mergers and acquisitions of Vought Aircraft and United Technologies Corp. These different cases focus on mergers and acquisitions between companies at varying levels of lean maturity. For example, the merger between Boeing and McDonnell Douglas is between companies at a similar level of lean maturity, while Vought's acquisition of Aerostructure required integration between a low-level lean company and a company with more advanced lean initiatives.

The thesis provides detailed discussion of the changes that occurred after the mergers or acquisitions in terms of lean effort, barriers and solutions to lean transition during the integration process, and changes in the rate of lean efforts during and after the merger or acquisition.

The research concludes that leadership, communications, and education are pivotal to successful lean transition during the integration process. Lean offices and Process Councils, generally part of a structured lean effort, facilitate the process. The difference in level of lean maturity was not a big factor during the early stage of a merger or acquisition, but different levels of lean maturity, as well as lean expertise, had important impacts in later stages of the integration process.

Key Words: Lean Enterprise, Lean Manufacturing, Lean Engineering, Lean Supply Chain Management, Lean Transition, Mergers and Acquisitions, Leadership, Communications, Educations, Lean Maturity, Integration, Boeing, McDonnell Douglas, Hughes Space and Communications.

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Acknowledgements

As a result of this thesis work, I have achieved my academic goals: understanding lean enterprises and how to apply lean principles to real business. Understanding the concept of lean and of mergers and acquisition was a journey to an unknown world for me. This thesis work changed my perspective on the world by helping me see the engineering world from a management perspective. I really appreciate Dr. Joel Cutcher-Gershenfeld, my thesis advisor, for equipping me with a complex perspective that lies somewhere between engineering and management. He instilled in me a better, more efficient way to think and the know-how to combine and manage different perspectives. My desire is to take this learning back to Korea and seek opportunities to apply lean principles to Korean companies in order to enable them to develop a competitive edge in the global economy.

There many people to whom I must give my appreciation for their assistance with my thesis work.

Above all, I would like to thank my Korean friends, Yong Sung, Woojai, and Jung In, who have been like a family to me. Without their invaluable support, I would have stopped this work months ago. I owe them a great debt. I also wish to thank the Korean students at the Sloan School for encouraging me with their many warm words and hospitality. Likewise, my thanks go to my supporters in Korea, including old friends and colleagues in previous companies.

Certainly I wish to thank various interviewees from different companies for taking their valuable time to share their experiences with me. Specifically, I appreciate Allen, the gentleman who supported my thesis work enthusiastically, clarifying for me its business and academic perspectives. Other faculty members at MIT were extremely helpful, including Prof. Debbie Nightingale, Prof. Paul Carlile, Prof. Earll Murman, Dr. Kirk Bozdogan, and Ted Piepenbrock who helped guide my thesis work and gave me creative perspectives.

I also wish to thank Wei Hu, Kin Sing, Nisheeth, and Christos, international students in SDM for sharing many difficult hours together with me as we cheered each other on. My thanks, too, for the people in the SDM office—Denny, Ted, Bill, and Jeff. They supported my study in countless ways. Ann and Helen in the ESD office, like my mother, constantly encouraged me not to give up on this hard work, and they helped me successfully complete the SDM coursework in this country.

Finally, I thank my family with great respect and love. They taught me to live my life with passion, honesty, and ambition — hidden motivations instilled in my mind, encouraging me to grow endlessly.

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CHAPTER 1

INTRODUCTION

1.1 BACKGROUND

The U.S. aerospace industry has experienced many changes in the past twenty years, including cuts by the Federal government in the budget for the Department of Defense after the end of the cold war. Global competition has increased on the commercial business side. These changes have led aerospace companies to reshape their business mindset, thus improving profitability and business efficiency. And many aerospace companies have begun to introduce so-called “lean” practices, which can be defined as a specific culture and business philosophy, not a business tool. Some companies have accomplished their lean practices by merging or acquiring other companies in order to gain a competitive advantage.

The process referred to as lean has proven to be a superior approach to improving operational efficiency in the aerospace industry. This phenomenon has occurred partly as a result of pressure on the commercial manufacturers from the U.S. Air Force as well as from other companies. In response, several companies have studied lean practices and subsequently changed their manufacturing systems to a lean production system. Companies that started lean have succeeded in reducing production cycle times and inventories, and have introduced statistical quality management systems. However, those companies, as well as others, are still in the process of becoming lean.

There have been many mergers and acquisitions in the aerospace industry. According to a semi-annual review by the trade journal *Defense Mergers and Acquisitions*, nearly \$60 billion worth of deals were announced or completed in the first half of 1999, while the total value of defense mergers in 1992 was about \$2.5 billion, and \$6 billion in 1993. The top three U.S. defense contractors—Lockheed Martin, Boeing, and Raytheon, which together accounted for 25% of all defense contracts in 1998—have all evolved as the result of major mergers (Hellman, 1999).

These two major changes—mergers and acquisitions and lean production—have wrought significant change in the aerospace industry. However, few studies have been done about the relationship between mergers and acquisitions and lean production. For this thesis, I researched the impact of a lean production transition which took place between two companies who merged and then I reviewed several merger/acquisition cases involving companies with different lean maturities.

I selected Boeing as the primary subject of my research for two reasons. First, Boeing actively deploys lean production, including a lean vision of the aerospace industry, and it has studied lean deployment based on its experience. Second, Boeing merged or acquired different companies who were at different levels of lean, including the largest merger experience in the industry with McDonnell Douglas. Then, to obtain added supporting data about mergers and

acquisitions from other companies who represent a different level of lean maturity, I also researched the mergers and acquisitions of Vought Aircraft and United Technologies Corporation (UTC).

1.2 OBJECTIVE

The purpose of this thesis is to determine the effects of mergers and acquisitions on a company's lean enterprise efforts, and thus be in a position to recommend a better way to accomplish the transition to lean during and after a merger/acquisition between companies with different lean maturities.

There are several key questions to be considered:

- What changes have occurred after mergers and acquisitions, in terms of lean effort?
- What are the barriers and solutions to the lean transition after mergers and acquisitions?
- Did the rate of lean effort of a company change after mergers and acquisitions?

To answer these questions, I conducted interviews of Boeing employees who were involved in the lean production process and with mergers and acquisitions, choosing interviewees who represented various levels in the company structure. I structured the interviews specifically to gather data about two Boeing mergers: one with McDonnell Douglas and the other with Hughes Space and Communications. These cases are quite different in that both companies were at different levels of lean maturity at the time they merged with or were acquired by Boeing.

Then, in order to better understand the merger/acquisition process when it involves companies at different stages of lean, I interviewed people from Vought Aircraft and from UTC. Vought Aircraft acquired Aerostructure Company in 2000; UTC acquired Sundstrand in 1999.

I categorized the interviews in the following way: the effect of mergers and acquisitions on the lean efforts between—

- a merger of two companies that had a medium level of lean but different levels of lean expertise;
- the acquisition of a company that had a mature level of lean with a company that seemed less successful prior to the merger/acquisition;
- the acquisition of a company that had a medium-low level of lean with a company that had no experience with lean (absorption);
- the acquisition of a company that had a low level of lean with a company that had no experience in lean (limited integration)

These case studies helped me determine whether differences in lean expertise and lean maturity would affect the lean transition during and after the merger/acquisition; what changes, barriers, solutions, and lessons could be identified in each situation; and what general lessons were available for exemplifying a successful lean transition in a merger or acquisition.

1.3 RESEARCH METHODS

I used two research methods: literature research and personal interviews with employees of aerospace companies.

In the literature research presented in chapter 2, I gathered publicly available information about the aerospace industry, lean enterprises, mergers and acquisitions, and Boeing itself. This chapter focuses on:

- industry dynamics in the aerospace industry over the past twenty years
- lean enterprise or lean concepts in the aerospace industry
- mergers and acquisitions as an integration process in the context of lean efforts.

From the literature research, I began to understand why lean deployment and mergers and acquisitions occurred in the aerospace industry, what lean practices have been used and developed, the nature of the organizational and cultural changes that occur during and after mergers and acquisitions, and the areas that should be carefully considered prior to a merger or acquisition between two companies with different levels of lean expertise and maturity.

In chapter 3, I analyze Boeing's lean efforts and its mergers and acquisitions based on public information. I sought reasons for mergers and acquisitions in terms of organization, business portfolio, and lean enterprise effort. I also gathered brief background information about the mergers and acquisitions engaged in by Vought Aircraft and UTC.

In chapter 4, I provide detailed information about the interviews, as well as the interview questions and the analysis method used to support the interview results.

The results are provided in chapter 5, where I give feedback from my interviews with Boeing employees and those in other companies who were directly or indirectly involved with lean enterprise efforts and mergers/acquisitions with other companies. The chapter includes:

- Case 1: Boeing's merger with McDonnell Douglas
- Case 2: Boeing's acquisition of Hughes Space and Communications
- Case 3: Vought Aircraft's acquisition of Aerostructure Corporation
- Case 4: UTC's acquisition of Sundstrand
- an additional case study of Boeing's lean transition with its suppliers

From the interviews, I gathered data about all the cases, focusing specifically on the changes, barriers, solutions, and lessons learned relevant to lean efforts during and after mergers and acquisitions.

In chapter 6, I developed models of a lean transition for each case study and then discuss general principles for a successful lean transition during the merger or acquisition. In Boeing's mergers and acquisitions, I tried to confirm whether the mergers and acquisitions accelerated the

company's efforts to transition to a lean enterprise, based on qualitative data from the interviews and quantitative data from the financial information available in Boeing's annual reports.

In chapter 7, I offer conclusions arising from my research, make suggestions for future work, and recommend a roadmap for the success of post-merger lean processes.

The thesis structure is illustrated in the Figure 1.1.

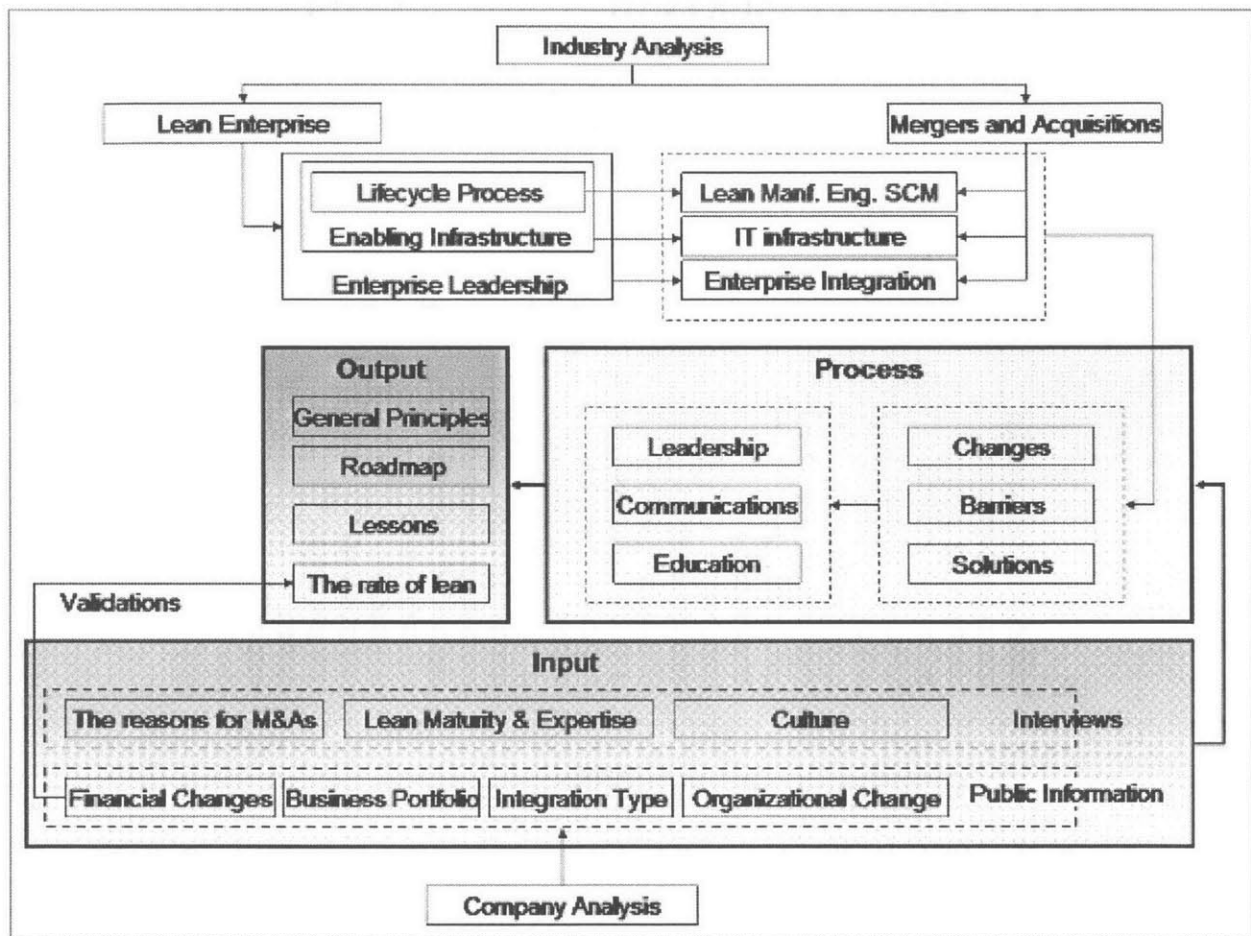


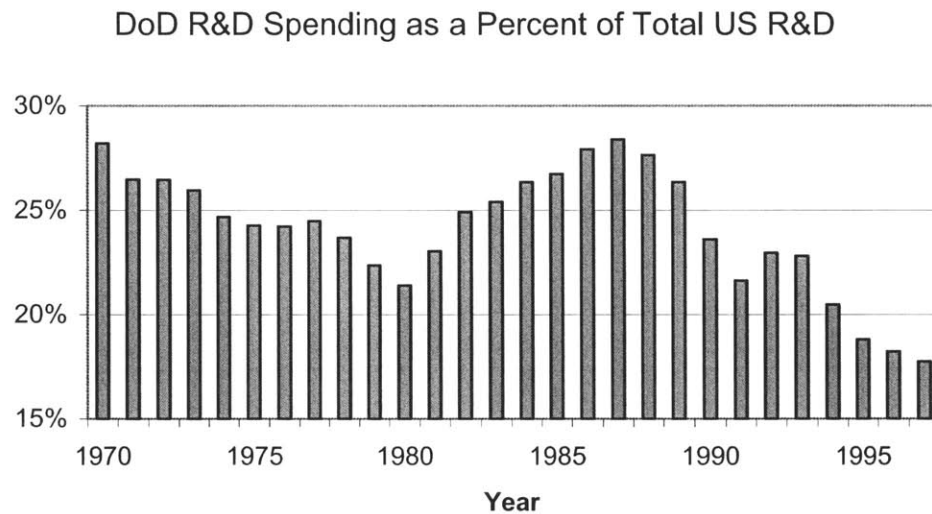
Figure 1.1 Thesis Structure

CHAPTER 2

LITERATURE REVIEW

2.1 TWENTY YEARS OF CHANGE IN THE AEROSPACE INDUSTRY

With the collapse of the Soviet Union in the early 1990s, and the end of cold war, the American aerospace industry entered an era of dramatic restructuring and downsizing (Murman, 2002), which triggered deep cuts in defense spending. Figure 2.1 illustrates the cuts in defense spending for R&D.



Source: National Science Foundation.

Figure 2.1 Department of Defense R&D spending

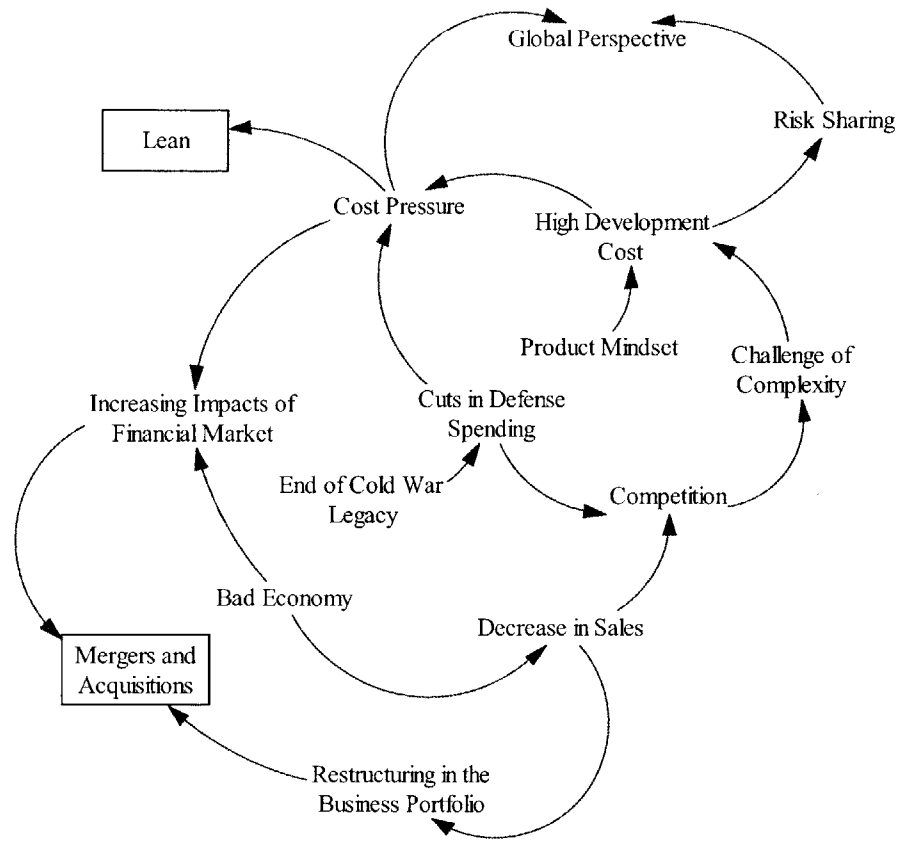
The cuts in defense spending triggered the integration of commercial and defense technologies in the aerospace industry in general (Ciardello, 2000). That meant that the Department of Defense (DOD) began to place greater emphasis on technologies that could be used in both the commercial and defense industries. It led to consolidation of competition among the top eight defense suppliers. The DSB Report on Antitrust of Defense Industry Consolidation (April 1994) noted that “budget reductions have led to vast overcapacity in the defense industry that can only be eliminated through downsizing and competition.”

A sluggish global economy in the early 1990s caused problems for civil aviation as well. Many airlines canceled their orders, and competitions were expected to be severe, impelling a number international joint ventures, mergers and acquisitions, layoffs, and restructuring.

In addition to competition, high development costs as a result of increasingly complex products led American aerospace manufacturers to enter into work arrangements with foreign companies. This was different from the past in that while earlier arrangements included co-production and licensing agreements, the new trend covered joint ventures and collaborative arrangements in the design, production, and marketing of aerospace products and systems. In the end, internationalization expanded far beyond the original practice of subcontracting. Given rising production expenses, American firms willingly broadened their horizons to include risk-sharing with foreign manufacturers of structural subassemblies.

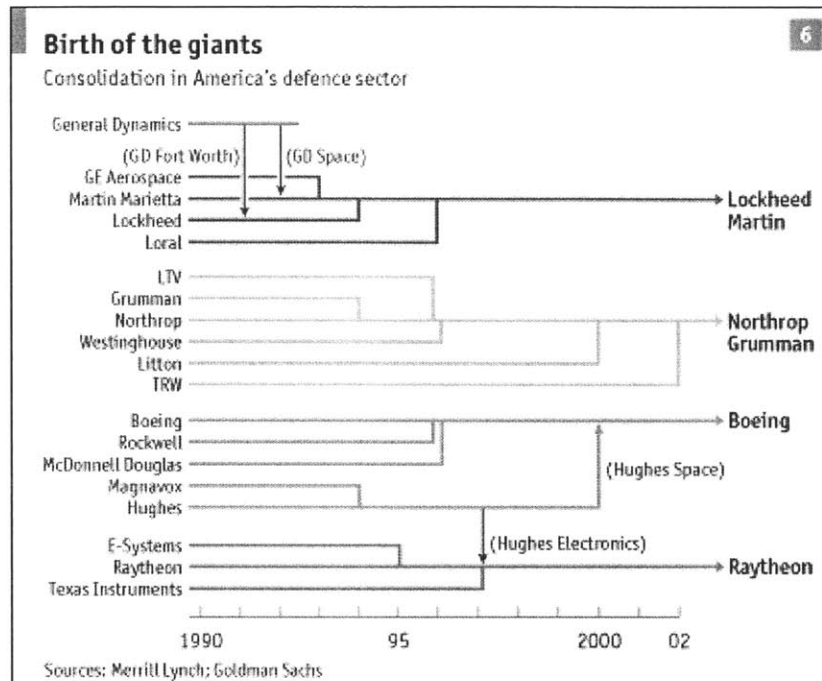
Financial markets have always been important stakeholders, but their impact on the aerospace industry as grown as well. In this context, pressures for lower costs and improved return on capital were being required by the financial markets, again impelling the dramatic restructuring and mergers and acquisitions that began to occur in the aerospace industry.

In the end, U.S. aerospace companies embarked on mergers and acquisitions, and they began to introduce the entire concept of “lean” with the aim of reducing costs and increasing profitability. Figure 2.2 is an exploratory cause-and-effect diagram that shows the dynamics of the U.S. aerospace industry. As you can see from the diagram, various factors in the industry led in mergers and acquisitions and lean deployment. Figure 2.3 shows the mergers and acquisitions of aerospace companies in the U.S. As you can see from this diagram, there has been significant consolidation in this industry.



Source: author

Figure 2.2 Aerospace Industry Dynamics in the Past Twenty Years



Source: *The Economist*, 7/18/02

Figure 2.3 Mergers and Acquisitions in Aerospace Industry

2.2 THE LEAN ENTERPRISE

2.2.1 The Concept

The Lean Aerospace Initiative at MIT, which created the concept of a lean enterprise, defined it as follows:

“A lean enterprise is an integrated entity which efficiently creates value for its multiple stakeholders by employing lean principles and practices.”

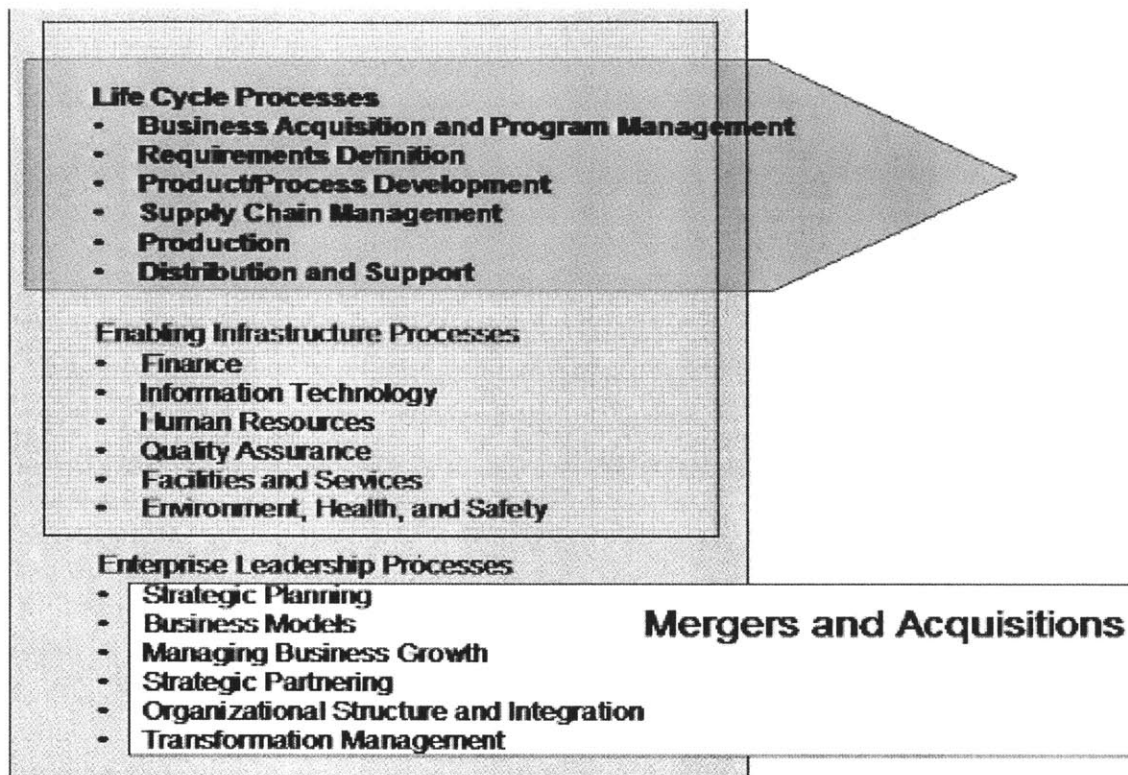
-Lean Aerospace Initiative, MIT, 2001

The following description of a lean enterprise appears in the Boeing 2001 Annual Report, describing the concept of lean enterprise that Boeing pursues:

Our entire enterprise will be a Lean Operation, characterized by the efficient use of assets, high inventory turns, excellent supplier management, short cycle times, high quality and low transaction costs.

- 2001 annual report of Boeing

“Lean Enterprise Value” describes the generic enterprise process architecture of a lean enterprise as shown in Figure 2.4.



Source: Murman, 2002

Figure 2.4 Generic Enterprise Process Architecture

The life cycle process shown in the figure includes the traditional functional aspects of a business related to product or program execution. These are the value stream activities that contribute directly to revenue generation for the enterprise through the creation of products, systems, or services delivered to the enterprise customers.

Enabling Infrastructure Processes includes many traditional corporate support functions. In a lean enterprise, they are reoriented to support the Life cycle Processes. This can involve a major transformation in the operation of most support functions.

The final set, Enterprise Leadership Processes, does not show up on traditional organizational charts, but these processes play a critical role in setting the direction for an enterprise that wishes to transform to lean.

In this thesis, mergers and acquisitions that take place between companies with different levels of lean maturity are discussed in the context of enterprise integration as described by “Enterprise Leadership Processes.”

2.2.2 Characteristics of Lean

One of the key characteristics of lean is a culture of continuous improvement rather than a business tool for cutting costs, which is one of the main reasons why lean is so hard to deploy. The MIT Lean Aerospace Initiative describes the following as characteristics of lean (Murman, 2002):

1. Lean is *customer-focused*. “Customer focus” means that enterprise activities are pulled by customer needs and expectations. Implementing a Just-In-Time policy is an example of pull-based production. Through mergers and acquisitions, companies have more suppliers and more customers. A Just-In-Time policy that meets customer requirements on time requires companies to integrate or reduce their supplier base and the number of common parts in products during the integration process.
2. Lean is *knowledge-driven*. Lean maximizes productivity by drawing upon knowledge and innovations from everyone, including workers and suppliers, thus contributing to perfect quality. The involvement of different stakeholders in knowledge sharing requires trust-based relationships that include mutual commitment and obligation, both internal and external, with suppliers. In a merger or acquisition, the transfer of lean practices or knowledge will occur between companies that are at different stages of lean maturity or lean expertise. Therefore, in a merger or acquisition of lean companies, it is very important for one company to manage the transition of lean efficiently to the other company.
3. Lean *eliminates waste*. Lean identifies defects, over-production, transportation, movement, waiting, inventory, and over processing as wastes. Eliminating waste not only improves productivity but also increases flexibility and responsiveness to changing demands. In mergers and acquisitions, duplicated resources, such as materials, information, and people, are found during the process of integration. These resources can be minimized or efficiently managed with the lean principles for reducing wastes.
4. Lean *creates value*. It puts a premium on the growing pie, not just reducing cost, to benefit all stakeholders. Mergers and acquisitions can create value to stakeholders by reducing costs through supplier integration and by increasing sales through customer-base expansion.
5. Lean is *dynamic and continuous*. It pursues ongoing systemic as well as incremental improvement, both innovations and continuous improvement. Continuous improvements are accomplished through work standardization, productive maintenance, root-cause analysis, and worker training and empowerment. The post-merger or acquisition process requires continuous improvements it involves integration of two companies’ cultures and vision.

2.2.3 Life-Cycle Processes

The term 'Lean' originally referred to the lean manufacturing system utilized by Toyota, generally called the Toyota Production System (TPS). As lean thinking was applied to different areas of an enterprise, the concepts of lean engineering and lean supply-chain management also emerged. These three lean areas employ the same basic concepts and principles of lean thinking, but the goals and attributes are different. In this section, I focus on the difference in lean applications to each area.

2.2.3.1 Lean Manufacturing and Lean Engineering

The goal of lean manufacturing is to provide customized or diverse products to customers at the right time and with perfect quality. Thus the key issue in lean manufacturing is cost control. Using Just-In-Time, waste can be eliminated and production rate raised even with different customer requirements. *Jidoka* enables the company to remove defects and improve the quality of its products. Standardized work, leveled and balanced production, and *kaizen* contribute to the implementation of Just-In-Time and *Jidoka*, and a creative and engaged workforce supports this contribution (Shields, 2003). Figure 2.5 shows the attributes of lean manufacturing.

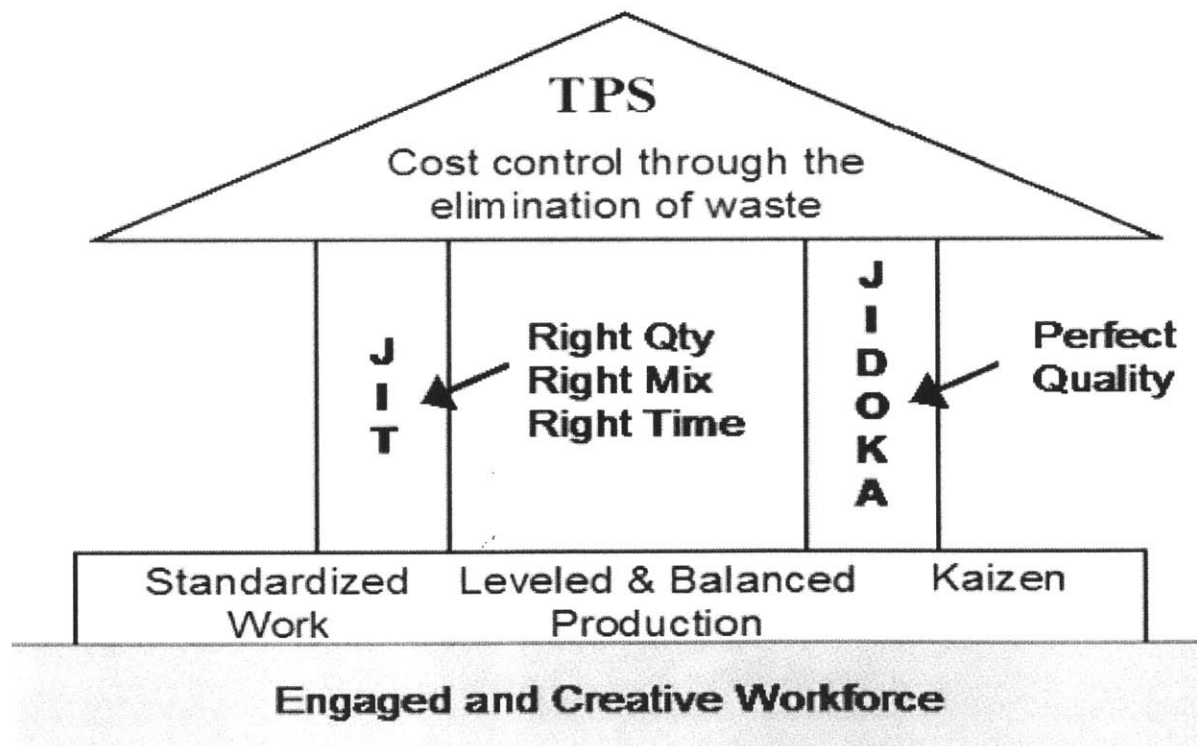


Figure 2.5 Toyota Production System

In a merger or acquisition, an organization with lean manufacturing expertise should share its lean expertise with the merged or acquired company which typically has different lean expertise. Therefore, the most synergies are obtained when the expertise of each company is exchanged between the two companies.

Lean engineering and lean manufacturing are part of the basic characteristics of lean, but the focus of each is somewhat different. Lean engineering has different goals from lean manufacturing, that is, engineering is the activity of product development, while manufacturing is the activity of producing products. The goals of lean engineering are to streamline the production development process and improve the product development cycle time. Lean engineering focuses on making sequential processes flow seamlessly and manages iterations to avoid unplanned rework. Thus, while the waste found in lean manufacturing generally covers materials, the waste found in lean engineering is related primarily to information (Nightingale, 9/03). Table 2.1 shows the difference between waste in lean engineering and lean manufacturing, and Table 2.2 shows the difference of focus between lean engineering and lean manufacturing.

Table 2.1 Waste in Lean Engineering and Lean Manufacturing

Waste	Lean Manufacturing	Lean Engineering
Over-production	Producing more or sooner than required	Creation of unnecessary data and information; information over-dissemination; pushing, not pulling, data
Inventory	Accumulations of materials beyond JIT requirements	Lack of control; too much in information; complicated retrieval; outdated, obsolete information
Transportation	Excessive movement of material, tools or parts	Information incompatibility; software incompatibility; communications failure; security issues
Unnecessary Movement	Any human movement that does not add value	Lack of direct access; reformatting
Waiting	Time in which no value is added	Late delivery of information; delivery too early (leads to rework)
Defective Products	Any item that does not meet specifications	Haste; lack of reviews, tests, verifications; need for information or knowledge, data delivered
Processing	Effort expended that does not add customer value	Unnecessary serial production; excessive/custom formatting; too many iterations

Source: Lean Aerospace Initiative

Table 2.2 Differences of Focus between Lean Manufacturing and Lean Engineering

	Lean Manufacturing	Lean Engineering
Define Value	Visible at each step	Harder to see, emergent goals
Identify Value Stream	Parts and Material	Information and Knowledge
Make Process Flow	Iterations are waste	Iterations often beneficial
Customer Pull	Driven by Takt Time	Driven by needs of enterprise
Perfection	Process repeatable without errors	Process enables innovation and cuts cycle time

Source: Lean Aerospace Initiatives

In an organization that has strength in lean engineering, engineering units have strong cultures. Thus, the diffusion of lean engineering to other organizations during mergers and acquisitions is not a simple exchange. Instead, the transition of lean overlaps with the transition of the strong engineering culture.

For efficient control of product and process development in lean engineering, Integrated Product and Process Development (IPPD) is critical in lean engineering. IPPD is a management technique that simultaneously integrates all essential acquisition activities through the use of multidisciplinary teams to optimize the design, manufacturing, and supportability of processes.

2.2.3.2 Lean Supply Chain Management

Lean supply chain management represents a new way of thinking about supplier networks. The lean principles in lean supply chain management require cooperative supplier relationships while at the same time balancing cooperation and competition. Cooperation involves a spectrum of collaborative relationships, coordination mechanisms and supplier partnerships, and strategic alliances are a key feature.

Lean supply chain management is a hybrid approach to organizing inter-firm relationships, representing a blend of “Arm’s Length” and “Vertical Integration” (Nightingale, 10/03). Arm’s length is defined as the way in which firms buy highly standardized inputs from outside specialized suppliers. This method lowers production costs but requires higher coordination costs. Vertical integration is the way in which firms produce required inputs in-house. It is quite customized, involves high transaction costs or dedicated investments, and requires close coordination. Usually companies use vertical integration for specialties and arm’s length for commodities. Table 2.3 shows the strengths and weakness of each approach.

Table 2.3 Vertical Integration versus Arm's Length

	Strengths	Weakness	Products
Vertical Integration	<ul style="list-style-type: none"> • Technology development • Better coordination of complex tasks • Less coordination and communication costs 	<ul style="list-style-type: none"> • Loss of economies of scale • High cost and capital expenditure 	<ul style="list-style-type: none"> • Specialties that requires specific quality and requirements
Arm's Length	Economies of scale and high productivity	High coordination Cost Less of technology development	Commodities that is sensitive to price

Mergers and acquisitions can change the structure of supply chain management. When two companies with vertically integrated suppliers and suppliers at arm's length integrate, there may be opportunities to reduce the number of suppliers or achieve economies of scales with each type of supplier. Meanwhile, the ratio of vertical integration to arm's length can change or a third supply network, such as virtual integration, can emerge.

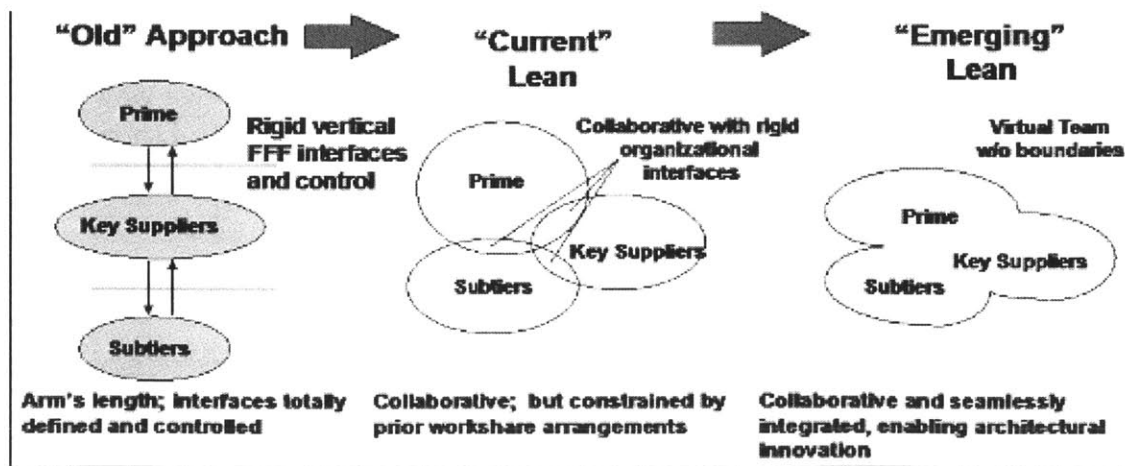
The advancement of information technology reduced coordination costs, making vertical integration less attractive. Increasing customization of demand and complexity of product made arm's length less desirable. So a mix of the two approaches emerged as a form of lean supply chain management. In this case, firm buys both customized and standardized inputs, and partnerships and strategic alliances are required for collaborative advantage (Piepenbrock, 2003). This can be gained through synchronized production and delivery. In order to achieve this, a company should share its lean principles with the supplier network.

Meanwhile, a transition of lean principles from the customer company to the suppliers occurs. The customer company should manage integrated supplier lead times and delivery schedules, and make customer demand pull supplier flows. The customer company and suppliers should try to minimize inventory throughout all tiers of the supply chain, thereby ensuring on-time supplier delivery to the point of use. A good quality management system can minimize incoming inspections and encourage companies to strive for zero quality defects. However, these applications are only available with an IT infrastructure that enables effective two-way communications about coordinating production and delivery schedules. Table 2.4 shows the lean principles and actions of the lean supply chain management.

Table 2.4 Lean Principles and Actions in Supply Chain Management

Lean Principles	Actions
Design Supplier Network Architecture	<ul style="list-style-type: none"> • Design of supplier network driven by strategic thrust • Fewer suppliers: Clustered control • Supplier selection based on performance
Develop complementary supplier capabilities	<ul style="list-style-type: none"> • Ensured process capability certification • Targeted supplier development • Greater responsibilities delegated to suppliers
Create flow and pull throughout supplier network	<ul style="list-style-type: none"> • Linked business processes • IT infrastructure • Two-way information change and visibility • Synchronized production and delivery (JIT)
Establish cooperative relationships and effective coordination mechanisms	<ul style="list-style-type: none"> • Joint problem-solving • Mutual assistance • Partnerships and strategic alliances • Open and timely communications • Increased interdependence and shared destiny
Maximize flexibility and responsiveness	<ul style="list-style-type: none"> • Seamless information flow • Flexible contracting • Rapid response capability
Optimize product development through early supplier integration	<ul style="list-style-type: none"> • Integrate suppliers early into design and IPTs • Collaborative design: Architectural Innovation • Open Communications and information sharing • Target costing: design to cost
Integrate knowledge and foster innovation	<ul style="list-style-type: none"> • Knowledge sharing: technology transfer • Aligned technology roadmaps

IT infrastructure plays an important role in designing and managing a supplier network. Figure 2.6 shows the role of IT infrastructure in integrating different stakeholders of supplier networks and in removing barriers among stakeholders.

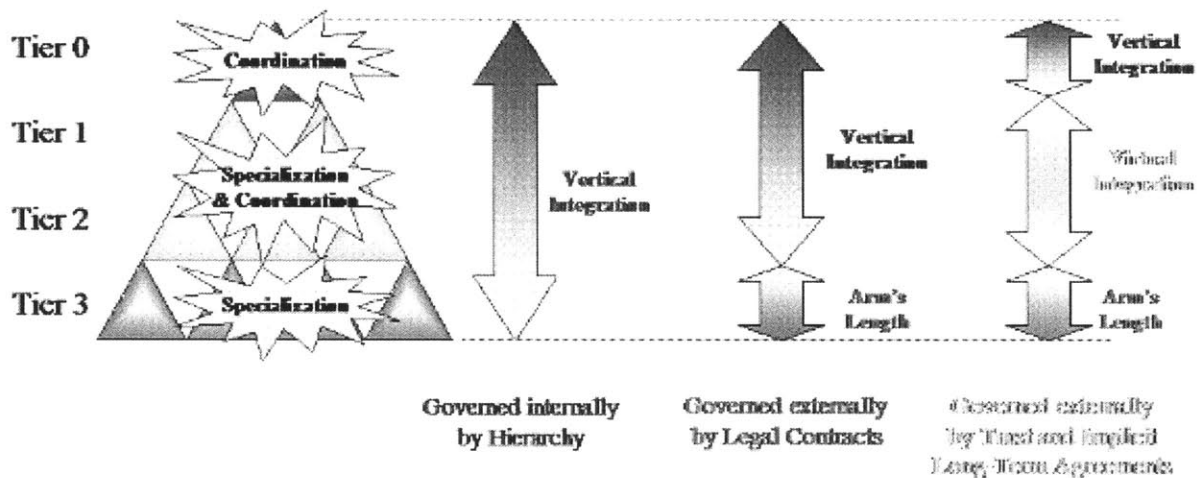


Source: Nightingale, 2003

Figure 2.6 Evolution of Supplier Network through IT Infrastructure .

In mergers and acquisitions, an ideal model of “Emerging Lean” seems hard to produce in a short period because companies have different policies of supply management—prescriptive or collaborative—and because differences of lean maturities between suppliers and the prime company cause barriers to the synchronization of production information.

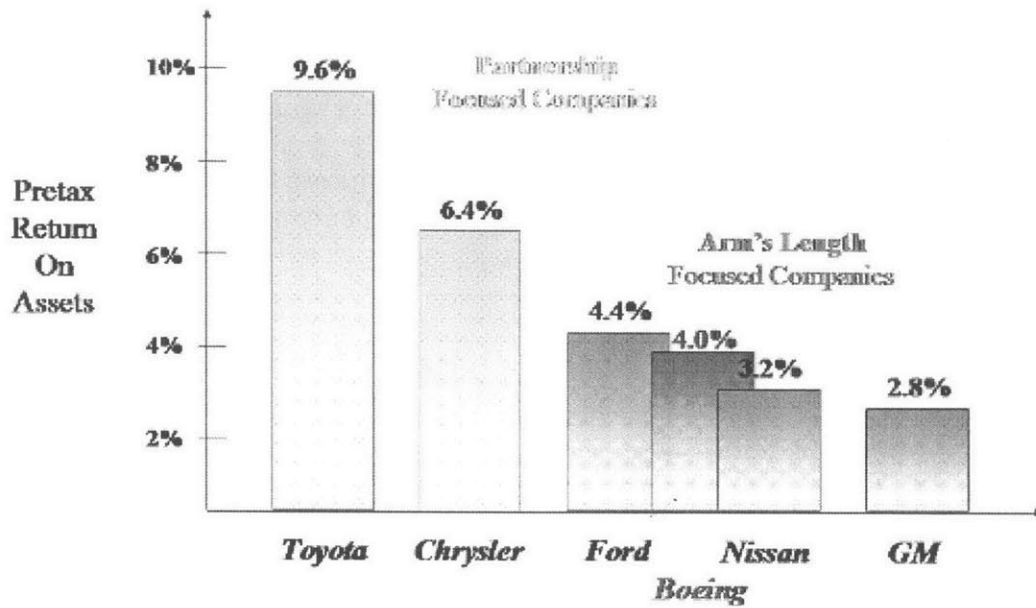
Figure 2.7 shows differences between traditional supplier networks and virtual supplier networks based on IT infrastructure and partnerships. Virtual integration means that suppliers working in the partnership supply specialties by participating in the product development process and sharing production information through the Internet. This not only decreases production costs and product development risks, but also raises operating efficiency as a result of achievement of Just-In-Time implementation.



Source: Piepenbrock, 2003

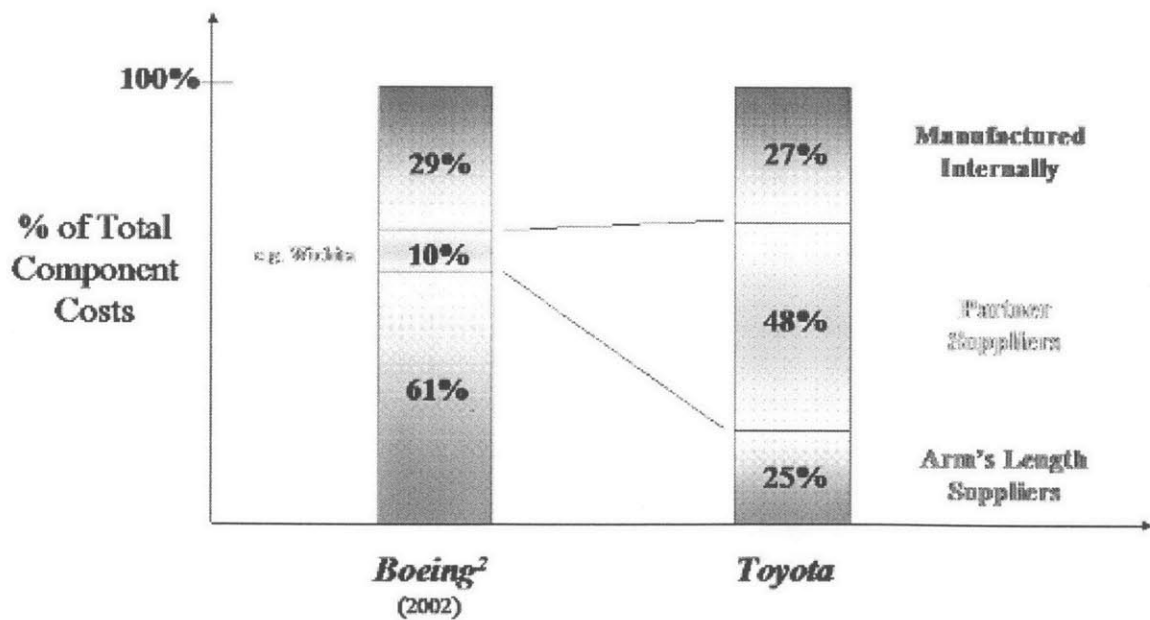
Figure 2.7 Virtual Integration

Figures 2.8 and 2.9 shows how effective the virtual integration is. Toyota, the leader of lean, bases half of its suppliers on the partner suppliers. Partnership based companies shows higher ROA than the companies based on vertical integration and arm’s length.



Source: Piepenbrock, 2003

Figure 2.8 Effectiveness of Partnership Relations with Suppliers



Source: Piepenbrock, 2003

Figure 2.9 Comparison of Supplier Networks Between Boeing and Toyota

2.2.3.3 Relationships between Lean Manufacturing, Engineering, and Supply Chain Management

When there is waste in lean manufacturing, the elimination of waste is integrally related to suppliers. For example, over-production and wait time in the production process can be resolved by synchronizing production with deliveries by suppliers and orders from customers. Parts inventories can be decreased by a supplier's timely provision of parts to the company, and defects can be minimized by a quality control system for suppliers.

This effort can be applied to the lean engineering. Integrated product and process development requires suppliers of specified parts to participate in the design process to increase customer satisfaction, decrease development cycle time, and increase manufacturing efficiency.

Therefore, when two lean companies with different lean expertise merge—e.g. one company with lean manufacturing and the other with lean engineering—management of the supply chain is one area in common where lean manufacturing and lean engineering can save costs. It can also provide excellent opportunities for the companies to begin collaborations that lead to an exchange of different perspectives.

2.2.4 Enabling Infrastructure

The enabling infrastructure links different functions, such as IT, finance, human resources, and facilities. In this section, I will discuss the IT infrastructure, because IT is an important enabler of communications and information sharing with different stakeholders.

When different organizations are integrated, they must consider the integration in terms of organization, processes, technology, and information. Information integration, or the integration of IT infrastructure, is key to enabling the integration of the organization, processes, and technology because IT infrastructure controls the information flow among different stakeholders. It prescribes how information will flow into different functions and tasks.

For example, in technology integration, the IT infrastructure enables a global integrated product development team to share the same data and information with developers in different areas, making the development process faster and more efficient. Also, the IT infrastructure can be a kind of knowledge database which can be applied to different areas in an enterprise. For example, Boeing manages its own web pages to communicate its lean vision to employees and to share best practices. E-business solutions, such as an e-commerce system, a customer relations management system, and a supply chain management system, connect the company with customers and suppliers and synchronize production information between suppliers and the company, thereby eliminating information waste.

From this standpoint, IT infrastructure is crucial to a company's lean capability. The IT integration strategy, such as one IT system or separate IT systems, should be carefully selected based on the lean maturity of different functions of the company.

2.2.5 Enterprise Leadership Process

Enterprise leadership is an intangible infrastructure that makes life cycle process and enabling infrastructure work. Leadership contributes to cultural change, knowledge transfer and generation, and enterprise integration, based on shared vision and efficient communication. This section discusses the leadership process in the context of mergers and acquisitions, that is, enterprise integration and cross-cultural diffusion of lean thinking

2.2.5.1 Enterprise Integration in Mergers and Acquisitions

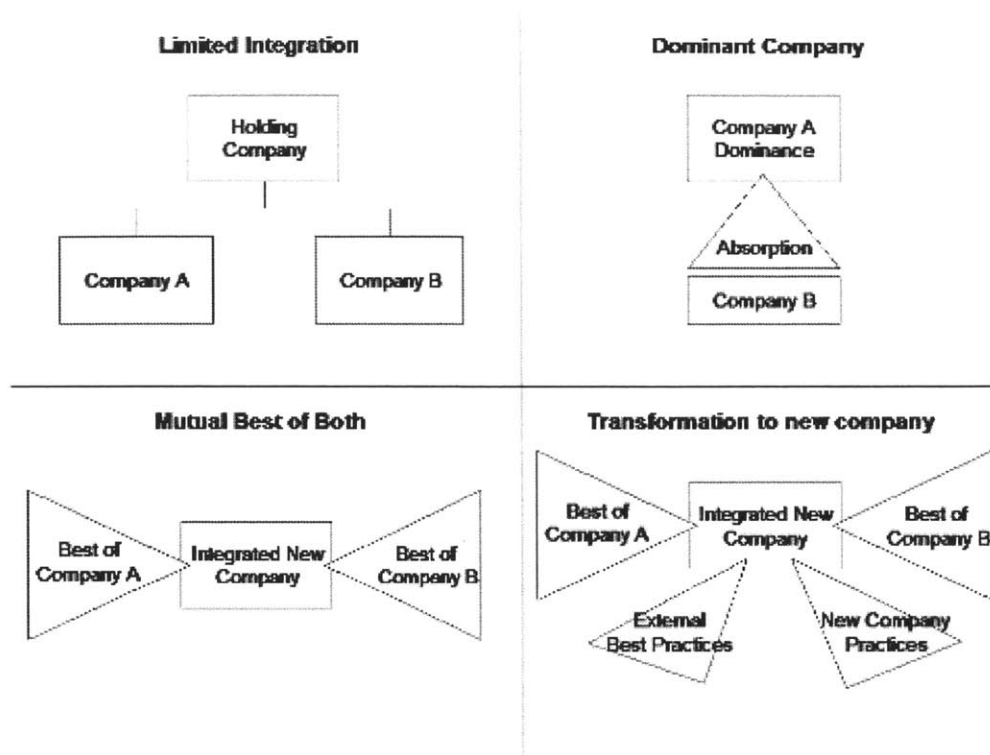
Many companies expect a merger or acquisition to provide the scale of operations, resources and capabilities, financial strength, and broad market reach necessary for growth and long-run competitiveness. Specifically, in large mergers and acquisitions, companies engage in a merger and acquisition that is intended to strengthen their competitive position by building new capabilities or adding new resources to existing businesses (Schmidt, 2001).

Companies in the aerospace industry merged or acquired other companies for similar reasons. To overcome cost pressures, companies integrated common suppliers, R&D, and manufacturing facilities. To avoid business risk from cyclical trends among commercial and defense businesses, companies expanded their business portfolio by acquiring other companies that had cutting-edge technologies in a different business area.

Schmidt, in his book, *Making Mergers Work*, describes the integration philosophy and integration processes.

Integration Philosophy

Along a continuum of philosophies for integrating acquired or merged corporate entities, four methods are widely used today, as illustrated in Figure 2.10. The integration philosophies apply not only to the integration of people and organizations but also to the integration of IT systems after the merger/acquisition.



Source: Schmidt, 2001

Figure 2.10 Integration Philosophy

a. Limited Integration

This method involves creating a place for the acquired corporation within the acquiring company's structure. The acquiring company views the acquisition as an addition to its existing business portfolio. Consequently, the acquired company usually retains its management team and operational and administrative practices, and employees and their work environment are virtually unaffected. This embodies a "light touch" integration philosophy characteristic of holding companies and highly diversified businesses.

United Technology Company's (UTC) acquisition of Sundstrand is a kind of limited integration. UTC is a holding company that owns different companies in various industries, including Pratt & Whitney, OTIS, Carrier, and others. Sundstrand was acquired by UTC and became one of the subsidiary companies of UTC.

In limited integration, the subsidiaries companies are on an equal level, and if the holding company does not have a lean leadership, there may be a problem in introducing and integrating one company's culture and vision into the acquired company during the lean transition.

b. Dominant Company

In this approach, the new entity is absorbed or becomes completely subordinate to the acquiring company. Absorption means the acquired company conforms to the management system, organizational structure, business processes, and operating philosophy of the acquiring company. Absorption is often preferred in intra-industry mergers and acquisitions, which are largely motivated by cost savings, where competing companies are consolidated into a single, larger organization.

In Dominant Company integration, the acquiring company takes the leadership during the integration process. The important thing during the lean transition is that the acquiring company knows the strengths and weaknesses of the acquired company, in order to motivate employees in the acquired company during the integration process.

Boeing's acquisition of Hughes Space and Communications, and Vought Aircraft's acquisition of Aerostructure Corporation are good examples of the Dominant Company philosophy. In both cases, the acquiring company integrated the target company in terms of technology, people, structure, and manufacturing facilities.

c. Mutual Best of Both

In this approach, the two companies set out with a fresh view of how to manage, organize, and operate the new entity. This task is accomplished systematically via thorough and objective examination of the approaches used by both companies—their structures, systems, processes, cultures, and technologies. The purpose is to select the best practices from each company and incorporate them into a blueprint for the new entity. Boeing's merger with McDonnell Douglas exemplifies this philosophy.

During the lean transition in the integration process, both companies should understand the differences in both companies and what areas can be shared. Then they can establish a new culture, new vision, and standardized lean principles that apply to the new entity.

d. Transformation to a New Company

Transformation extends beyond the mutual best of both by reviewing—and sometimes incorporating—selected features from the business models or processes of other prominent and highly regarded companies. Mergers and acquisitions that are designed to incorporate leading-edge technologies and world-class sales or other functional capabilities tend to follow this track.

2.2.5.2 Integration Process after Merger or Acquisition

To determine what factors should be considered for a lean transition in the post-merger process, it is important to see the process of merger and acquisition.

The post-merger process of merger and/or acquisition comprises the following two stages: (1) due diligence, and (2) integration planning and implementation.

Due Diligence

During Due Diligence stage, which takes place largely after an offer to merge or acquire has been made, companies must ensure that the proposed deal is sound from strategic, economic, and implementation perspectives. This stage includes the following issues (Schmidt, 2001):

- verify strategic expectations
- validate the price
- confirm leadership commitment
- discover significant liabilities and exposures
- confirm legal ability to combine
- verify the expected organizational capabilities
- analyze people issues such as retention, cost, and cultural fit
- evaluate IT position
- understand variations among company units and jurisdictions.

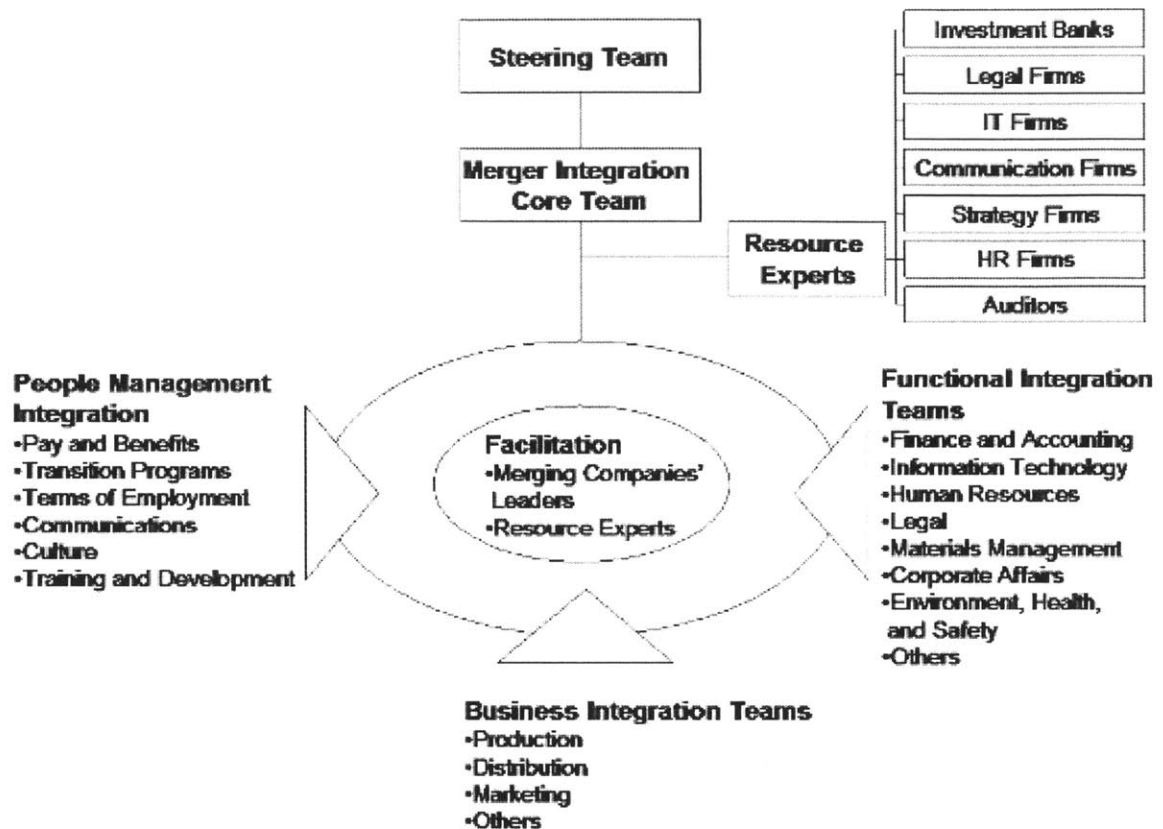
There are few references or information about lean transitions in mergers and acquisitions at the due diligence stage. However, one important factor in for successful mergers at the due diligence stage with different operating expertise is that cultural differences and leadership commitment should be fully considered in this stage, for the reason that motivations for sharing knowledge with and identifying and obtaining best practice from different companies in the integration process are deeply affected by the culture and leadership style of each company.

Integration Planning and Implementation

In the Integration Planning stage, successful acquirers or merger partners create a comprehensive plan for all aspects of integrating their businesses and organizations. In the Implementation stage, acquiring or merging partners execute the merger integration plan for the new enterprise, and measure and report the progress.

In Figure 2.11, the planning for people integration, business integration, and functional integration is accomplished through the facilitation of a merger integration core team and resource experts. In this stage, the following jobs are considered (Schmidt, 2001).

- strategic framework or context for the deal
- performance expectations and the actions required to realize them
- project organization, including team structures, composition, and mobilization
- master schedule and key milestones
- approach to decision-making and project coordination
- integration plans for organization and workforces, people systems, culture, work processes, and technology
- communications and change plans.



Source: Schmidt, 2001

Figure 2.11 Integration Structure

In the mergers and acquisitions cases of lean companies, a process council takes on the role of merger integration team. Process councils set the common vision, design the architecture for communications and education systems, and foster a new culture in the new enterprise. It also standardizes products, processes, technologies, and information management systems and leads integration within and across enterprise boundaries.

2.2.5.3 Barriers to Integration

Cultural Issues

Cultural issue can be a major obstacle to achieving synergies following a merger or acquisition. And when lean transition is included in the merger/acquisition, there is an added layer of cultural transition, which requires that cultural factors be focused in the context of integration between companies who are undoubtedly at different lean maturity levels. That

means there is a further overlay of lean initiative. Examples of possible barriers to integration are (Schmidt, 2001):

- management style
- decision-making process
- degree of customer commitment
- entrepreneurial spirit
- innovation, creativity, and speed to market
- value of teamwork and collaboration
- accessibility of leadership
- performance accountability system
- total rewards philosophy

Political Issues – Power Relationships

Politics within either company can affect integration in two ways. First is the political relationship between the acquiring company and the target company. If a supplier to the target company is integrated equally into the acquiring company (and not as a form of vertical integration), employees in the acquiring company may not be willing to accept the target company as a partner. When a small company absorbs a larger company, it is not easy for those in the large company to accept the acquisition.

The second power obstacle is the political relationship between the management and different stakeholders. Layoffs after a merger/acquisition may not be accepted by the unions on either side. It is possible that managers will not deal with the changing and uncertain environment that inevitably accompanies a merger or acquisition. Companies may find that employees are no longer willing to commit their loyalty to a new venture that their executives believe is best for the company. And if employees do not buy into the deal in the belief that it will enhance their careers, their teams, their business units, or the company as a whole, they are more likely to resist change. High performers who have other possible employment options may choose to leave if they become too frustrated or anxious about the new company's prospects.

2.2.5.4 Managing the change process

Schmidt (2001) describes the characteristics of a successful implementation as: commitment and leadership, culture, and connections.

Commitment and Leadership

The extent to which people are dedicated to the new company and are willing to expend their full energy toward making it a success is the measure of their commitment (Schmidt, 2001). Employees who are involved in a merger/acquisition find themselves in a changing situation they did not create. In order to motivate employees in such a dynamic situation, companies should begin by making their new vision clear to the employees. Common values should be identified among all levels of employees and stakeholders, and the management of both companies should speak consistently with all their stakeholders.

Leadership is another factor motivating employees. Leadership is probably the single most powerful variable in determining the success of a merger/acquisition (Schmidt, 2001). Specifically, in the uncertain situations that always occur during the implementation stage of a merger/acquisition, employees in both companies pay more attention to the action and words of the leader. Thus, when two organizations merge, the impact of new leadership on the culture will be great, and therefore must be carefully thought through in advance, right down to the operating levels. Objectives must be clear ahead of time, and the resulting new management culture must ultimately motivate both parties to succeed over the long run.

Culture

Creating a new culture, or assimilating people into the established culture of an acquiring company, is crucial during integration phase. Inspirational leadership, common values, clear measures, challenging work, and worthwhile rewards provide the impetus and energy needed to fuel the change process and facilitate a true melding of cultures (Schmidt, 2001). While cultural messages may be communicated and reinforced through websites, newsletters, and e-mails, culture is embedded firmly within the company through the actions of its leaders.

Connections and Communication

The primary goals of communication during implementation are to prepare employees for their new roles, help them accept specific changes and the reasons for them, and enable them to see how the many different change initiatives fit together during the implementation stage. In fact, communication often pertains to specific implementation initiatives.

In the longer term, how well communication occurs at all levels is crucial during that sensitive period when two organizations first join forces. Being frank with information and clearly sharing the long-term game plan can mean the difference between chaos and acceptance during the transition to new leadership. During this period, the reason for the merger/acquisition, the details of integration, and the roadmap and milestones as the integration proceeds, should be communicated and shared among employees.

The faster people feel connected to their new company and their work unit, the faster they are likely to fully embrace the goals of integration. One way connections are established is by keeping employees informed about integration and business-related decisions. Combining high-tech and high-touch media can help to ensure connections remain interactive and collaborative and have a human touch.

The most powerful connections are formed when communities of people begin working toward the goals of the larger organization. This is why successful integrators pay careful attention to the formation, nurturing, and management of teams. These teams need clear mandates, explicit goals, empathic leadership, and opportunities to achieve recognizable success early. These early wins will help to solidify the connections and foster the energy and confidence needed for future success.

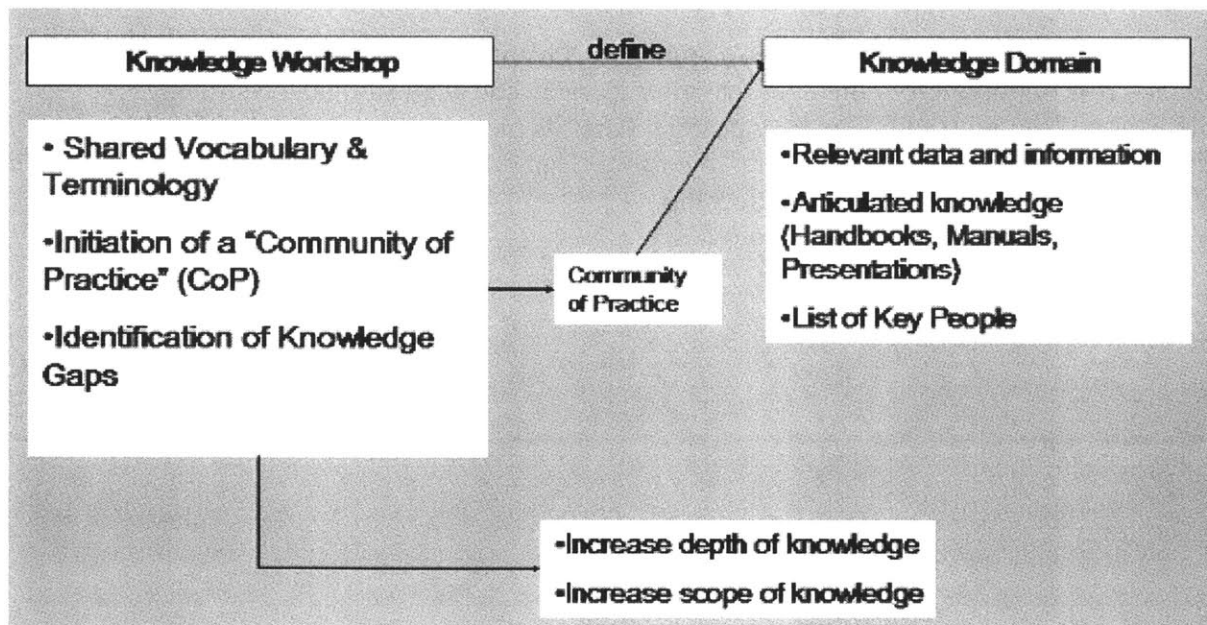
2.2.5.5 Knowledge Transfer of Lean Thinking

Efficient knowledge transfer or an efficient sharing process often makes use of knowledge workshops and a knowledge domain.

In a knowledge workshop, people share the same vocabulary and terminology, and initiate a community of practice where best practices can be shared. The knowledge workshop can be a formal workshop within the company or an informal workshop such as everyday conversation and conferences. Internal process councils and a lean office can take the role of a knowledge workshop where people exchange their best experiences, which often fosters those practices across the enterprise.

A knowledge domain saves relevant data and information and shares it with other people in the organization through a variety of media such as the Internet, presentations, and manuals. IT infrastructure is an important tool as a knowledge domain, linking different stakeholders and sharing information and knowledge. This process is shown in Figure 2.12.

In this process, the role of communities of practice is important. Communities of practice are the core group of participants of the workshop and the custodians of the knowledge domain, where people share and create knowledge and practices to achieve organizational and personal objectives.



Source: Nightingale, 11/03

Figure 2.12 Knowledge Transfer Process

2.2.5.6 Cross-Cultural Diffusion of Lean Principles

In the book, *Knowledge Driven Work*, the authors suggested three strategies for diffusing lean principles in a cross-cultural context: a piecemeal strategy, an imposed strategy, and a negotiated strategy.

Piecemeal strategies introduce aspects of change to the parties in smaller, easier-to-manage pieces. This strategy motivates people by making each part of the change small and easier to absorb — but it risks inducing a change process that is not systematic. Among the cases studied, Boeing used a piecemeal strategy during its lean transition implementation at Hughes Space and Communications.

The **imposed strategy** involves introducing change initiatives as a whole, with relatively little opportunity to challenge or adjust the plan. Imposed strategies can be problematic, especially when two companies involved in a merger or acquisition differ in terms of culture and the perception of political relationship. The merger between McDonnell Douglas and Boeing and in UTC's acquisition of Sundstrand both illustrate the problems of imposed strategies during specific stages of lean transition.

A **negotiated strategy** stands in contrast to the above two approaches by assuming that the implementation will involve a give-and-take exchange. Boeing used this approach after its merger with McDonnell Douglas, and Vought pursued this strategy from the outset.

These three strategies can be also applied to a lean transition between a customer and its suppliers. It is important to remember that after mergers and acquisitions, the strategy for implementing lean with suppliers may change. After its merger with McDonnell Douglas, Boeing's relationship with its suppliers, in terms of lean diffusion, became closer to a partnership, evolving away from a more rigid relationship.

2.2.6 Measurements of Leanness

In order to measure the leanness of a company and the rate of lean efforts after a merger/acquisition, objective measures of leanness, based on public information, are required. Analyzing leanness by using financial information is one reasonable measure, even if it cannot fully reflect the lean activity of a company that outsiders do not know.

There have been many discussions about how to determine the effect of lean on corporate financial statements. Noel Nightingale (N. Nightingale, 2003) recommends several methods for measuring a company's leanness: (1) profit margin, (2) asset turnover, (3) return on invested capital, and (4) inventory turnover.

Profit margin measures the fraction of each dollar of sales that trickles down through the income statement to profits, and reflects both the enterprise's pricing strategy and its ability to control costs. Profit margin has been the focus of many well-known initiatives in the past, since its focus is cost. Reducing "cost of goods sold" has always been a focus and remains so under lean manufacturing, lean supplier chain, TQM, 6 Sigma, and other similar initiatives.

The second measure is asset turnover, which is defined as the ratio of sales to assets. This measures how productive each dollar invested in assets is working to generate sales.

The third measure is return on invested capital (ROIC), which reflects whether an enterprise is practicing lean principles. ROIC has strengths in that it quickly reflects an imbalance within an enterprise when all value positions have not been taken into account. While the absolute level of ROIC is important, its profile over time is of paramount importance. The goal is not so much to increase ROIC but rather to maintain its level without deterioration.

The fourth measure is inventory turnover, defined as the ratio of cost of goods sold (COGS) to inventory. Inventory turnover shows how quickly a company sells the products it produces, a measure of basic operation efficiency

It should be noted that the measures related to profit and sales have limitation in that they are greatly affected by the economic environment, such as changes in the economy, rather than by the operating efficiency inside the company. Thus, they are relevant for finding whether a company becomes lean over the long term, but they give limited insight into determining whether a company's leanness has improved after a merger or acquisition.

CHAPTER 3

BACKGROUND OF CASE STUDY COMPANIES

In this chapter, I provide background information about Boeing, Vought Aircraft, and UTC/Pratt & Whitney, each of which will be presented in Chapter 5 as case studies.

3.1 BOEING COMPANY

In this section, I will analyze Boeing Company, with a specific focus on organizational changes that have occurred as a result of several mergers and acquisitions. I will also discuss the company's efforts to evolve into a lean enterprise.

In Boeing's 2001 Annual Report, the company described its strategy and vision with respect to mergers and acquisitions:

"When Boeing acquired Rockwell Aerospace in 1996, it marked the beginning of the transformation articulated in our vision, from a predominantly commercial airplane company to the broadest of aerospace companies. The transformation continued with the merger of McDonnell Douglas into Boeing in 1997, and the acquisitions in 2000 of Hughes Space and Communications and Jeppesen Sanderson."

As a result of the mergers, Boeing has today expanded its business focus from that of a commercial airplane company to a business that also includes defense and communications.

3.1.1 Boeing's Mergers and Acquisitions

Over the eight years from 1996 to 2004, Boeing bought or sold 32 companies (see Appendix A for further details). Among those deals, Rockwell Aerospace (1996), McDonnell Douglas (1997), and Hughes Space and Communications (2000) rate as the largest deals in the company's history. Table 3.1 shows the largest mergers and acquisitions since 1996.

Table 3.1 Summary of Boeing's Mergers and Acquisitions (dollars, millions)

Company Acquired or Merged	Year	Deal Price	Boeing Asset	Deal Price/Boeing Asset	Deal Price/Boeing Asset as of 2000
Rockwell	1996	\$ 3,055	\$ 22,098 (1995)	13.8%	8.45%
McDonnell Douglas	1997	\$ 15,454	\$ 27,254 (1996)	56.7%	42.8%
Hughes Space & Communications	2000	\$ 3,750	\$ 36,147 (1999)	10.4%	10.4%
Autometric	2000	\$ 119	\$ 36,147 (1999)	0.3%	0.3%
Continental Graphics	2000	\$ 183	\$ 36,147 (1999)	0.5%	0.5%
Jeppesen	2000	\$ 1,524	\$ 36,147 (1999)	4.2%	4.2%

Sources: Thompson Financials website; Boeing Annual Reports

3.1.1.1 Acquisition of Rockwell Aerospace

In 1996, Boeing acquired Rockwell Aerospace, including its associated defense business, by issuing 9.2 million shares of common stock valued at \$875 million and by assuming debt valued at \$2,180 million. At the time, the Rockwell aerospace and defense units had annual sales of \$2.5 billion (excluding sales to Boeing), with approximately 21,000 employees. The acquired business units were merged into the existing Boeing North America unit.

As a result of this acquisition, Boeing expanded its product portfolio in the defense and space segments with respect to space systems and information/battle management systems.

3.1.1.2 Merger with McDonnell Douglas

Boeing merged with McDonnell Douglas on August 1, 1997. The merged company operates under the name of The Boeing Company. Combined sales for the new company were approximately \$36 billion in 1996 before consideration of inter-company transactions and conforming accounting methods. Just prior to the merger, McDonnell Douglas had annual sales of \$14 billion and net income of \$780 million, with approximately 63,000 employees. The ratio of commercial to defense business at McDonnell Douglas before the merger was 75% to 25% (Boeing Annual Report, 1998).

Tables 3.2 and 3.3 show the business portfolio and product portfolio for McDonnell Douglas, prior to the merger.

Table 3.2 McDonnell Douglas Business Portfolio before Merger

	Sales		Operating Income	
	in million	%	in million	%
Military Aircraft	\$7,952	57%	\$990	73%
Commercial Aircraft	\$3,317	24%	\$101	7%
Missile, Space and Electronic Systems	\$2,178	16%	\$194	14%
Financial Services and others	\$387	3%	\$74	5%
Total	\$13,834	100%	\$1,359	100%

Source: Company Information about McDonnell Douglas in 1996 in Hoover's online

Table 3.3 McDonnell Douglas Product Portfolio before Merger

Military Aircraft	AH-64 Apache (helicopter) AV-8B Harrier II C-17 Globe master III F-15 Eagle F/A-18 Hornet MD 500 (helicopter) MD Explorer (helicopter) T-45 Training System
Missile, Space, and Electronics systems	Delta rockets Harpoon/Standoff Land Attack Missiles (SLAM) Mast Mounted Sight (targeting system)
Commercial Aircraft	MD-11 tri-jets, MD-80 twin jets, MD-90 series of twin jets, MD-95 series of twin jets

Source: Company Information about McDonnell Douglas in 1996 in Hoover's online

3.1.1.3 Acquisition of Hughes Space and Communications Business

Boeing acquired Hughes Space and Communications and its related operations for \$3.75 billion, in October 2000. As a result of this acquisition, Boeing became one of the leading providers of satellite and satellite-based services.

The acquired businesses were combined and renamed Boeing Satellite Systems. Today it is a satellite-based communications company with about 9,000 employees located in Southern California. Boeing Satellite Systems is included in the company's space and communications segment

3.1.1.4 Other Acquisitions

Autometric Inc, a geospatial information technology company, was acquired for \$119 million in cash. Autometric is now part of Boeing's space and communications segment.

Continental Graphics Corporation, a provider of technical information to the aviation industry, was acquired for \$183 million in cash.

On October 4, 2000, Boeing acquired Jeppesen Sanderson Inc for \$1,524 million in cash. Jeppesen is a supplier of flight information services and is now included in the commercial airplanes segment.

3.1.1.5 Effect of Each Merger or Acquisition

It is not easy to determine the effect of each merger or acquisition on the overall business operations of Boeing because the company has continued to buy and sell companies. However, most of the other mergers and acquisition—except the deals with the six companies named above—were so small as to be negligible in measuring their effects on Boeing's financial statement and operation.

When we compare the asset price Boeing paid for each merger or acquisition, we can estimate how big each deal was. Based on the data in Table 3.3 presented earlier, the effect of the merger with McDonnell Douglas is the greatest, compared to other deals, and it can be assumed that Boeing's financial statement will reflect positively the effect of that merger. The second greatest effect can be seen in the several acquisitions in 2000.

3.1.2 Changes at Boeing Following the Mergers and Acquisitions

Based on publicly available information, I analyzed changes in Boeing's organization and in its business portfolio as a result of the mergers and acquisitions.

3.1.2.1 Organizational Changes

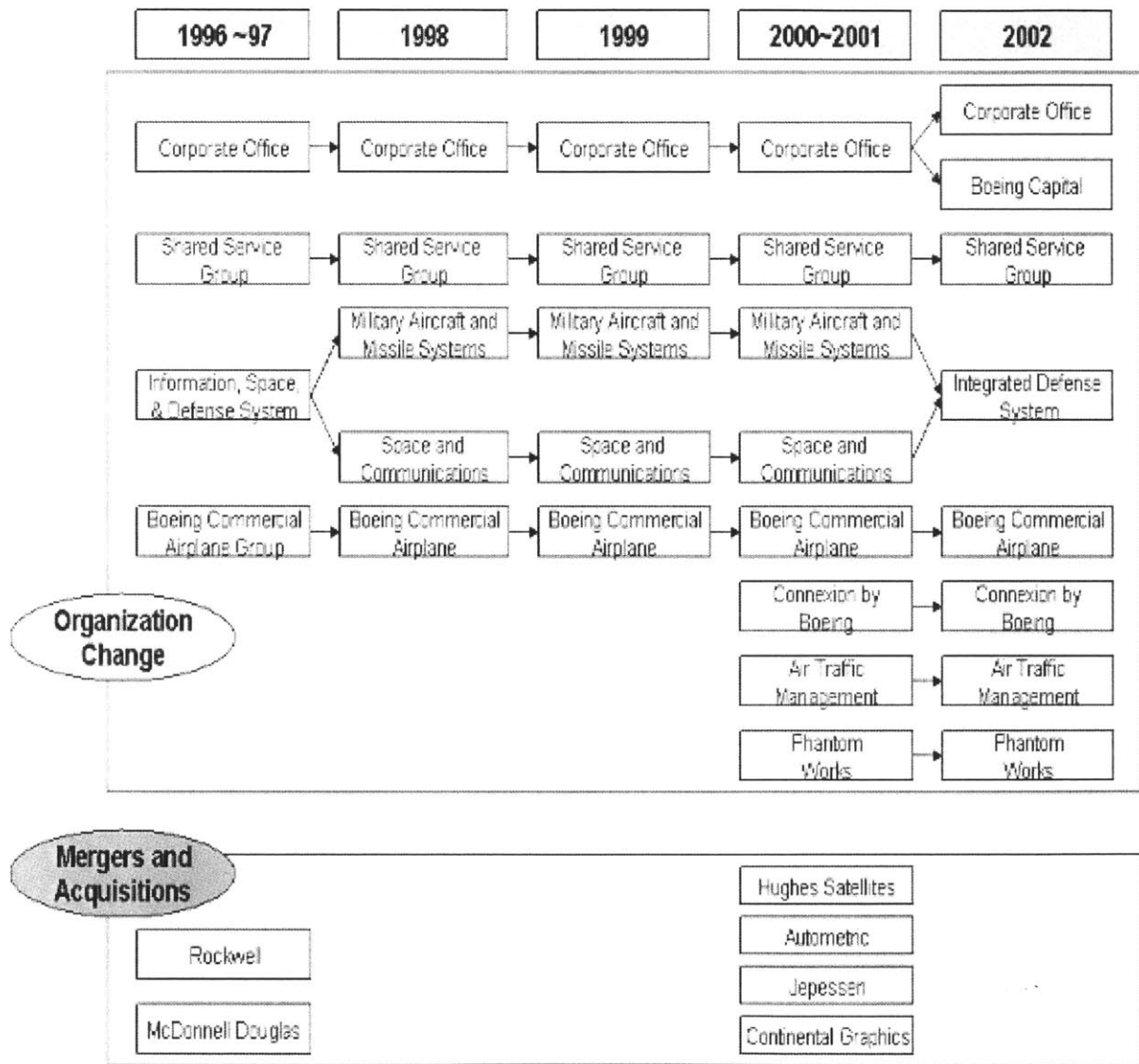
After several mergers and acquisitions, Boeing experienced a number of organizational changes.

After the merger with McDonnell Douglas and the acquisition of Rockwell Aerospace, Boeing's defense business segment was strengthened and subsequently reorganized. The original unit named Information, Space and Defense System (ISDS) was split into two pieces and renamed Military Aircraft and Missile Systems and Space and Communications. These business units were reorganized again into the Integrated Defense System (IDS) in 2002.

In 2000, Boeing acquired four companies: Hughes Aerospace, Autometric, Jeppesen, and Continental Graphics. This was done in pursuit of Boeing's intention to transform its business

from strictly airplane manufacturing to the broader spectrum of aerospace system provider. To conform to this new vision, new business units were formed: Connexion by Boeing (Boeing’s telecommunications business), Air Traffic Management, and Phantom Works (integrated product development).

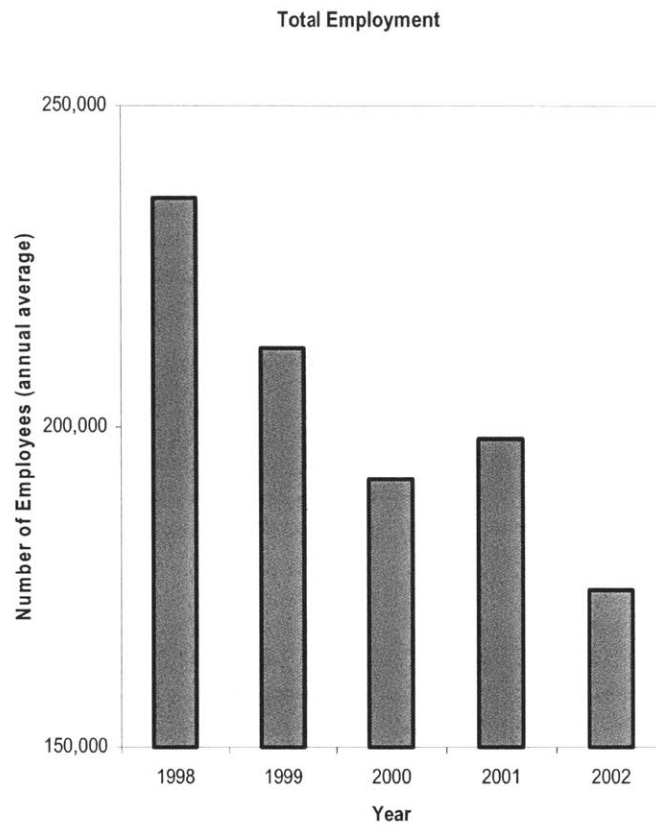
Meanwhile, the workforce within Boeing’s Shared Service Group was expanded. Figure 3.1 shows how the organization has changed after the various mergers and acquisitions.



Source: Author

Figure 3.1 Boeing Organizational Changes after Mergers and Acquisitions

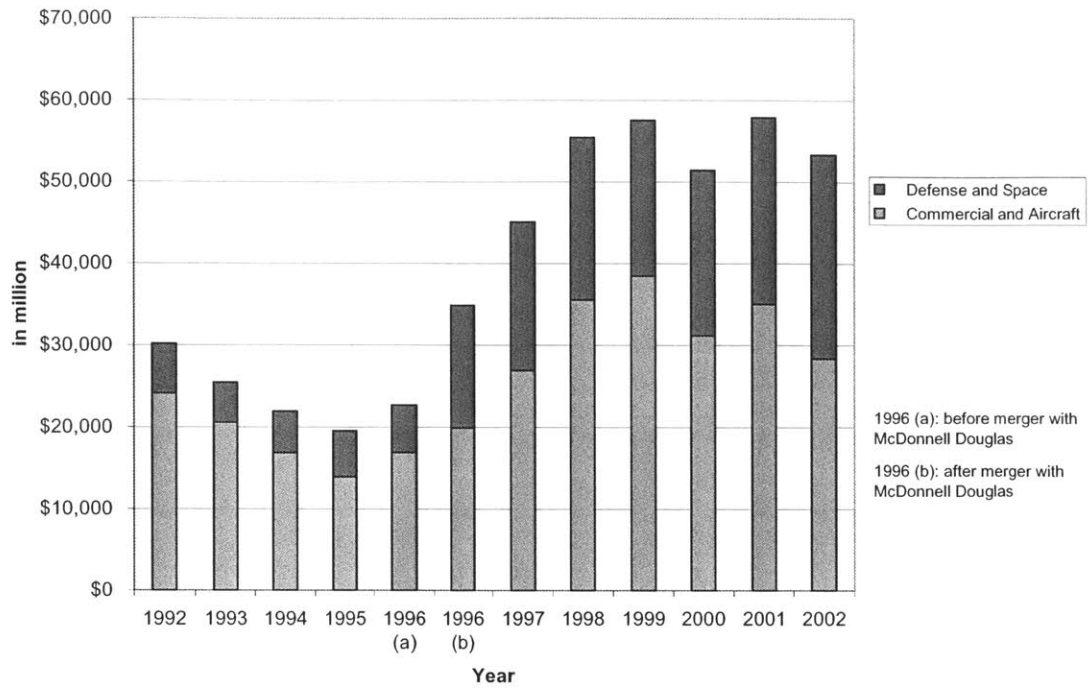
Figure 3.2 shows how the number of employees has changed as a result of the mergers and acquisition.



Source: Data from Boeing website.

Figure 3.2 Changes in Total Employment since Merger with McDonnell Douglas

As can be seen in Figure 3.3, the total number of employees decreased in spite of increased revenue after several mergers and acquisitions. This means that revenue per employee increased after the mergers and acquisitions. Figure 3.4 clearly shows this trend.



Source: Boeing Annual Reports, 1996-2002

Figure 3.3 Revenue Changes for Different Business Sectors

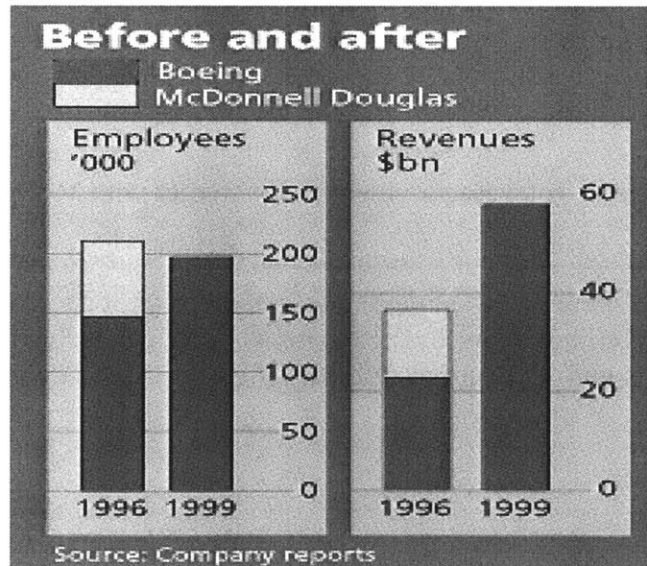
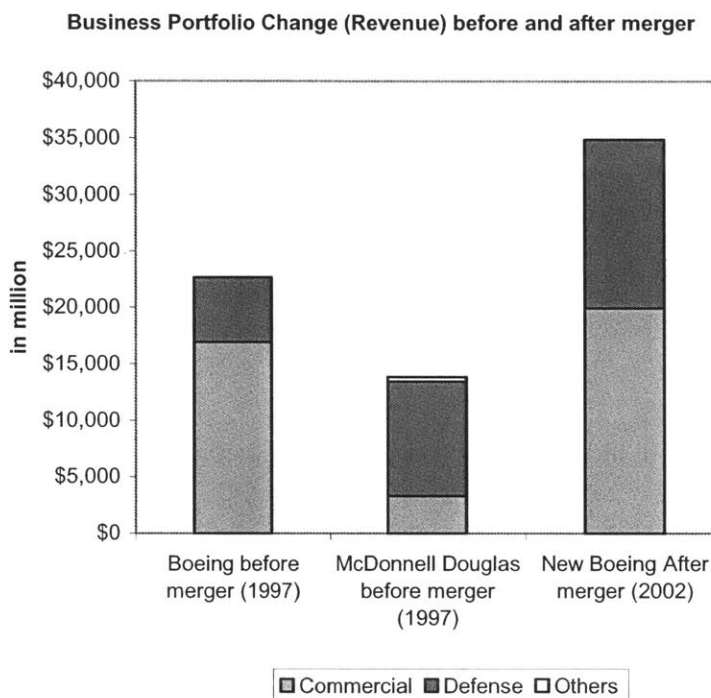


Figure 3.4 Revenue and Employees before and after Merger with McDonnell Douglas

3.1.2.2 Business Portfolio Changes

Figure 3.3 also shows how the business portfolio changed after the mergers and acquisitions. The biggest impact on this change arose as a result of the merger with McDonnell Douglas. Figure 3.5 shows this change more clearly. Before the merger, Boeing's main business was commercial aircraft and McDonnell Douglas' main business was in defense. After the merger, the new Boeing entity developed a business portfolio that was balanced between defense and commercial business.

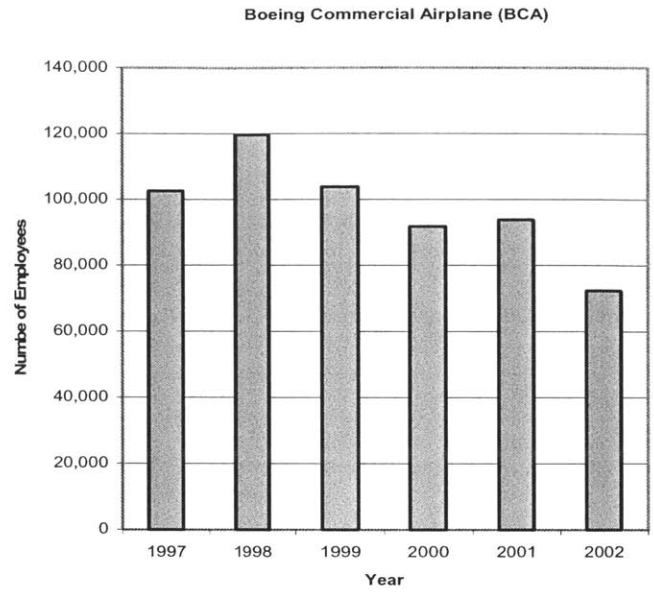


Source: Boeing Annual Reports, 1998 and 2002.

Figure 3.5 Business Portfolio Change in terms of Revenue before and after Merger

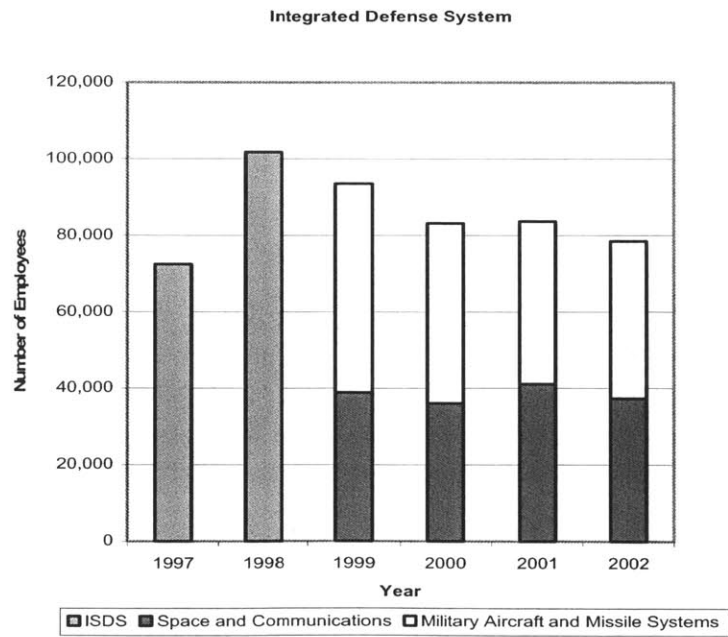
Boeing's business portfolio illustrates the ideal strategy for the aerospace industry, based on the past experience of cyclical ups and downs between the defense and commercial business in the industry. When defense business is bad, commercial business applied new technologies from the defense business to products, thus increasing revenues, and vice versa.

Figures 3.6 and 3.7 show employment changes in Boeing's commercial airplane business and its Integrated Defense System since the merger with McDonnell Douglas. The number of employees was decreasing continually after 1998, due to corporate restructuring and layoffs. However, Figure 3.8 shows that the number of people in the Shared Service Group increased. Considering that the role of the Shared Service Group is to set up IT infrastructure, an e-commerce system, and buy supplies for the company in order to achieve economies of scale, the increased number of employees in the Shared Service Group means the company is strengthening its infrastructure after the merger.



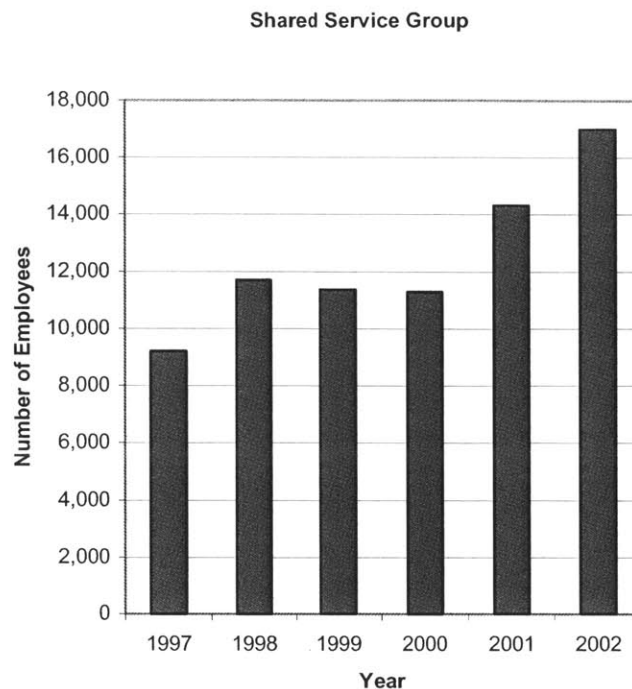
Source: Boeing website

Figure 3.6 Change in number of employees at Boeing Commercial Airplane



Source: Boeing website

Figure 3.7 Change in number of employees at Integrated Defense Systems



Source: Boeing website

Figure 3.8 Change in number of employees in the Shared Service Group

3.1.3 Lean Enterprise Efforts at Boeing

3.1.3.1 History

In the mid-1990s, the U.S. Air Force induced the aerospace companies to cut costs through mergers and acquisitions and to deploy lean enterprise principles. In addition to Boeing's desire to implement an efficient manufacturing system, this motivated Boeing to learn more about lean principles with an eye to implementing the program throughout the company. The 1997 Annual Report notes:

We are using lean-manufacturing techniques throughout the company to reduce internal costs and improve our production systems. Lean manufacturing relies on the experts to change their work areas and processes to maximize efficiency, improve quality and safety, and eliminate unnecessary motion and inventory.

Boeing began by implementing lean manufacturing on the assembly floor. In order to learn the lean techniques, Boeing sent different levels of managers to acquire the fundamentals from Japanese companies. The first big lean manufacturing achievement was to change the Boeing 737 airplane assembly line to a moving production line that incorporated lean manufacturing. Since implementing the next-generation 737 upper-wing panel moving assembly

line, employees in this area improved their cycle time by 73% and productivity by 53% (Annual Report, 1999).

Boeing also applied lean principles to other areas, such as defense aircraft development. A defense system is different from commercial products in terms of lean applications, in that the usual goal of a defense system is product development with quality assurance, while the goal of commercial business is to cut manufacturing costs. So lean efforts in the defense business focus on the engineering and design side—cutting product and design cycle time and cost. For example, in the development of the Joint Strike Fighters, the company reduced design times and costs by 30% to 40% and cut production cycle time by 25%. During the upgrade of the Super Hornet, an integrated team consisting of personnel from Navy, Boeing, and its suppliers applied lean practices to the design and manufacturing to reduce maintenance and support throughout its lifecycle.

Lean engineering and design led to a 90% reduction in the number of unique parts and a 95% reduction in the number of welds. These improvements resulted in unifying and reducing the number of suppliers and focusing instead on the quality of the parts provided by the suppliers—the start of lean supply chain management. The effects of lean design and supply chain management on lean manufacturing resulted in increased airplane floor panel fabrication productivity, reduced manufacturing time and space, 95% reduction in lead time, 68% reduction in parts cost, 62% reduction in inventory costs, and 50% reduction in floor space.

Boeing described the major process improvements in its 1999, 2000, and 2001 annual report:

Recent commercial and government developmental programs included early commitment of resources for integrated product teams, design interface with customer representatives, use of advanced three-dimensional digital product definition and digital pre-assembly computer applications and increased use of automated manufacturing processes. Although these measures have required significant current investments, substantial long-term benefits are anticipated from reductions in design changes and rework and improved quality of internally manufactured and supplier parts.

The differences in lean efforts between the defense and commercial sides are described in Table 3.4.

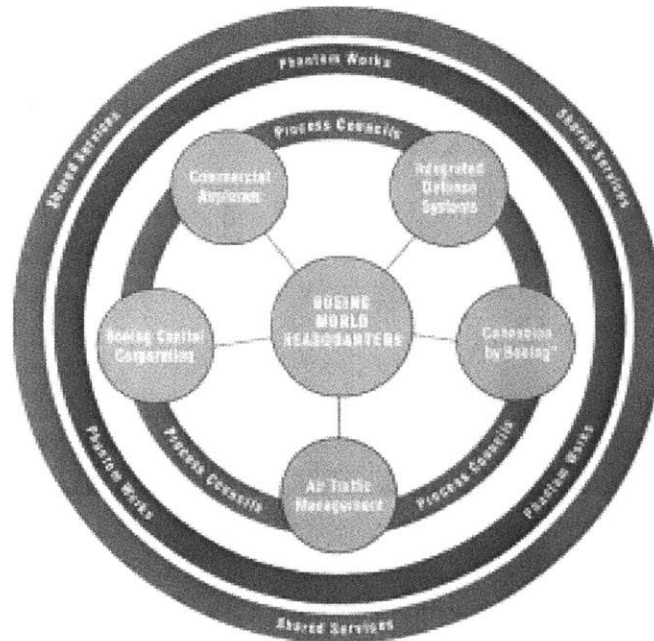
Table 3.4 Differences in Lean Efforts for Different Business Sides

Lean Effort	Commercial Side	Defense Side
The goal	Reduction in the manufacturing cost	Reduction in the design cost and mission assurance
Lean Deployment	Lean Manufacturing	Lean Engineering
Methods	Reducing inventory (JIT) Part number reduction Production cycle time	Integrated design team Design for manufacturing Part number reduction Advanced design tools Parts quality management
Common Area	Supply Chain management for parts quality and part number reduction	

Source: author

3.1.3.2 Lean Enterprise

In its 2001 Annual Report, Boeing announced it would pursue the 'Lean Enterprise' in the future, and it changed its organizational structure to what is illustrated in Figure 3.9.



Source: Boeing Annual Report, 2001

Figure 3.9 Boeing's Enterprise Architecture

Boeing's deployment of lean enterprise depends on three key enablers that drive essential technologies, common systems and processes, information, and changes throughout the company (Annual Report, 2001).

The first enabler is Boeing Phantom Works, the company's advanced research and development group, which rapidly propagates and disseminates advanced technologies and cost-saving processes across the company. This group focuses not only on the application of new technologies to current and future products, but also on innovative developments and manufacturing processes for cutting costs. Specifically, integrated product development teams try to cut design cycle times and cost in half, eliminate the need to build costly prototype hardware, and produce more efficient, supportable, higher-performance systems with first-time quality, using 3-D modeling, simulations, and virtual reality tools.

The second enabler is the Shared Services Group. This group allows business units to focus on profitable growth by providing the infrastructure services required to run their global operations. The group provides a broad range of services worldwide, including computing and network operations, real estate and facilities services, employee benefits and programs, travel, and security and safety. By integrating all these services, the company delivers greater value, creates lean processes and operations, leverages buying power, and simplifies access to services.

Harnessing the power of electronic-based transactions to improve service and drive down cost is a key shared services strategy. The development of electronic portals for suppliers and employees allows instant access to information from anywhere. The Shared Services Group delivers major cost savings as the company puts in place its e-business applications, such as on-line procurement and electronic auctions.

The third enabler is Process Councils, which link different business units throughout the structure to realize synergies company-wide. The councils consist of leaders from all functional groups in the company. Their role is to rapidly share best practices and diffuse its effects at multiple levels across the enterprise.

Aligned with the goals of the Process Councils, the Leadership Center plays an important role in communicating and educating lean to employees at different levels of the company. The company's goal for the Leadership Center is to make it a central part of the shared experience for all Boeing managers.

3.2 VOUGHT AIRCRAFT

Vought Aircraft is a manufacturer of wings, fuselage subassemblies, empennages, nacelles, thrust reversers, and other components for prime manufacturers of aircraft. Vought's major customers are Boeing, Airbus, Gulfstream Aerospace, Lockheed Martin, Northrop Grumman, Bell Helicopter, Cessna, and Embraer. The company headquarters are located in Dallas, Texas. It employs 6,290 people, and recorded revenues of \$1.2 billion as of the end of 2002.

For the past ten years, the company had experienced a variety of mergers and acquisitions. In 1992, Ling-Temco-Vought (LTV) sold the assets of its aircraft division to The Carlyle Group and Northrop Corp. Two years later, Northrop, following its acquisition of Grumman Corp., bought the remaining 51% of the Dallas and Grand Prairie operations from Carlyle. In July 2000, The Carlyle Group bought Northrop Grumman's aerostructures business, and that business was renamed Vought Aircraft Industries, Inc. and it remains based in Dallas. In July 2003, Vought Aircraft Industries purchased The Aerostructures Corp, with manufacturing sites in Nashville, Tennessee; Brea, California.; and Everett, Washington.

When Vought acquired Aerostructures Corp. in 2000, Vought did not have a structured lean program. However, the company had specific positions related to lean within its manufacturing operations and it has continued to focus on process improvements throughout the total company. The company's CEO is focused on ensuring that they use the right tools, such as value stream maps and JIT.

The company has not had a formal lean system, but it is trying to implement lean techniques to meet and enhance its business needs. To that end, the company has implemented lean manufacturing and supply chain management. It uses a *Kanban* system on the shop floor and has achieved \$100 million in inventory reductions. Also the company implemented lean with its outside suppliers, and streamlined and computerized its SCM and HR systems, thus reducing paperwork.

The acquired company, Aerostructures Corp., is not as lean as Vought, but its employees are hungry to learn the new lean principles

3.3 UTC/PRATT & WHITNEY

UTC is a global technology corporation working in aerospace, aviation, helicopter design, climate control, elevator design, and hydrogen fuel cells. As a holding company, it has the following companies as its business divisions: Carrier, Otis, Pratt & Whitney, Sikorsky, Chubb Security, UTC power, and United Technologies Research Center. The company had \$25.7 billion revenue in 1998. Today it has 155,000 employees with \$28.2 billion in revenue in 2002.

In 1999, the UTC acquired Sundstrand Corp. for \$4.3 billion in cash and stock. Sundstrand was a supplier of components and subsystems for aerospace and industrial customers, including Boeing and Airbus. Sundstrand combined with UTC's Hamilton Standard division to form one of the world's largest suppliers of high-value-added airframe components and subsystems. The new division was named Hamilton Sundstrand. Reported 1998 sales were \$2 billion, with 10,400 employees.

The acquisition was made to increase UTC's total system sales content per aircraft and to provide one-stop-shopping for aircraft manufacturers seeking Auxiliary Power Units (APUs), engine controls, hydraulics, and other items.

When the acquisition occurred in 1999, Pratt & Whitney, one of the UTC companies and a customer of Sundstrand, was in the early stages of lean deployment but did not yet have structured lean efforts. Hamilton Sundstrand, the new subsidiary, therefore started out closer to the traditional company in terms of lean. After the acquisition, however, Pratt & Whitney began to implement the transition to lean at Hamilton Sundstrand.

CHAPTER 4

METHODOLOGY

4.1 INTERVIEWS

I interviewed seven people from different aerospace companies who were involved with lean implementations and mergers and acquisitions. The case studies are listed in Table 4.1.

Table 4.1 List of Cases

Case	Buyer Company	Target Company	Number of Interviewee	Announcement
1	Bocing	McDonnell Douglas	4	1997
2	Boeing	Hughes Satellites	3	2000
3	Vought Aircraft	Aerostructures Corp.	1	2000
4	UTC	Sundstrand	1	1999
5	Boeing	Suppliers	2	N/A

In Case 1, the interviewees are:

- A former Vice President of Boeing who worked for McDonnell Douglas before merger.
- A current Vice President of Boeing who worked for Boeing before merger.
- A current middle level manager of Boeing who worked for McDonnell Douglas before merger.
- A current middle level manager of Boeing who is in charge of supply chain management.

In Case 2, the interviewees are:

- A current mid-level manager of Boeing who is involved in the post-merger process with Hughes Satellites.
- A former Vice President of Boeing who worked for Boeing during the acquisition (same individual as above).
- A current Vice President of Boeing who worked for Boeing during the acquisition (same individual as above).

In Case 3, the interviewee is:

- A current high-level manager of Vought Aircraft, who was in charge of materials before Vought's acquisition of Aerostructure Corporation, and was involved in the acquisitions.

In Case 4, the interviewee is:

- A former industrial engineer at Pratt & Whitney, who was responsible for converting development into manufacturing and was involved in the lean transition at Hamilton Sundstrand.

In Case 5, the interviewees are:

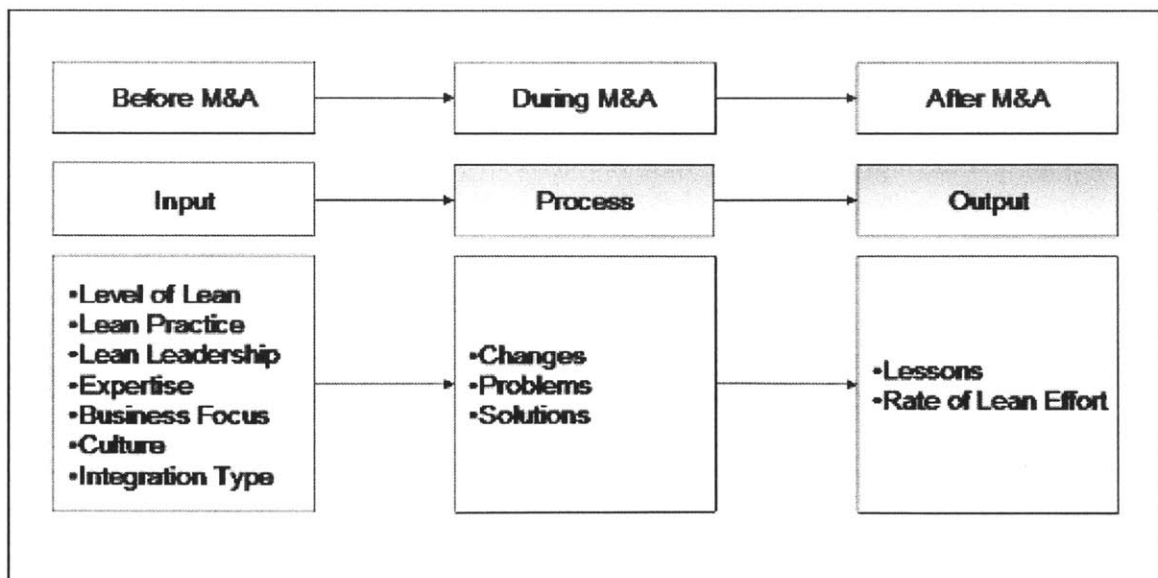
- A current mid-level manager of Boeing who is in charge of supply chain management (same individual as above).
- A former Vice President of Boeing who worked for McDonnell Douglas before the merger (same individual as above).

4.2 INTERVIEW QUESTIONS

The main questions focused on the relationship between the lean enterprise and the mergers and acquisitions, i.e., reasons for the merger or acquisition, changes that took place after the merger or acquisition, barriers and solutions to implementing the lean transition in the new organization, lessons learned, and the rate of lean effort after the merger or acquisition. Appendix C contains a full set of the interview questions.

4.3 ANALYSIS METHOD

Following the interviews, I analyzed the data from the perspectives shown in Figure 4.1.



Source: Author

Figure 4.1 Analysis Method

“Input data” means the level of maturity of lean implementation, practices, culture, and integration before the merger or acquisition. This data was prepared from public information sources and interview data.

“Process” shows what happened during the merger or acquisition in terms of lean efforts and lean transition. The literature research about lean implementation and mergers and acquisitions provided a perspective from which to analyze changes, problems, and solutions in the process.

“Output” refers to the lessons and changes in the rate of lean efforts after a merger or acquisition. In the case of the merger between Boeing and McDonnell Douglas, I analyzed the financial data, looking for validation of the changes in the rate of lean efforts.

Based on this framework, I developed a lean integration model of each merger or acquisition. These models were developed using preliminary research information about the company, interview data analysis, and the literature research about mergers and acquisitions. This led me to identify common characteristics of successful lean transitions that can occur during mergers and acquisitions, and the factors that should be considered.

CHAPTER 5

CASE STUDIES

5.1 CASE 1—BOEING AND MCDONNELL DOUGLAS MERGER

5.1.1 Main Reason for the Merger

The merger was done for strategic reasons. McDonnell Douglas was a leader in the defense industry, and Boeing was a leader in the commercial aerospace industry. Based on past data of cyclical market ups and downs in the defense and commercial businesses, the merger was anticipated by both companies as a way to avoid business risk. Even though management of both companies knew that the companies had different levels of lean expertise, creating a lean enterprise was not a reason for the merger.

5.1.2 Level of Lean Maturity in Both Companies Prior to the Merger

Boeing embarked on its implementation of lean manufacturing in the mid-1990s, and McDonnell Douglas deployed its method of lean engineering in the early 1990s. However, while Boeing's lean efforts were structured and initiated by management throughout the company, McDonnell Douglas did not have a structured lean effort before the merger. It had no lean enterprise office, and low-level managers did not fully understand the process being deployed by management. The following quotes from former McDonnell Douglas managers show that the varied perceptions of McDonnell Douglas's lean efforts.

“McDonnell Douglas was more excellent than Boeing in terms of lean engineering and supply chain management.”

– High-level manager at McDonnell Douglas

“MD did not have structured lean promotion. Lean effort was not as mature as Boeing because MD did not have a promotion office on site, for example. In engineering, McDonnell Douglas was better than Boeing, but I am not sure we can call it lean.”

– Mid-level manager at McDonnell Douglas

Meanwhile, at Boeing, the entire company tried to understand lean manufacturing, but it was not in place in all functions. The lean activities in place were led by the lean Boeing office which fostered lean implementation at the enterprise, business unit, and floor levels. In contrast, at McDonnell Douglas, the company used lean principles when needed, but not everyone in the

company recognized the lean effort, even though the company had some level of expertise in lean engineering.

Therefore, the merger that eventually took place between the two companies was a merger between a medium-level lean company with manufacturing expertise and a medium to low-level lean company with engineering expertise.

5.1.3 Changes in Lean Efforts After the Merger

After the merger, both companies took advantage of the opportunity to learn different aspects of lean expertise from each other. Best practices were shared between both companies; Boeing was good at the application of lean manufacturing to the assembly line and floor unit, and McDonnell Douglas was good at design for manufacturing and lean engineering. Boeing's lean manufacturing and systematic application methods were transferred to McDonnell Douglas, and McDonnell Douglas' lean engineering practices were transferred to Boeing.

The result was that lean manufacturing was applied to the floor shop at McDonnell Douglas, and designs for manufacturing were applied to Boeing's engineering site. Specifically, integration technology used for military products at McDonnell Douglas was used for commercial products manufactured by Boeing. This enabled Boeing to evolve its lean efforts from manufacturing and supply chain management to lean engineering.

“Lean effort of Boeing moved from lean manufacturing to supply chain management and lean engineering, affected by McDonnell Douglas.”

– Mid-level manager of Boeing

Regarding supply chain management, both companies found opportunities to cut costs. Recognizing that aerospace suppliers are common in commodity parts, both companies began to share suppliers and components among different business units and programs. In specialty parts, both companies maintained their existing partnership relationship with previous suppliers. However, they were able to reduce the number of suppliers from 33,000 to 17,000 and managed the supplier network using Boeing's supplier certification system. The merged company also used an e-commerce system to streamline the ordering process from global suppliers, thereby increasing the proportion of virtual integration in the supplier networks.

However, supply chain management of specialty suppliers was applied in a different fashion because the philosophy of supply chain management was different between the commercial and military sides and therefore each company's focus on the supply chain management of specialty suppliers was different. The commercial side is more influenced by cost pressures, but on the defense side, cost pressure is not as important. Ultimately, the supply chain management practices of McDonnell Douglas were applied to the military side and those of Boeing were applied to the commercial side of the merged company.

“Supply chain management of both companies was differently focused; philosophy was different, fundamental differences in commercial side and defense side. The Commercial side is very influenced by cost pressure while cost pressure in defense side is not as important as commercial side.”

– Mid-level manager of Boeing

McDonnell Douglas’ lean maturity model was very robust and used to measure the performance of suppliers, which contributed to changes in Boeing’s relationship with its suppliers—from paternalistic relations to a partnership relationship based on trust. The new Boeing company implemented a supplier certificate system to measure the operating efficiency of suppliers and to motivate suppliers to accept lean principles and the quality management system.

5.1.4 Barriers and Solutions to Lean Transition at the New Company

There were several barriers to lean transition between the two companies after the merger.

The first was objections from the union. McDonnell Douglas’ union was not accustomed to the new Japanese terms used in a lean enterprise, and the unions of both companies were not willing to accept layoffs. To resolve the issue, the new company changed the Japanese terms to English equivalents, and efforts were made to persuade the unions that lean techniques would result in greater value in the long term although there would be layoffs in the short term. Management told the unions that lean principles would bring the company more value by cutting costs and streamlining operations, which would result in more job opportunities in the future. Eventually, union officials agreed with management, and they increased their knowledge of lean principles at an Accelerated Improvement Workshop offered by the company.

The second barrier was objections from mid-level managers who had heavy workloads and did not want more work added because of organizational changes. This problem was solved by rotating people into different functions at the various business units, which motivated people to learn new practices from the other organization while not increasing their workload. In addition, education and communication programs at the Leadership Center helped mid-level managers understand the company’s vision and their own role in the merged organization. Exposure to new knowledge and practices, and communication with and education about other levels in the company made mid-level managers feel that people in the new organization were experiencing the changes together, and that there might be more opportunities for growth.

The third barrier was the cultural difference between the merged two companies. People in one company did not recognize the excellence or expertise of those in the other. For example, Boeing employees thought that Boeing was better than McDonnell Douglas, not only in lean manufacturing but also in lean engineering. And the McDonnell Douglas people felt the same way about their company. This problem was solved by rotating people through both companies during the early stage of integration. People rotation enabled both parties to realize the

differences between the two companies—their strengths and weaknesses—and then make suggestions about what could be improved further.

Another cultural problem was that the goal of engineering on defense side is mission assurance, and the lean culture at McDonnell Douglas was different from that of Boeing. On the defense side, quality was the major focus, rather than cost; on the commercial side, cost was the key consideration. This meant that the culture on the defense side was stricter. At the same time, the strong engineering culture at McDonnell Douglas set higher standards for lean than was generally the practice at Boeing—higher standards meant a higher goal for operating efficiency, such as shorter product development cycle time and lower inventory levels. In the beginning, these differences were not accepted by either company, and some managers who were not accustomed to the new standard were moved to other positions. In the end, however, the higher lean standards practiced at McDonnell Douglas raised overall standards for the new company, supporting the goal of lean efforts at the integrated company.

The last problem was a standardization issue. After acquisition, both companies had to consolidate their distinct lean principles in a way that would apply satisfactorily to these two companies with different cultures. But, applying generalized principles to companies with different cultures and expertise was not easy. When both sides admitted that standardization would contribute to faster integration of the two companies, then there was more room for improvement and a move toward customized principles for the integrated company. This problem was solved when the Process Council was put in place. Employees from both companies began to understand each other's expertise through job rotation and at workshops for sharing best practice. People from various functions got together regularly and had conversations about lean application to manufacturing, engineering, program management, and supply chain management. In addition, through web pages, company letters, and other promotions of lean practices, a common vision was actively fostered.

“But at Process Council, best practice was shared from both companies, where we found that many of the best parts from both companies actually overlapped. In the end, MD’s supply chain management was applied to the defense side and Boeing’s was used on the commercial side, with common suppliers completed integrated.”

– High level manager at Boeing

5.1.5 Lessons Learned

Leadership as part of a lean enterprise office is important when transitioning lean principles to other organizations. Boeing’s lean enterprise office took a leadership role in increasing the momentum of lean transition to McDonnell Douglas. Before the merger, Boeing already had a lean enterprise office which diffused lean practice through the company from the top down, but McDonnell Douglas did not have such a lean office.

In general, both sides realized that a lean enterprise office contributes to better communication of lean at the enterprise level, in the business units, and at the factory level. It

also can provides training and metrics, establish a cohesive vision, track savings, decrease defects and number of suppliers, and implement lean principles.

Communication and education are critical in a lean transition. The new companies held workshops on lean principles, which included employees from every function and department, with the goal of identifying and sharing best practices from practical experience. These workshops helped both companies realize their strengths and weaknesses, and promoted a better understanding of the lean status of both companies.

The usual pitfall in the applying best practices to a new company is that people are willing to take generalized lean principles from best cases. However, in a lean transition between two big companies like Boeing and McDonnell Douglas, it is important for the merged companies to identify customized lean principles that apply to different functions, especially when both companies' lean principles and expertise are so different.

“Education and communication are the key elements in improving the lean enterprise among different functions and the two companies. The lean enterprise office was in charge of education and communication, and it was established in different parts of the Boeing companies when Boeing first began to embrace lean principles.”

– High-level manager of Boeing

5.1.6 The Rate of Lean Efforts After the Merger

During interviews, I asked the following question, and most interviewees felt it was very difficult to answer: did the lean efforts of Boeing and McDonnell Douglas accelerate? Apparently, it was hard to answer because it is ambiguous to gauge the rate of lean effort, and because there are various standards for measuring the level of lean application. In some areas, the rate may have increased, but in other areas perhaps not.

However, the common opinion among interviewees was that both companies have different levels of expertise with lean, and the spectrum of their lean efforts is becoming broader. Boeing absorbed the practices of lean engineering from McDonnell Douglas, and McDonnell Douglas assimilated the practices of lean manufacturing from Boeing. Meanwhile, the supply chains in the new integrated Boeing have evolved and improved.

5.2 CASE 2 – BOEING’S ACQUISITION OF HUGHES SPACE AND COMMUNICATIONS

5.2.1 Main Reason for the Acquisition

Satellites are a key element in the defense business. Boeing’s growth strategy is to be an operating system maker, with specific focus on networks and satellites, beyond its original business as an airplane manufacturer.

5.2.2 Level of Lean Maturity in Both Companies Prior to Acquisition

In 2000, when Boeing acquired Hughes Space and Communications, lean maturity within Boeing had been evolving steadily following the merger with McDonnell Douglas. Hughes Space and Communications (owned by General Motors before acquisition by Boeing) had also deployed lean, but its efforts were less successful. Thus, Boeing’s acquisition of Hughes makes an interesting integration case between a medium to high-level lean company and a low-level lean company, which had structured but less successful lean experiences and different lean principles than those practiced at Boeing. Even though the lean efforts at Hughes were less successful before its acquisition, the company did in fact have its own lean manufacturing system in place and was practicing some lean techniques. And it was generally agreed that both companies would focus on adjusting Hughes’ lean principles to the Boeing style rather than setting up new principles after the acquisition.

“Hughes came with their lean principles. The issue during the integration process was much more about alignment of lean principles.”

– Mid-level manager of Boeing

5.2.3 Changes in Lean Efforts After Acquisition

What has changed at Hughes since the acquisition was a decision to focus on operational efficiency. Metrics and visual controls on the shop floor were established. A cultural shift—from a focus on quality to a focus on cost—led lean efforts from the shop floor to the office. Tooling, tactics, and support groups for operational efficiency were improved and goals were visualized.

5.2.4 Barriers and Solutions to Lean Transition at the New Company

Currently, the lean transition following Boeing’s acquisition of Hughes is still ongoing. The biggest barrier was a cultural shift in the business. Fundamentally, the satellite business does not focus on operations because quality rather than cost is usually the issue in such programs. But Boeing’s lean practices evolved from its lean manufacturing processes in place for the manufacture of Boeing commercial airplanes. Thus, the change of focus, from quality to cost in the satellite industry, has not been easy for Hughes employees. Today, the new company uses a

matrix structure that focuses on both quality and operations, with leadership operations coming from a lean office.

“There was a big cultural shift, and the shift is ongoing. In the satellite business, the first goal was mission assurance and the second was operational efficiency. Hughes had not focused on operations as much as Boeing. Lean engineering comes after manufacturing: they do not come together.”

– Mid-level manager of Boeing

The less-successful experience of lean deployment at Hughes prior to acquisition by Boeing was also another barrier. Even though the company had a lean promotion team, no one on the team wanted to be involved in lean. So Boeing hired new people from outside Hughes to start over again with lean and to identify and implement new lean strategies, in order to remove the less successful experience at Hughes in the past.

“There was a lean promotion team in lean satellites. They were responsible for the lean maturity target and operational improvements. No one wanted to be associated with the lackluster success of lean deployment in the past, and people were very cautious about starting over again with lean. One solution was to recruit people from outside.”

– Mid-level manager of Boeing

5.2.5 Lessons Learned

Typically, lean engineering follows after lean manufacturing; they do not evolve at the same time. But at Hughes, both were considered simultaneously because the manufacturing part of the satellite business was too small to start lean, and most of the satellite business related to the engineering side anyway.

5.2.6 The Rate of Lean Efforts After Acquisition

When asked about the rate of lean efforts after Boeing’s acquisition of Hughes, some interviewees answered that the rate had increased because Hughes had had some lean experience before the acquisition. However, another interviewee who was involved in the early stages of the lean transition after acquisition answered that the past experience at Hughes actually hindered the rate of lean implementation after the acquisition by Boeing.

Based on this data, I found that it takes more time to stabilize a lean transition into an acquired company which has had a less-successful experience with lean deployment, due to a reluctance among employees to be involved in lean implementation. But once this stumbling block passes, by hiring new people and developing a matrix organization focused on both cost and quality, employees are motivated to foster new successes, and the lean assets owned by the acquired company actually accelerate the lean transition effort.

5.3 VOUGHT AIRCRAFT'S ACQUISITION OF AEROSTRUCTURE CORPORATION

5.3.1 Main Reason for the Acquisition

The main reason for acquisition was to expand Vought's customer base and reduce business risk in its markets. Both companies had different customer bases—Vought's main customer was Boeing, and Aerostructure's main customer was Airbus. The new company's business portfolio goal was to reach a 50:50 ratio of military to commercial customers.

5.3.2 Level of Lean Maturity in Both Companies Prior to Acquisition

Vought originally implemented lean manufacturing to meet its internal needs. People in the company used tools, such as value-stream mapping and reduced inventory, even though they were not identified as lean principles. The company did not have a lean office, but lean efforts were being led by management and supported by some lean experts in the company. However, the lean effort overall was not fostered throughout the company.

The target company, Aerostructure Corporation, was not as lean as Vought, but was closer to a traditional company.

So this case represents an acquisition by a company with a low level of lean maturity and a traditional company with no experience related to lean.

"Our company does not have a formulated program for lean as might be identified in other companies. We have specific positions within manufacturing and we continue to focus on process improvements of the total company. Our CEO focuses on making sure that we use the right tools, such as value stream mapping. The company does not have a formalized system of lean implementation but tries to execute lean techniques to meet our business needs."

– High-level manager of Vought

5.3.3 Changes in Lean Efforts after Acquisition

Vought learned how to manage employees and engineers with respect to releasing information to the shop floor in a timed sequence. When both companies' computer systems were merged, this time-keeping strategy was helpful for controlling materials on the floor and at the supply base. Also both companies could utilize a centralized supply chain management system and were able to reduce the total number of suppliers. In addition, Vought introduced international suppliers into the supply chain of the acquired company.

5.3.4 Barriers and Solutions to Lean Transition at the New Company

There were few barriers to the lean transition in the acquired company because employees in the newly integrated company were very positive about the acquisition and highly responsive to accepting lean techniques. The reason for the acquisition and the vision of the new company were clear to everyone and fully accepted by employees in both companies.

“People in both companies were very supportive of the acquisition. Everyone knows the importance of Vought balanced business portfolio in the aerospace industry.”

- High-level manager of Vought aircraft

For the efficient transition to a lean enterprise, people at Aerostructure came to the Vought site, and Vought sent lean experts to Aerostructure. They formed a transitions and operations team which consisted of people from different sites in both companies. The team discussed about how to apply lean principles to the new company and everyone shared best practices. Throughout this process, Vought did not push, which made both parties very positive about the lean transition.

“The transition team and operation team from the different sites helped other sites implement lean techniques. One of the sites achieved a 30% improvement in materials efficiency, and other sites also realized small achievements.”

- High-level manager of Vought aircraft.

5.3.5 Lessons Learned

The process review during due diligence helped both companies make the decision to pursue acquisition early. Identification of cultural, organizational, and operational fits between the companies were reviewed at the due diligence stage.

This suggests that to facilitate a lean transition during mergers and acquisitions, the companies should review the lean maturity or operational efficiency of the target company during the due diligence stage. The transition to a lean enterprise requires time and money, and there may be tradeoffs between potential synergies and the cost of the transition.

The biggest lesson is that regardless of different levels of lean maturity and expertise between two companies in a merger or acquisition, the first step for the successful lean transition during the integration process is to understand the reason for the integration and to define a shared vision and culture.

Maintaining the partner relationship between the acquiring and acquired companies is also very important for a lean transition, promoting the sense of one company among employees of both companies and accelerating the rate of knowledge sharing. Shared learning through people exchanges and discussions about best practices not only increases the rate of learning but also contributes to the common vision and culture of the newly integrated company.

5.4 CASE 4 –UTC/PRATT & WHITNEY’S ACQUISITION OF HAMILTON SUNDSTRAND

This case involves UTC, which acquired Sundstrand and made a new company called Hamilton Sundstrand, and Pratt & Whitney’s subsequent implementation of a lean transition to Hamilton Sundstrand.

5.4.1 Main Reasons for the Acquisition

Pratt & Whitney wanted to create a niche market, and Hamilton could provide complete external control system solutions to other engine makers.

Another reason was cost savings. UTC could realize some synergy savings by reducing headcount. And because Hamilton was a supplier to P&W, UTC was familiar with the cost savings it could achieve by buying Hamilton’s products.

A third reason was that UTC wanted to take on the whole-system approach used by Hamilton, which had added knowledge of other engine companies.

5.4.2 Level of Lean Maturity in Both Companies Prior to Acquisition

At the time of acquisition in 1999, P&W had a more mature lean enterprise than Hamilton, that is, P&W had more lean resources than Hamilton. But both companies were in the early stage of lean implementation, so could be classified as closer to traditional companies than to lean companies.

5.4.3 Changes in Lean Efforts After Acquisition

Technologically, P&W gained some component expertise from Hamilton. Both companies realized new business and increased revenue. But there were few benefits in terms of lean or operating improvement on either side.

5.4.4 Barriers and Solutions to Lean Transition at the New Company

UTC’s overall policy for acquiring companies is that the company wants to remain a holding company with equivalent companies under the UTC entity. But the UTC entity is too loose to bind P&W and Hamilton as one company. Further, it became increasingly difficult for both companies to develop a cohesive vision and share knowledge.

In this case, although Hamilton was a supplier to P&W, this acquisition was not a vertical integration. Hamilton was an equivalent company to P&W under the UTC umbrella. However, employees at P&W did not think like that. Because Pratt & Whitney had lean practices and

resources, it (rather than UTC) tried to lead the lean transition at Hamilton. As time went by, people at P&W viewed its relationship with Hamilton as that of supplier and customer, and it became difficult for both companies to maintain a strong relationship. Instead, the relationship was closer to a customer-supplier relationship after the acquisition.

Another problem was the bureaucratic culture at Hamilton, and UTC did not provide a single voice during high-level decisions, and no priority was given to the transition. P&W had negative feelings toward Hamilton, and Hamilton had negative feelings about not being able to meet the requirements and provide resources to P&W. Today, this problem is ongoing, and no relevant solutions have yet to be recommended.

“UTC’s policy when acquiring a company—limited integration under the holding company—makes the acquiring company and the target company think they are not part of one company, thus hindering both companies’ ability to share the same vision and knowledge.”
- Mid-level manager of Pratt & Whitney

5.4.5 Lessons Learned

When two companies merge or one company acquires the other, the key is to foster a common vision with common leadership. Both companies should establish teams to facilitate integration, and the two companies should work together as one profit center. There should be a centralized lean office responsible for continuous lean improvements. The new company should focus on process improvements using a common supply chain management system and the similarly skilled people in similar functions.

5.5 CASE 5—LEAN TRANSITION BETWEEN BOEING AND ITS SUPPLIERS

This case is about supply chain management rather than a merger or acquisition. Lean supply chain management involves considerable work to implement a lean transition among suppliers that have a culture and vision that differs from Boeing's. The focus of this case study is to present some ideas about how to make lean transition work between very different organizations.

5.5.1 Barriers to Lean Supply Chain Management Transition at Boeing

Boeing has a good understanding of lean at the enterprise level as well as the impact of lean on business, especially in a downturn. However, many of its suppliers do not. Therefore it is not easy for Boeing to share its vision and culture with suppliers that do not know much about the lean enterprise or its techniques. As Boeing has tried to teach its suppliers, I believe it can offer a prescription for transitioning lean to a company's suppliers.

Another barrier was making the rest of Boeing understand how suppliers are integrated into Boeing's supply chain management, and how the merger of Boeing's vision and values with those of suppliers would occur. Those who are not involved in such a delicate job do not understand the process, and thus are more willing to simply impose the initiative on suppliers without bringing them along in the process.

5.5.2 Solutions to Transitioning Lean Techniques to Suppliers

The first time a company begins to transit lean principles to its suppliers, an understanding each supplier's infrastructure capability is very important for measuring the lean capability of that supplier. Infrastructure capability defines the supplier's ability to handle information flow with IT technology, as well as people, flow-time buffers, and material parts. Also it enables the lean company to estimate how much of the lean company's infrastructure should be understood by the supplier and how to apply its lean principles to the supplier target.

The next step for lean transition to a supplier is to create an environment where the company works together with a supplier to find the best way to generate respect for each other and to resolve problems. Meanwhile, the company and supplier can meet regularly to develop one voice—an important component for building trust and increasing transition efficiency.

The last step is to determine different methods for handling suppliers that are at different levels of lean maturity or lean capability. Some suppliers are mature in terms of lean knowledge and deployment, while some are not.

The ultimate goal of the transition job is to share the company's vision with its suppliers and to merge suppliers into the company production system and supply chain management system efficiently and smoothly.

Table 5.1 shows different strategies that can be utilized for suppliers with different lean maturities or level of understanding.

Table 5.1 Various Lean Transition Strategies for Suppliers with Different Lean Maturities

Lean Maturity	Solutions	Focus
Medium to High Level	Much conversation to help both parties understand both companies' production systems.	Production system
Medium to Low Level	Much conversation about how each supplier can align its supply chain management with Boeing, and which leverage point or integration method can be used.	Alignment of supply chain management system between the two companies
Low Level	Usually these suppliers are not healthy financially. Both parties discuss lean concepts and how to optimize projections. Conversations start from lean techniques applicable to each supplier's enterprise level and then move to the supply chain management level.	Concept and application of lean
Limited Experience with Lean	It is difficult for both parties to achieve an outcome easily because suppliers need to first understand Boeing's lean terminology, techniques, production system, and vision.	Basic concept of lean

CHAPTER 6

DISCUSSION

6.1 DATA SUMMARY AND DISCUSSION

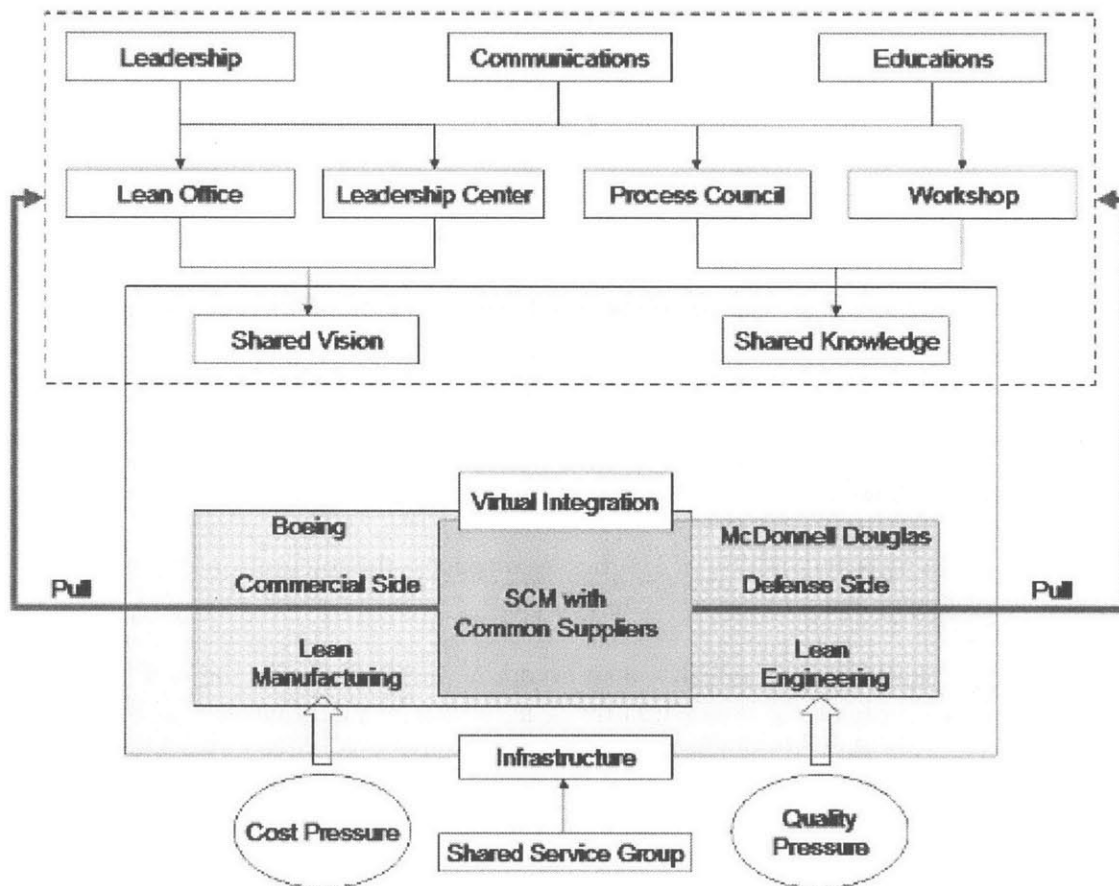
Table 6.1 summarizes the interview data. The input data in the table refers to the status of each company before the relevant merger or acquisition. The process data refers to the kind of process or change(s) that occurred during the merger or acquisition. Output data is the result after the merger or acquisition has occurred.

Table 6.1 Interview Data Summary

		Case 1		Case 2		Case 3		Case 4	
<i>Input</i>	Company	Boeing	McDonnell Douglas	Boeing	Hughes Space and Comm.	Vought Aircraft	Acrostructure	UTC (Pratt & Whitney)	Hamilton Sundstrand
	Level of Lean	Medium	Medium-Low	Medium-High	Low Level	Medium-Low level	Traditional	Low-Level	Traditional
	Lean Practice	Structured	Less structured	Structured	Structured, but not successful lean manufacturing	Less structured	None	Less structured	None
	Lean Leadership	Lean Office	Top Management	Lean Office	N/A	Management	N/A	Management	N/A
	Expertise	Manufacturing	Engineering	Manufacturing	Engineering	Manufacturing	N/A	Manufacturing	N/A
	Business Focus	Commercial	Military	Commercial	Space	Commercial and Military	Commercial (Airbus)	Engine	Engine Control System
	Culture	Cost focused Lean Leadership	Quality focused Strong Engineering Culture	Cost focused Lean Leadership	Quality focused Mission Assurance	Not prescriptive Partnership with acquired company	Positive for acquisitions and learning lean	Engineering culture	Engineering and Bureaucratic
	Integration Type	Mutual Best of Both		Dominant Company		Dominant Company		Limited Integration	
<i>Process</i>	Changes	<ul style="list-style-type: none"> Diffusion of Lean manufacturing and Engineering Common supply chain management Relationships with suppliers Expansion of virtual integration in suppliers network 		<ul style="list-style-type: none"> Focus on manufacturing efficiency at Hughes site Visualized goals 		<ul style="list-style-type: none"> IT system integration Time keeping strategy for the shop floor Reduction of the suppliers Sharing international suppliers 		<ul style="list-style-type: none"> Time keeping strategy for the shop floor Reduction of the suppliers Sharing international suppliers 	
	Problems	<ul style="list-style-type: none"> Unions and Middle Level Managers Cultural Differences Standardization 		<ul style="list-style-type: none"> Cultural Shift from quality to cost in space business Less successful lean experience 		<ul style="list-style-type: none"> Few Barriers 		<ul style="list-style-type: none"> Weak structure of holding company Sharing vision and knowledge Relation of customer and supplier 	
	Solutions	<ul style="list-style-type: none"> Education through Workshop Employees Rotations Knowledge and vision sharing at the process councils and leadership center 		<ul style="list-style-type: none"> Matrix Organizations to consider quality and cost Recruiting new people outside 		<ul style="list-style-type: none"> Exchange people and experts Transition and Operations team from both companies 		<ul style="list-style-type: none"> Not yet found 	
<i>Output</i>	Lessons	<ul style="list-style-type: none"> Lean leadership Education and Communications Getting best practice 		<ul style="list-style-type: none"> Lean engineering and manufacturing come together in space business which has strong engineering expertise 		<ul style="list-style-type: none"> Early review of operation culture and organizational structure at the due diligence is the key for the successful integration. 		<ul style="list-style-type: none"> Common vision with common leadership required 	
	Rate of Lean Effort	<ul style="list-style-type: none"> Not sure. But the lean area becomes broad 		<ul style="list-style-type: none"> Slow at the early stage when mindset change is required Fast at the later stage, due to the lean asset of acquired company 		<ul style="list-style-type: none"> Not sure Transition was quick 		<ul style="list-style-type: none"> Not sure Lean effort evolved separately without lean transition 	

6.1.1 Discussion of Case 1

Case 1 is Boeing's merger with McDonnell Douglas—a merger of similar lean-level companies which had different expertise. Education, communications, and leadership contributed to sharing a common vision and acquiring best practices from each other. Boeing pulled in the lean engineering practices from McDonnell Douglas, and McDonnell Douglas took on the lean manufacturing practices of Boeing. Meanwhile, common suppliers were integrated and virtual integration through a shared e-commerce system was expanded. These efforts were enabled by infrastructure developed and provided by Boeing's Shared Services Group. Figure 6.1 illustrates this case.



Source: Author

Figure 6.1 The integration model for the Merger Between Boeing and McDonnell Douglas

In Chapter 2 on the literature research, I pointed out the importance of leadership, communication, and cultures in the integration process. In this specific integration, Boeing's lean office and its Leadership Center contributed to leading the integration. The role of the lean office is to foster a company's lean vision, culture, and practices at the enterprise level, business unit level, and platform level. Boeing has lean offices at each site and regularly exchanges

people to different sites to encouraging sharing of knowledge. The Leadership Center takes a similar role. There, different levels of managers communicate with each other about the company's vision and share best practices.

The Process Council and the workshops it offered contributed to educating and communicating with employees from both companies. As described in Chapter 2, the role of the Process Council is to recognize the synergies in the different business units of the company and increase the efficiency of sharing practices and diffusing their effects at different levels in the newly integrated company.

The Shared Services Group provided the infrastructure for the integration process. As could be seen in Figure 3.9 (in Chapter 3), the number of people in the Shared Services Group increased after the merger, even while the total number of employees was decreasing. This means that the company strengthened the role of the Shared Services Group to make it an enabler of enterprise integration. The Shared Services Group contributed to enhanced communications through web pages and an internal communication systems, and added to the company's cost savings by achieving economies of scale through shared parts and supplies—buying common parts and office supplies through a strong e-commerce system. With that system, the company expanded the virtual integration of its supplier network and shared information with its suppliers. For example, the company now uses auctions, available via the e-commerce system, to buy common parts more cheaply.

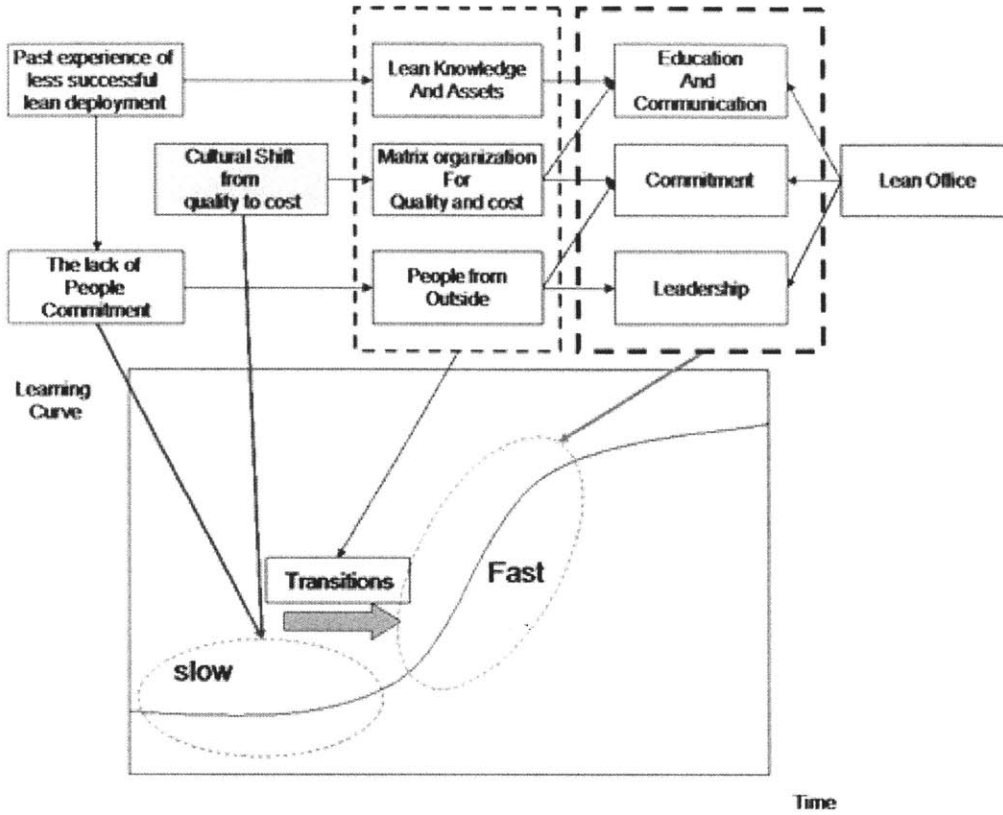
6.1.2 Discussion of Case 2

Case 2 is Boeing's acquisition of Hughes Aerospace—the integration of a medium to high-level lean company and a low-level lean company.

The biggest challenge in the lean transition during integration was the lack of commitment among employees due to a less-than-successful lean deployment experience at Hughes in the past. This slowed the learning curve at the early stage of lean transition in the new company. Through the use of communication and education, the company resolved this problem by recruiting new people from outside the organization.

The second challenge was a culture shift for those working in the space industry, who were focused on quality rather than cost. The solution was to help people experience both lean manufacturing and engineering, to change their mindset, by constructing a matrix organization. Currently, it is too early to tell whether these efforts will be successful or not. However, one thing is a lean asset—Hughes' employees now understand lean principles better and it has contributed to faster acceptance of lean coming from Boeing.

Meanwhile, these solutions, in conjunction with the lean office, have constructed an education and communication plan, motivated people's commitment, and played a leadership role, and thereafter the lean transition accelerated. These dynamics are shown in Figure 6.2.



Source: Author

Figure 6.2 The integration model for Boeing and Hughes

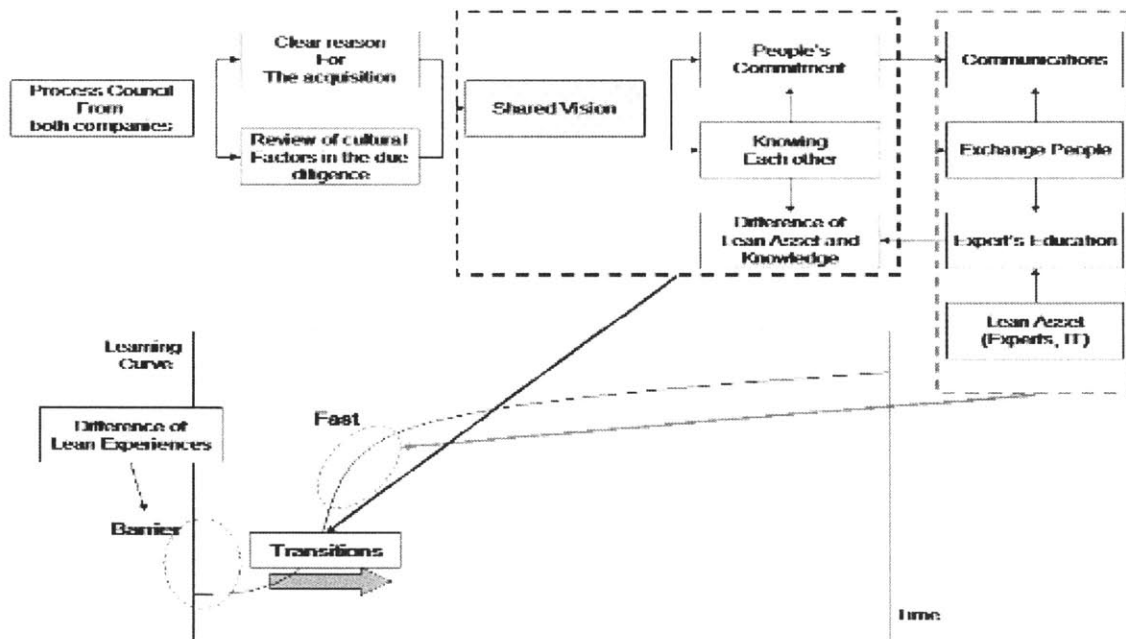
Cases 3 and 4 are based on limited data, so the results must be viewed as preliminary findings.

6.1.3 Discussion of Case 3

This case is Vought's acquisition of Aerostructure, i.e., the integration of a medium to low-level lean company with a traditional company.

Both companies experienced few barriers during the lean transition in the integration process, even though there were differences between the two companies in terms of their respective levels of lean maturity. This experience of relative ease was due largely to the fact that people in both companies were positive about the acquisition. Also that the new company's shared vision and values were communicated actively, because both companies anticipated strengthening the customer portfolio and avoiding business risks by acquiring Boeing and Airbus as customers of the new company. Thus people at all levels of both companies understood the rationale for the acquisition.

In addition, cultural, organizational, and operational differences were considered at the outset of the due diligence stage, when the Process Council (consisting of employees from both companies) helped everyone to understand the differences of culture and lean experience. This meant that people in the acquired company were eager to learn lean practices, and lean experts were sent to the acquired company. Integration of both IT systems helped each company share their suppliers quickly. The integration model for this case is shown in Figure 6.3.



Source: Author

Figure 6.3 The integration model for Vought and Aerostructure

6.1.4 Discussion of Case 4

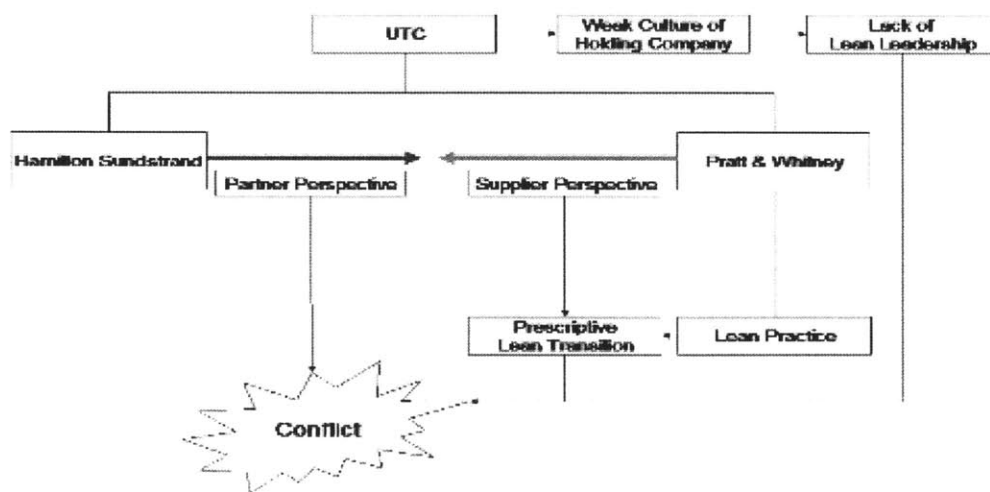
Case 4 is UTC's acquisition of Sundstrand and Pratt & Whitney's lean transition to Hamilton Sundstrand, i.e., the integration of a low-level lean company with a traditional company.

In this case, the focus is the integration philosophy and political relationships of the companies involved in the acquisition. The context of this acquisition is that UTC acquired Sundstrand and made Hamilton Sundstrand, and then Pratt & Whitney tried to implement a lean transition to Hamilton Sundstrand. Complicating the transition, however, was the fact that Hamilton Sundstrand was a supplier to Pratt & Whitney, and the acquisition made it one of UTC's subsidiaries at the same level as Pratt & Whitney. The result was that Pratt & Whitney viewed Hamilton Sundstrand as a supplier, and Hamilton Sundstrand thought of itself as an equal-level company to Pratt & Whitney.

In the end, Pratt & Whitney was responsible for the lean transition, and Hamilton Sundstrand was not willing to follow it. If the holding company, UTC, had tried to implement the lean transition using lean leadership and strong company culture, it would have been easier for Hamilton Sundstrand to accept the lean transition.

Also, both companies should have been informed their respective employees of the rationale for the acquisition and made strong efforts to share their common vision through communication.

Thus, the lack of lean leadership and a weak culture in the holding company were barriers to a successful lean transition, which hindered the rate of lean efforts in both companies. This dynamic is illustrated in Figure 6.4.



Source: author

Figure 6.4 The integration model for Pratt & Whitney and Hamilton Sundstrand

6.2 VALIDATION USING FINANCIAL INFORMATION

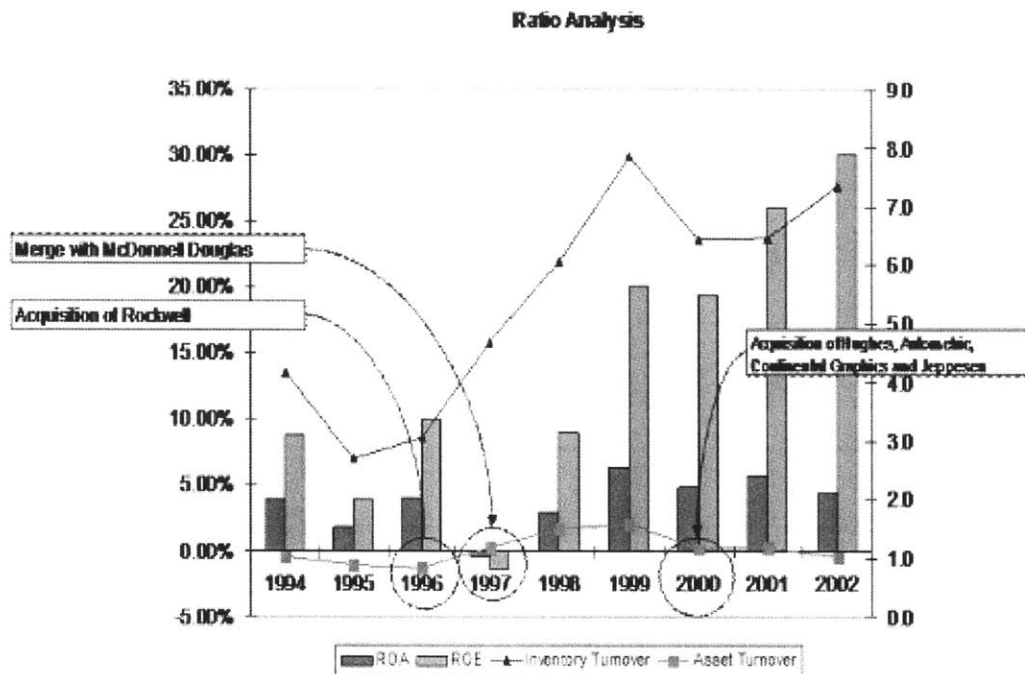
Because I had limited access to company information, I could use only public information to determine whether Boeing's various mergers and acquisitions accelerated or decelerated the company's efforts to enhance its lean enterprise.

It is not easy to measure changes of leanness in a company after a merger or acquisition because the principles of lean can affect sections of the financial statements; it is also difficult to determine the effects of a specific merger or acquisition on leanness. Lean as a culture requires considerable company time to embrace the concept into its culture and organization. And earnings and equity value are often affected by macro economies and financial markets rather than by improvements to internal operations.

To measure changes in leanness as a result of the mergers and acquisitions, I made several assumptions based on information already provided in Table 3.2 (see Chapter 3).

- The merger with McDonnell Douglas in 1997 had the largest effect on the financial statement.
- The several acquisitions made by Boeing in 2000 had the second-largest effect on the financial statement.
- Inventory turnover shows how efficiently a company manages its inventory on the shop floor, and parts from suppliers through supply chain management system.
- Asset turnover, ROIC, and ROA—usually strong measures of leanness—were only considered as references rather than as the main measures of leanness in the company, because the time period to gauge leanness was too short and those measures are greatly affected by the environment outside the company.

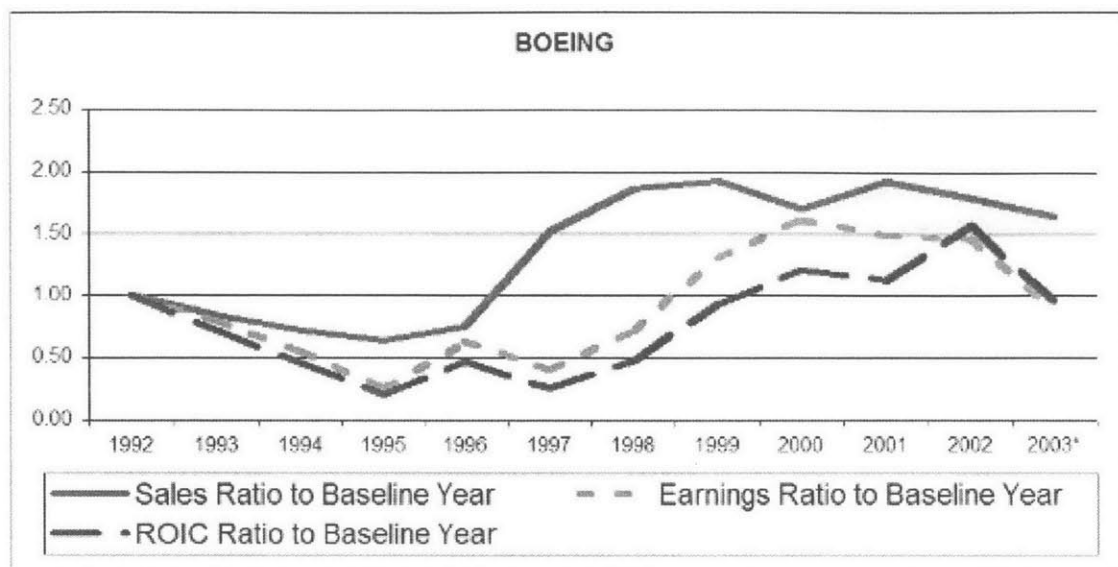
Based on these assumptions, I developed Figure 6.5, which shows the ratio analysis of Boeing based on its financial statements.



Source: developed by author based on Boeing 10-K reports from 1995 - 2002.

Figure 6.5 Ratio Analysis

Between 1997 and 1999, when the merger with McDonnell Douglas affected Boeing's financial statement, inventory turnover, asset turnover, ROA, and ROE accelerated. Figure 6.6 shows ROIC increasing during this period.



Source: N. Nightingale, 2003

Figure 6.6 Boeing's ROIC Analysis

The increase in inventory turnover has two meanings. The first is that the manufacturing floor minimized materials waste and managed employees very efficiently. The second is that the company shared production information with its suppliers to successfully implement a Just-In-Time system. The data proves that Boeing's merger with McDonnell Douglas increased operating efficiency both in materials and people. Figure 3.4 (Chapter 3) also supports this.

Considering the limitations of measuring leanness in a company based on financial information, I can only conclude that the merger with McDonnell Douglas at least did not decelerate the lean effort—especially in the manufacturing and supply chain management. But it is harder to conclude that the merger in fact accelerated lean efforts.

After 2000, when Boeing acquired several companies, including Hughes Aerospace, inventory turnover and ROA decreased. ROA and ROIC fluctuated while ROE increased.

Before drawing a conclusion as to whether Boeing's various mergers and acquisitions in 2000 accelerated the company's lean effort or not, other factors need to be considered. The poor market situation on the commercial and defense side may have had an affect on the decrease of inventory turnover, ROIC, sales, and earning ratios between 2000 and 2001.

Therefore, it is not certain that the several acquisitions in 2000 decreased these ratios or make the company avoid a steeper fall-off from those ratios. For a clearer conclusion, more information about the different industries and internal financial information are necessary.

6.3 FINDINGS FROM THE CASE STUDIES

From Case 1 (Boeing and McDonnell Douglas), Case 2 (Boeing and Hughes), and Case 3 (Vought and Aerostructure), I found that leadership, communications, and education played pivotal roles in the successful lean transition following the respective merger or acquisition.

The role of a lean office was very important in that it played a leadership role in the early stage of the lean transition during the integration process, and it provided the education and communications needed to share lean expertise and knowledge in the later stage.

The Process Council and its workshops offered a community of practice throughout the knowledge management process, generating and sharing best practices throughout the entire enterprise. IT infrastructure provided people with high-tech communications tools and a strong knowledge base.

In Case 1, the main focus by both companies on sharing vision and knowledge based on leadership, communications, and education was important in the early stage of lean transition during the integration process. In the later stage of the lean transition, different levels of lean expertise began to affect.

In Case 2, both companies consumed considerable time changing the engineering culture of the target company and motivating people. The lean assets of the target company showed their value in the later stage of the lean transition.

In Case 3, the rationale for the acquisition was very important in the early stage of the integration process. Understanding this clear rationale for the acquisition motivated people in both companies toward a common goal and shared vision. It was a catalyst for learning new knowledge and accepting the new culture, regardless of differences in lean expertise.

In contrast to Case 3, Case 4 showed that political relationships between the acquiring company and the target company are important for implementing lean transition, and for sharing knowledge and culture. One important lesson was the recognition that who retains leadership in the holding company structure affects whether or not the integrating companies can easily develop a shared vision.

Additionally, all of the cases highlighted the fact that a negotiated strategy for lean transition is the most efficient. In Case 1, the imposed strategy pursued by McDonnell Douglas — setting a higher goal of lean than that of Boeing — created problems by making McDonnell Douglas people appear to be quite rigid to the Boeing people. In the case of UTC, the lean transition by Pratt & Whitney, one of their customers, also seemed directive from the perspective of the Hamilton Sundstrand people. In Case 2, those who had a less-successful experience with lean deployment would benefit from a negotiated strategy that encourages people to accept lean knowledge. The negotiated strategy, pursued later in Case 1 and from the outset in Case 3, were effective for sharing knowledge. An agreed vision and clear rationale for the acquisition motivated people to actively accept new knowledge, and the Process Councils of both companies introduced change initiatives by exchanging people and experts from both sites.

In conclusion, the differences of lean maturity and lean expertise between the acquiring company and the target company generally have less prominence in the early stage of merger discussions, but have a major impact afterward. Also, mitigating factors on the impact of a merger, such as uncertainty and instability regarding lean principles is dependent on educating people about the underlying logic of the merger.

CHAPTER 7

CONCLUSIONS AND RECOMMENDATIONS

7.1 CONCLUSIONS

In a lean transition that takes place following a merger or acquisition, it is very important to determine and convey a clear vision and rationale for the integration. The lack of a clear vision or rationale will be costly because employees find it harder to cope with the uncertainty of the integration process, and leadership will be much less effective in the later stages of integration.

Second, differences in terms of culture, lean maturity, and lean expertise should be considered in the due diligence stage when the parties are getting to know each other. Then, management can become prepared for the kinds of barriers that may develop in the integration process, for the costs of developing preliminary solutions, for removing the barriers to lean transition in the early stages, and finally for minimizing uncertainties in the integration process.

Third, the integration process of lean companies requires leadership, communication, and education for the companies involved in the process. These requirements are important for motivating employees to accept new knowledge and share best practices. The lean office can take a leadership and communication role, and the Process Council can establish communities of practice and education throughout the knowledge-transfer processes and into post-merger improvements.

Finally, it is important for the companies involved in a lean transition during a merger or acquisition to determine what areas, resources, and expertise can be shared and what cannot be shared. For common areas, resources, or expertise, standardized lean principles can be applied; for areas where resources or expertise differ, customized lean principles must be applied. This strategy minimizes wasteful conflict and has the positive effect of making the lean transition show earlier than expected.

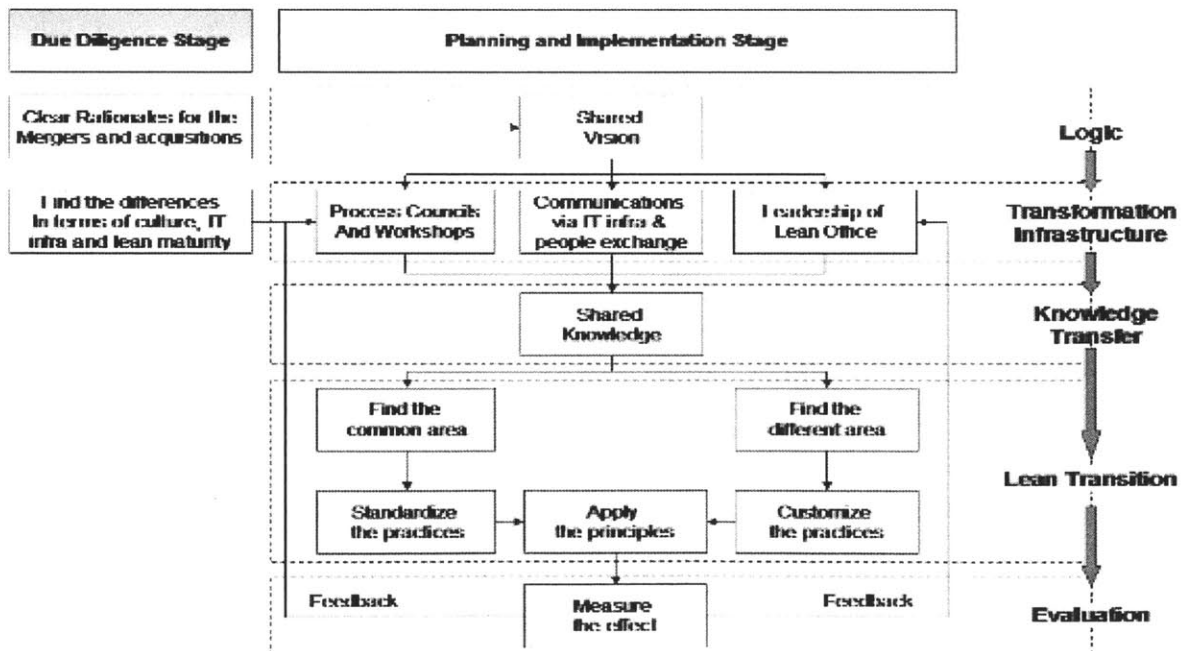
7.2 ROADMAP FOR LEAN TRANSITION DURING INTEGRATION

Based on the case studies and research, I recommend the following roadmaps for successful lean transition in an integration process following merger or acquisition:

1. Establish a clear rationale for the merger/acquisition in order to obtain support from different stakeholders and a shared common vision.

2. Determine barriers to the lean transition, such as cultural and operational differences, during the due diligence stage.
3. Clarify the lean capabilities already available in each company, such as different levels of lean expertise and expertise with IT systems.
4. Construct a Process Council consisting of managers from different functions of both companies; also workshops for education. Select a leader, such as a lean office, to take the role of guiding the transition.
5. Process and diffuse knowledge from the workshops and councils and actively encourage interactions among employees and functions through the IT infrastructure and via people exchanges.
6. Find common areas of lean expertise and standardize practices for those common areas. Diffuse different lean expertise in one company to the same area in the other company and develop customized approaches.
7. Implement lean principles at the enterprise level, business unit level, and factory level. Measure the effect and rate of lean effort and give feedback to the councils and lean offices.

These processes are shown in Figure 7.1.



Source: author

Figure 7.1 Roadmap for Lean Transition During Mergers and Acquisitions

7.3 RECOMMENDATIONS

In Case 1 (Boeing and McDonnell Douglas), standardization and customization of lean principles could have been more deeply leveraged as relevant, because both companies had different business areas and cultures. Determining what should be standardized and what should be customized accelerates the lean effort and reduces conflict among principles used in different industries and cultures. What ended up being a successful integration could have been accelerated by at least a year or more with such attention.

In Case 2 (Boeing and Hughes), it would have been better had the companies extracted the best practices of Hughes earlier in the lean transition. That would have given some small successes to people at Hughes and accelerated the rate of lean effort and lean transition in both companies.

In Case 3 (Vought and Aerostructure), a structured lean transition effort, such as lean offices, would have made the effort more efficient. However, the advance calibration during the due diligence stage has the potential to be an industry best practice – worthy of further study and replication by others.

In Case 4 (Pratt & Whitney and Hamilton Sundstrand), UTC could have assumed a greater lean leadership role by having a lean office that was in charge of the lean effort for all the subsidiary companies, instead of allowing only Pratt & Whitney to lead the lean transition with Hamilton Sundstrand.

7.4 SUGGESTIONS FOR FUTURE RESEARCH

For this thesis, I believe there were a limited number of cases and a limited number of interviews in each case. As a result, this work must be seen as an exploratory study. However, it can be used as a springboard for generating potential general principles of lean transition during mergers and acquisitions. Further confirmatory research based on more interviews with people from different functions and positions at more levels in the organizational hierarchy, would produce more detailed information about the lean transition during mergers and acquisitions.

Additional interviews with a more diverse set of employees will give insight into how the different elements of lean manufacturing, engineering, and supply chain management change after a merger or acquisition. Also more interviews will provide more accurate information about the leanness of a company before and after a merger/acquisition. More inside information about each business unit would more accurately inform how the rate of lean effort has changed and how different areas of lean expertise changed at different rates.

A lean transition during a merger or acquisition at the international level would also be an interesting case because cultural differences in the international setting would make an added overlay on the differences in lean expertise and corporate culture.

Finally, more quantitative analysis is needed. Quantification of input data, such as lean level and culture, and output data about changes in the rate of lean effort will give a clearer perspective on the factors that affect lean transitions during mergers and acquisitions.

7.5 CONCLUDING COMMENT

A merger or acquisition is a major event in the history of an organization. Lean transformation is an ongoing process that has the potential to have just as dramatic an impact. This thesis has examined the inter-relationships between the two. We see that there are many ways in which the potential associated with lean capability can be undercut or delayed as a result of a merger or acquisition. At the same time, with proper attention to the prior expertise in both organizations, an expansion of lean capability is possible. I hope this thesis helps organizations to realize this potential.

APPENDICES



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APPENDIX A

Mergers and Acquisitions of Boeing since 1996 (Buying).

No	Deal Type	Purpose	Announce Date	Company	Products	Deal Brief
1	Acquisition.	Horizontal	15-Dec-96	McDonnell Douglas Corp	Designs, makes and supports military aircraft systems and related products	Boeing has acquired McDonnell Douglas, offering 1.3 of its shares for each McDonnell Douglas share outstanding. The deal values McDonnell at \$76.29 per share, or a total of \$15.454 billion.
2	Acquisition.	Vertical	1-Jun-00	Autometric Inc	Provides software products and services in the geospatial information technology marketplace	The Boeing Co acquired Autometric for an undisclosed amount. Boeing is focusing its growth in the space and communications areas that include classified government program opportunities, the movement of broadband information on and off mobile platforms, and integrated military systems.
3	Divestiture	Horizontal	15-Aug-00	Jeppesen	Publishes a variety of aviation-related material and information	The Boeing Co acquired Jeppesen Sanderson, the world's number one provider of flight information services, from Tribune Co for \$1.5 billion in cash. Tribune will use the proceeds from the sale to reduce debt and repurchase stock.
4	Acquisition	Horizontal	6-Sep-00	Continental Graphics Corp	Provides customized and specialized technical information to the aviation industry	The Boeing Co acquired Continental Graphics for an undisclosed amount. This acquisition will bolster Boeings offering of information to airlines and aviation companies.
5	Acquisition	Horizontal	10-Jan-03	Conquest Inc	Provides system engineering and software technology solutions to the intelligence community	The Boeing Co acquired Conquest Inc for an undisclosed amount, confirming its vision of developing an integrated battle space, a network-centric system that enables all dissimilar legacy platforms from many different branches of the intelligence community to operate together, no matter where you are. Currently, Conquest has 20 contracts with other companies valued at approximately \$250 million, and as a result of the acquisition, Conquest now becomes the Maryland division of Boeing Space and Intelligence Systems. The transaction was closed on February 11, 2003.

No	Deal Type	Purpose	Announce Date	Company	Products	Deal Brief
6	Divestiture	Horizontal	17-Oct-00	Hawker de Havilland	Designs and manufactures aircraft and related components	Boeing Australia, acquired Hawker de Havilland from Tenix Holdings International for an undisclosed amount. The acquisition enables Boeing to lower manufacturing costs through increased operating efficiencies.
7	Acquisition	Horizontal	5-Sep-00	AeroInfo Systems Inc	Provides advanced maintenance software applications for the airline industry	Boeing acquired AeroInfo Systems for an undisclosed amount. The acquisition adds AeroInfos industry-leading aviation maintenance planning technology to Boeings portfolio of aviation services.
8	Acquisition	Horizontal	27-Jun-00	SVS Inc	Makes laser tracking and imaging systems	Boeing Co agreed to acquire SVS Inc for an undisclosed amount. SVS Inc is expected to bring to Boeing not only directed energy but also a wide range of electro-optical controls and imaging control applications for both the defense and commercial markets.
9	Divestiture.	Vertical	23-Sep-02	FlightSafety Boeing Training International	Provides flight training	Boeing acquired Flight Safety Boeing Training International for an undisclosed amount to expand its capabilities and customer offerings. FlightSafety Boeing Training International employs 800 people and has 70 full-flight simulators in 21 locations throughout the world.
10	Acquisition	Horizontal	27-Jul-01	SBS International	Provides software modules used in crew scheduling systems airlines	The Boeing Co, a developer and marketer of jet aircraft and provider of commercial airline services acquired SBS International for an undisclosed amount. Based in New York, SBS International develops software modules used in crew scheduling for airlines and will complement other recent Boeing acquisitions. This acquisition allows the leveraging of intellectual capital and technology as Boeing expands its business.
11	Divestiture	Horizontal	1-Aug-96	Aerospace and Defense Business	Makes aerospace and military equipment	Rockwell transferred the majority of its businesses to a new company that will keep the Rockwell name, leaving the Aerospace and Defense businesses acquired by Boeing.

No	Deal Type	Purpose	Announce Date	Company	Products	Deal Brief
12	Divestiture	Horizontal	13-Jan-00	Hughes Satellite Systems Business	Manufactures satellite and communications systems	Boeing acquired Hughes satellite business from General Motors for \$3.8 billion in cash to solidify its position as the leader in integrated space-based information and communications. The acquisition will boost Boeings space and communications revenues and earnings by more than a third.
13			5-Sep-00	AeroInfo Systems Inc.	AeroInfo provides computerized maintenance services through software it developed to plan, schedule and track aircraft maintenance requirements over the Internet.	
14	Acquisition	Acquisition of non-US	28-Sep-99	Preston Group Pty Ltd (The)	Develops software technology for air traffic management and airport terminal control	The Boeing Co acquired The Preston Group for an undisclosed amount to expand its portfolio of support products and services.
15	Divestiture	Horizontal		Aero Vodochody AS	Czech military aircraft manufacturer	Boeing Co and Czech airline CSA AS are buying a 37% stake in Aero Vodochody AS, a Czech military aircraft manufacturer. The acquisition is as a joint venture with Boeing owning 33.3 percent.
16	Divestiture	Vertical	4-Jan-95	Precision Gear	Helicopter gears & transmissions	Boeing Co acquired Precision Gear Unit through Litton Industries Inc.

Source: Thompson Financials

APPENDIX B

Mergers and Acquisitions of Boeing since 1996 (Selling)

#	Deal Type	Announce Date	Company	Products	Company	Products	Deal Brief
			Sold Companies		Acquirer		
1	Divestiture	25-Feb-98	Commercial Helicopter Business	Manufactures helicopters	Textron Inc	Makes gas turbine engines	
2	Divestiture	17-Apr-03	Aerospace Wiring Operations In Corinth	Primary Metal Processing harnesses for commercial jetliners and military aircraft	Snecma	Manufactures propulsion and aerospace equipment	Labinal SA, a unit of Snecma, agreed to acquire the aerospace wiring corporations of Boeing Co which is located in Corinth, Texas for an undisclosed amount. Included in the transaction is a wiring harness supply facility with its 900 employees.
3	Divestiture	24-Jan-02	Thermal Joining Centre	Manufactures titanium assemblies for the F22 Raptor aircraft	GKN PLC	Manufactures automotive and off-highway vehicle	GKN PLC acquired the Thermal Joining Centre from The Boeing Co for \$4.8 million
4	Divestiture	11-Jun-99	Boeing Information Services	Provides the federal government with information and systems integration services	Science Applications International Corp	Provides systems integration and information technology services	Information Services division to Science Applications International for an undisclosed amount. The sale is part of Boeings strategic plan of focusing on core businesses.
5	Divestiture	19-Oct-00	Military Plane Structures Operations of The Boeing Co	Manufactures plane parts	GKN PLC	Manufactures automotive and off-highway vehicle parts as well as aerospace and defense products	GKN acquired the military plane structures operations of The Boeing Co for \$61 million. The acquisition will almost double GKN aerospace sales. GKN intends to transfer additional manufacturing and new technology into St Louis, which will become a core facility for GKN Aerospace and its administrative headquarters in the USA.

#	Deal Type	Announce Date	Company	Products	Company	Products	Deal Brief
6	Divestiture	25-Nov-02	Spokane Fabrication Operation of The Boeing Co	Manufactures aircraft parts	Triumph Group Inc	Designs, engineers, manufactures, repairs, overhauls, and distributes aircraft parts	Triumph Group Inc acquired the assets of the Spokane fabrication operation of the Boeing Co. This acquisition will expand the product and customer service offerings of Triumph Group Inc. The Spokane Fabrication Operation of the Boeing Co employs approximately 400 people.
7	Divestiture	18-Mar-02	Ordnance business of Boeing Co	Manufactures medium-caliber automatic cannons and machine guns	Alliant Techsystem	Develops and supplies aerospace and defense technologies, products, and systems	Alliant Techsystems acquired the ordnance business of the Boeing Co for an undisclosed amount. The ordnance business has about 50 employees and is based in Mesa, Arizona. Alliant Techsystems will operate the ordnance business in Mesa and will assume ownership of the facilities and other assets associated with the company.
8	Divestiture	3-Aug-01	Sensors And Electronic Systems Business of Boeing Co	Provides advanced electro-optical airborne and naval surveillance and targeting systems, high-performance military infrared cooled sensor systems, and infrared uncooled sensor systems	DRS	Supplies electronic systems and products for the defense industry	DRS Technologies acquired the assets and certain liabilities of Sensors and Electronic Systems Business of The Boeing Co for \$67 million in cash. This acquisition increases the annual sales of DRS Technologies by about 50 percent, adding around \$75 million to annual sales.
9	Unit Minority. Divestiture	17-Jan-01	HRL Laboratories LLC	Provides government research and development programs and provides research and development services	General Motors Corp	Manufactures automobiles and trucks and provides financing services	General Motors acquired a one-third equity stake in HRL Laboratories from Boeing and Raytheon for an undisclosed price. As a result of the acquisition, GM, Boeing and Raytheon will share equal ownership of HRL Laboratories, with HRL providing corporate research and development for all three companies. The acquisition enhances the technical capabilities in several areas of critical importance to GM, while also allowing HRL another corporate owner, further providing for global alliances and

#	Deal Type	Announce Date	Company	Products	Company	Products	Deal Brief
							partnerships.
10	Divestiture Unit Management	26-Feb-99	McDonnell Douglas Technical Services Co	Provides contract engineering, technical, and information technology staffing services	Private Group Led By Management and CIVC Partners	Investment group led by management and CIVC Partners	A private group led by management and CIVC Partners acquired Boeings McDonnell Douglas Technical Services unit for an undisclosed amount. The sale is part of Boeings effort to concentrate on its core businesses.
11	Divestiture	3-Nov-99	Aces II	Makes ejection seats for the U.S. Air Force and international defense customers	Goodrich (BF) Co	Makes a range of aerospace systems and component parts, and provides maintenance for those systems	B.F. Goodrich acquired the ACES II ejection seat business from Boeing for an undisclosed amount. ACES II is now part of B.F. Goodrich Aerospace Safety Systems division. With this acquisition, B.F. Goodrich expands its product lines and existing ejection seat business.
12	Divestiture	22-Oct-99	Boeing Precision Gear	Assembles, tests, and maintains drive systems	Derlan Industries Ltd	Makes aerospace and specialty products	Derlan Industries acquired Boeing Precision Gear unit for \$10.2 million in cash. The deal is part of Boeings' plan to focus on its core business.
13	Divestiture	1-Oct-00	Structural Fabrication Operations of Boeing Company	Fabricated Metal Products Not Elsewhere Classified	Gkn Plc	Manufacturing automotive drive line systems and engineered and agritechnical products.	GKN Plc, Redditch, Worcestershire, England, the engineering and industrial components company, acquired the structural fabrication operations based in St Louis, Missouri, USA, of The Boeing Company, Seattle, Washington, USA, the aerospace company. Consideration US\$61m (GB44m).
14	Divestiture	23-Jan-92	de Havilland Unit	Manufactures airplanes	Bombardier Inc	Manufactures transportation equipment	Purchasing in conjunction with the Ontario provincial government

#	Deal Type	Announce Date	Company	Products	Company	Products	Deal Brief
1 5	Divestiture	7-Jul-99	Radar-Jamming Device Unit	Makes devices that analyze, intercept and jam radar and military communication signals	Condor Technology Solutions Inc	Provides information technology services	Boeing agreed to sell its Radar-Jamming Device Unit to Condor Systems for an undisclosed amount. The sale is part of its strategy to trim its exposure to the defense industry, as spending in this area has been flat.
1 6	DIVESTITURE	30-Sep-96	Boeing Georgia Inc	Makes cargo handling systems and related components for aircrafts	LucasVarity PLC	Designs, makes and supplies advanced technology systems, products and services	The acquisition of Boeing in Georgia buy LucasVarity is in line with strategy to strengthen position in the aerospace industry.

Source: Thompson Financials

APPENDIX C

Interview Questions

The Role of Lean Enterprise Initiatives in Mergers and Acquisitions

1. Introduction and Objectives

1.1 Introduction

I am a graduate student in the system design and management program at MIT. I am from Korea and I have three years experience in a chemical company, about strategy planning, operations, and new business development. I am working on my thesis with Dr. Joel Cutcher-Gershenfeld, and my work regards examining mergers and acquisitions involving the Boeing company, and the possible impacts of the lean enterprise concept in those mergers.

1.2 Interview Objective

What I am looking for in my thesis is how the mergers and acquisitions of Boeing are related with lean enterprise efforts in your company, with a specific focus on enablers and barriers in this process.

1.3 Ethical issues

(1) *Confidentiality*: My thesis will be published as a public document. The final analysis will be open to others. If you want keep specific information confidential, I will abide by that decision. I will also send you a draft of the write-up in advance of submitting my thesis.

(2) *Anonymous Quotes*: If you don't want your name used in my thesis, I will disguise your identity. For example, "An experienced manager in a department noted...".

2. Research Questions

2.1 Focus

Over the last several years, Boeing has acquired a number of big companies, such as Rockwell aerospace (1996), McDonnell Douglas (1997), and Hughes Space and Communications (2000). My interest is in these companies and other M&As in the past 10 years. If you were involved in the work of pre or post merger organization, I would like to discuss your experience and views.

2.2. Key Question.

How the lean enterprise efforts were helped or hindered as a result of the merger or acquisition?

2.3. Interviewee's background

(1) Current Position and Duties

(2) Previous Position and Duties, specifically when you were involved in one of the mergers and acquisitions in the above cases.

2.4. Overall situation

(1) Which mergers and acquisitions were you involved in?

(2) At the time when the mergers and acquisition was being discussed, what was

the status of lean enterprise efforts of both companies (Boeing and target company)? Was there any company wide effort for lean at that time? If not, where was the focus? (e.g. lean manufacturing)

Brief Lean Concept Introduction: At their most basic level, Lean principles involve creating value by eliminating non-value added steps, inventories and other processes while maximizing cash flow and return on investment, and establishing and maintaining positive stakeholder perspectives.

2.5. Motivations

- (1) What was the motivation for the merger/acquisition? Was "lean" a factor?
- (2) What organizational needs are being met? How do lean principles fit in?

2.6. Motivation from multiple perspectives

- (1) What cultural factors affected the merger/acquisition and the experience of lean?
- (2) What political factors affected the merger/acquisition and the experience of lean?

2.7 Organization and Strategy

- (1) How has the structure of Boeing Company or targeted company changed after the merger and acquisition? How has this affected lean enterprise effort?
- (2) How has the strategy of managing global suppliers and customers changed?
- (3) How are people in Boeing and the target company measuring whether the merger/acquisition is successful. What are the metrics being used? Financial performance? Employee morale?

2.8. Interaction between mergers/acquisition and lean enterprise efforts

- (1) What was the benefit and cost of mergers/acquisitions in implementing lean principle in Boeing company after mergers/acquisitions?
- (2) Did these lessons affect the next mergers/acquisitions? How come?
- (3) What would you recommend for future mergers and acquisitions of Boeing?
- (4) What elements of the companies have changed since the merger/acquisition? (Product Line/ Supplier Management/ Organization/ Employment/ New product development effort/ Sales/ Financial)

3. Conclusion

Do you have any additional comments or observations?
 What e-mail address may I use to send you a copy of my write-up for your review?
 Thank you for your time.

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