Engineering Management
Field Project

Business Case for the Application of Lean Design at XYZ, Inc.

By

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I would especially like that thank [Name withheld] , VP of Operations, XYZ, Inc. Manufacturing, who personally introduced me to and inspired me to research and understand Lean Enterprise and Lean Design. His presentation of Lean Design for operations and engineering management, at XYZ, Inc., was a pivotal moment that awoke awareness of this subject.

I would also like to recognize the faculty and staff of the University of Kansas Edwards Campus Engineering Management program for their hard work and positive inspiration in the ever changing world of Engineering Management. I have been amazed at the applicability of the material that provides insights into managing highly technical businesses in a globally competitive world. Motivation for this Field Project was inspired from EMGT 867 “Advanced Operational Management” and EMGT 821 “Strategic Analysis of Technical Projects” which created an excitement for me into the inter-workings of strategic planning, operations, engineering, marketing, sales, and management.

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Executive Summary

This field project is an exercise in developing change in a business where aging strategies threaten the competitiveness of the business as a whole. Research and analysis into the market, for XYZ, Inc., are used to build the case that the market has changed. Old methods of competing are no longer effective at maintaining the market lead. Recent loss of the market lead is direct evidence that the company has not been paying attention to the low-end of the market and that a new strategy is needed.

The current method of Lean Design is explored as it relates to revitalizing businesses, without the higher risk of new product development. Exploring the history and expert commentary of Lean Enterprise helps the reader develop insight into the correct way to achieve positive results for a business and how to avoid common pitfalls.

To help XYZ executive management understand the benefits of Lean Design, a pilot project is proposed. Two project approaches will be addressed. The first project, Project A, is the first impression method, which explores the expected question of: Why not implement the change on all Appliance-A products? The purpose of addressing Project A before jumping to the best solution is to preemptively prevent the project from starting off on a high-risk path.

The second project, Project B, is the best-result method, which explores the lowest-risk with highest-gain approach. Creating a small win for the business,

without risk, should pave the way for a positive improvement in the organization and allow for a strategy, which could lead to an eventual recovery in the market.

Operational metrics combined with project estimates clearly shows that capital investment for these projects will be recovered quickly. Sensitivity analysis for the projects shows which elements are the most critical. Finally, an intuitive understanding of the project risks directs a clear path for the best choice.

Implementation of Lean Enterprise is a complex endeavor and requires efforts that transcend this business case. The final portion of this field project points out several areas where further research and analysis could augment a fuller more complete implementation of Lean Enterprise.

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Abbreviations

[Many abbreviations removed to protect the confidentiality of XYZ, Inc.]

BOM – Bill of Material

COGs – Cost of Goods

FYP – Fiscal Year Planned

XYZ - XYZ, Inc.

Chapter 1 - Introduction

XYZ, Inc. Inc. is comprised of three business units: Appliance-A Products, Appliance-B Products, and Service Business. This business case is focused on the Appliance-A Products business unit because it is a mature product line and has the best applicability to the Lean Design techniques and benefits proposed.

In this business case, company metrics are used to show that the competition in the Appliance-A products market is moving toward a low-cost winner. Despite the strong brand loyalty of many customers, becoming a low-cost leader with the best features is sure to dominate the criteria of the next market leader.

To remain competitive, a company must adopt new business strategies periodically in order to revitalize the business. Companies that survive over many decades all demonstrate the resilience required to change. This case presents a low-risk method, Lean Design improves the ability to become more aggressive in market-price wars and creates the ability to apply more efficiency to next-generation products.

To convince executive management, in the upcoming 2007 strategic planning meeting, as to the viability of Lean Design to the organization, a pilot program in product platform consolidation is presented that demonstrates the capital justification. The pilot introduction of Lean Design represents a great way of

introducing the benefits of this process, on a trail basis, without jeopardizing the entire business.

Chapter 2 - Literature Review

Research for this project was accomplished through the use of the KU EMGT program, books, articles, and the internet. Several books listed below, as presented in the EMGT setting, created the excitement that makes understanding, planning, and implementing these wonderful concepts interesting. The most influential readings were:

1. "Operation Management for Competitive Advantage"
2. "Strategy: Winning in the Marketplace 2nd Edition"
3. "Managing Strategic Innovation and Change"

While these books were of significant influence, it must be stated that equally important was the quality and experience of the EMGT faculty, as real-world knowledge was combined with the text to create a better whole.

Books

1. Chase, Jacobs, Aquilano, *Operations Management For Competitive Advantage*, McGraw-Hill, 2004, 10th Edition

The authors present a current picture of managing and operating a business. They take the reader into the strategies of what types of business exist and how to plan in order to remain competitive. Techniques are given that explore all elements of the company from the top down and suggest that operations is just as important to the organization in its strategies to be competitive.

The material makes the reader think about all of the areas in operations that need to be managed and gives current tried and true techniques to accomplish this in a complex organization. The overriding goals focus on creating a stable efficient manufacturing organization that creates successful products that customers want.

2. Thompson, Gamble, Strickland, *Strategy: Winning in the Marketplace*, 2nd Edition, 2006

One of my favorite quotes from the book is: "A more fruitful approach to achieving and sustaining a competitive edge over rivals is for a company to develop competencies and capabilities that please buyers and that rivals don't have or can't quite match", p 103. This powerful statement suggests that companies need to work constantly at their business in order to remain competitive. This concept and many others in this book provide positive justification for performing business case analysis as presented in this field project.

The material is presented by introduction and overview developing a better understanding as to why strategy is important. Next the authors present the tools to analyze a company and determine a situational awareness of the business. Strategies can then be tailored to fit the particular company needs, in order to make improvements in the organization. Finally the authors present the management techniques most suited to allow for successful execution of a developed strategy. The case studies presented with the theory give good

background on what other businesses have done to create successful strategies. They are insightful and up to date.

3. Tushman and Anderson, *Managing Strategic Innovation and Change*, Oxford University Press, 1997

The authors offer a fantastic collection of examples to support managers in understanding and planning how to create and maintain successful technology businesses. The real-world cases explore why some businesses fail, some businesses succeed, and some highly-successful businesses lose the position of market leader. The text provides a roadmap on how to analyze the product life-cycle within a business and how to determine which strategies work best at which stage.

Presentation of the Swiss watch maker's case shows how the company failed to see the changes in their market and is an example that stresses the need to remain vigilant and agile toward business strategies.

The case of the Sony Walkman is a perfect example how to use product platforms to create low cost models that out perform the competition. This case has high-level of relevance toward this field project and the use of common hardware to create economies of scale.

4. Meyer and Lehnerd, *The Power of Product Platforms: Building Value and Cost Leadership*, Free Press 1997

The concept of product platforms is a method of product management that characterizes many of today's successful businesses. In this book, numerous business cases demonstrate real pragmatic examples of how companies have evolved the business to become more competitive and profitable. It focuses product development on using a core set of technology to build a variety of models. Using common hardware realizes economies of scale that make the product cheaper to build, more reliable, and more functional.

The authors make the case that many companies never give the concept much thought or plan the business strategy around the idea. This is true for this business case; a close look at all of the products in the law enforcement Appliance-A products market will show you that product platforms is not practiced well by XYZ, Inc. Inc. or the Appliance-A product competition. Thus, just as the authors indicate, there is an opportunity to create a competency that the competition cannot match which allows XYZ, Inc. Inc. to better control the market from top to bottom.

The Pilot Project presented in this business case draws from the ideas and concepts of using product platforms to create a lower cost more competitive product. This concept fits very well into the lean thinking of Lean Design.

5. Ronald Mascitelli, *Lean Design Guidebook: Everything Your Product Development Team Nees to Slash Manufacturing Costs,* 2004

Mascitelli offers a concise text to managers that help with the actual implementation of Lean Design within an organization. The text takes the reader through the steps of justifying new product development through analysis of NPV and IRR. He explores the important first step of learning to create products that customers want, by understanding and capturing customer requirements.

The author gives a good treatment into the pros and cons of implementing product platforms and teaches the reader how to organize a product in the optimal form of modularity. The point is made, that through modularity economies of scale can be realized to improve product competitiveness.

The book is accompanies by a number of tools, in the form of templates, forms, and worksheets, which give the practitioner simple methods to follow. This is a great one-stop reference for implementing Lean Design within an organization.

6. Thomas Klammer, Jan Bell, and Shahid Ansari, *The Capital Budgeting Process*, McGraw-Hill, 2000, ISBN 0-07-231575-X

This book gives the reader a basic understanding of how to present a capital budget case to management. It starts with the introduction of detailing project costs and ends with the development of time value analysis through NPV and IIR.

Numerous exercises are given that teach how to put together a business case using real world scenarios, showing a variety of different situations.

Articles

1. Peter Hines, Matthias Holweg and Nick Rich, *Learning to evolve a review of contemporary lean thinking*, International Journal of Operations & Production Management, Vol 24 No. 10, 2004, pp. 994-1011

The authors in this paper do a great job of presenting the history of lean and discuss many of the pit falls discovered in earlier implementations. They succeed in dispelling many of the more confusing aspects of lean management and offer insight into the customer value creation aspects of lean application.

This paper provides an important presentation of the fact that implementation of waste reduction has a de-humanizing component to it. The authors caution that a successful implementation of lean requires strict attention to this fact and point out that this is a key element to long term stability.

The authors point out that a lack of understanding about lean and how it impacts different industries creates a formula for failure in implementation. They give good examples of how this has occurred in real cases and help give the reader real insight into how lean can be successfully implemented in their business. Reading this material will educate one in the evolution of lean and provides a clearer understanding into the successful application of lean. It would be a necessary reading for the XYZ, Inc. organization and would greatly help achieve a lucrative implementation of the pilot program proposed in this business case.

2. M.L. Emiliani and D.J. Stec, *Leaders lost in transformation,* Leadership & Organization Development Journal, Vol. 26 No 5, 2005 pp. 370-387

The authors of this article give further credence to understanding the history and changes to lean management before implementing the process within an organization. They point out that lean management has evolved over time, with good reason.

The article gives detailed information on how manufacturing organizations work and how to apply lean principles throughout a company to make it successful. This is a manufacturing oriented presentation with a focus on waste reduction at the assembly floor level.

The most important point of this article is how managers can become lost (lost in translation), in the operational features of lean and miss the organizational aspects. The cultural impact of lean remains the largest missed issue during implementation and is the leading cause of failure. Any form of lean implementation, including this field project, can benefit from the insight provided by these authors.

3. Daniel T. Jones, *Corporate renewal through lean design,* World Class Design to Manufacture, Volume 2 Number 2, 1995, pp. 6-9, ISSN: 1352-3074

Jones uses the business strategy of Chrysler during the 1980's to show how restructuring a business using Product Platform teams can revitalize a business, creating new synergies.

The point is made that the implementation of lean thinking at the design phase of a product can have dramatic impacts on the business. Reductions in costs, time to market, and re-engineering wastes can create improvements to a product that competitors cannot match.

4. Ron Mascitelli, PMP, *Lean Design as a Competitive Mandate,* The Journal of Advanced Manufacturing Systems, 2004

Mascitelli, author of the Lean Design Guidebook, has written this article for the Journal of Advanced Manufacturing Systems, which outlines the benefits of implementing Lean Design. He does a good job of pointing out that many companies cannot afford to remain at the leading-edge of their industry by innovating their way into the next big product. A more efficient way to compete is to develop skills in applying lean design at the earliest phases of product development.

Products can be developed using platforms of modularity that improve costs through economies of scale. New designs will analyze many approaches, with the consideration of how the new product fits within existing product line synergies being a top decision criterion.

5. Marty J. Schmidt, MBA, PhD, *Business Case Essentials: A Guide to Structure and Content,* A Solution Matrix Ltd. White paper, Revised April 2003

Schmidt offers one of the best guides on presenting a business case to management. This white paper demonstrates an outline including the details of what belongs in each section.

There are many ways to present a business case; this author provides the guidance to make the presentation flow in its most efficient form. Following the author's process generates a formula to help the audience understand the material quickly and the results better. A business case must remain crisp and clear and the author has captured this essence in a simple how to way.

Examples of tables and diagrams give the reader great ideas on ways to present data and results that look sharp and make the point of the case clear. The author's understanding of what executive management wants and needs to see is self evident.

Chapter 3 - Procedure and Methodology

Company data was collected over a 6 month period and used to generate the charts and tables in this business case. The business metrics are published weekly to manage operations. This business case used the published data from January 2006 until September 2006.

Most of the company metrics are taken directly from the Enterprise Resource Planning (ERP) system database and represents real business data. The data is only accurate to the degree that some input is based on estimates and time surveys that are only updated periodically. With this in mind, it has been accurate enough to manage the business with confidence over many years.

Historical product information was gathered through discussions with several employees that have been with the business for 30 or more years. Some of the information was contradictory, such as what year the first product was put into production. When this occurred additional questioning and debate narrowed the choice to the most likely answer.

The Product Manager for the Appliance-A Products Business unit provided data regarding the market size and competition market share. In addition the Product Manager provided insight into the market history and potential market direction. Finally, the Product Manager provided the quotes from a consulting company, which gives some insight into the customer.

The concept that XYZ, Inc. Inc. is not as competitive originates through the common-knowledge of many of the employees. It is well known that the company is losing market share and not the market leader of the past. The presentation of Lean Design by the VP of Operations planted the seed that lean would be a great way to revitalize the business.

Research into Lean Enterprise re-affirmed the applicability of lean thinking as a tool to revitalize a struggling business. This research revealed the applicability of applying product platforms and economies of scale as a low-cost, low-risk, approach to company renewal. The projects in this business case are a direct application of product platforms.

The resources and project planning information was collected from the Engineering Manager in charge of Appliance-A products. The board prices were collected from the Materials Buyer in charge of printed circuit boards.

Information about how to write a business case was given by Dr. Bowlin in the form of a white paper by Marty Schmidt listed in the references. This document was used to outline the material in Chapter 4 of this field project. The collected material was compiled to create the business case.

Data was hand typed by the author using Excel spreadsheet to create derived information, tables, and graphs. Visio was used to generate the drawings such as the History of Lean and Appliance-A Product timelines.

Additional research and information was collected online using the internet. Product pictures were taken from the web pages of each company. Many articles were taken from online sources and the online KU Library. Example Field Projects were referenced at the KU Library to better understand the content of a field project.

Sales Data:

Sales data is collected from the sales team and is taken from the invoices generated for customers.

COGs Data:

Cost of good (COGs) is based on periodic updates to the prices paid for raw materials in the Bill of Material (BOM) and periodic estimates by Manufacturing Engineering, based on time surveys', to assembly and overhead labor.

2006 FYP Data:

2006 Fiscal Year Planned (FYP) data is based on previous year's data and expected market trends. It is managements estimate and promise to the stock holders regarding targeted sales for the year.

Margin Data:

Margins (M) are derived from the number of units sold (N), the gross sales (S), and the cost of goods (C) as described in the following formula.

$$M = (S - C*N)/S$$

Number of Units Data:

The number of units is taken directly from the number of systems built and sold to customers from the ERP system.

Pilot Project Board Price Quotes:

Circuit board assembly prices from outside vendors is based on estimates form the results of previous cost reduction projects that used board economies of scale to lower prices. The estimates were solicited and acquired from the Materials Group at XYZ, Inc..

Pilot Project, Project Estimates

Labor, labor rates, project material costs were provided by the Engineering Project Manager, at XYZ, Inc., based on the high level requirements for this project. Estimates are considered rough and could vary by as much as ±50%. This is typical for the level of planning at this stage in the process.

Interview Verbatim:

Quotes were taken from interviews provided by an externally hired consulting firm, [Name withheld].

XYZ Owner Expectations:

XYZ Owner Expectations of XX% return is the amount used for 2005 and 2006 operational planning. The same amount will be used for the 2007 planning.

Widgets:

Margins and cost for the Widget-A have been averaged to create the Widget-A data. This was done to make the presentations less busy and more readable. The charts still convey the same in trends and generate the same conclusion.

Chapter 4 - Results

A business case is presented, for the purpose of examining the XYZ, Inc. Inc. product line and market position. This case identifies and defines a problem facing the company. It presents new ideas and offers creative solutions to support efforts in the 2007 strategic planning meeting.

This business case explores the concepts of Lean Enterprise and Lean Design in order to offer a new strategy to address a changing market. Information about lean is presented to educate the reader about the history and evolution of lean. It is used to dispel any misconceptions about what lean thinking is and how lean is best introduced into an organization.

A pilot project is provided, offering two project approaches, Project A and Project B. The two projects are analyzed to provide a cost-benefit presentation, which will allow for a low-risk introduction to Lean Design.

Project A represents a first impression approach and is used to define the scope of how far to go in extending product platforms. It is expected that management will ask: “Why not extend the economies of scale across the entire Appliance-A Products business unit?” Project A will address this question and show that the increased risk makes this project less desirable than Project B.

Project B offers the best approach which combines lowest-risk and best-gain to create the optimal project to demonstrate the benefits of Lean Design.

Subject

This business case examines the metrics surrounding XYZ, Inc.'s products and explores the business strategies used to create the current, 2006, market state. Companies that compete over long periods of time must remain agile and reexamine their operational strategies on a regular basis in order to remain competitive and stay in business. XYZ, Inc. has been in business for more than XX-years and a critical look at recent metrics will show that the old way of competing is not necessarily the best way to conduct future business.

Purpose

To augment the executive strategic planning for 2007, this case will demonstrate that XYZ, Inc. Inc. faces the problem of remaining competitive and that developments are becoming critical. The search for a deeper understanding will reveal the fact that the market has transitioned from a high-end brand market to a low-cost leader market.

A study such as this can be used to create input for the 2007 strategic plan; with current trends in Lean Design and Lean Enterprise being presented to offer a low-risk solution to the impending crisis. Many companies find competitive renewal through the implementation of Lean Enterprise without the exorbitant costs or risks associated with trying to discover the next big hit

product. The advantages will be presented, tempered with the lessons learned by expert practitioners of the lean model.

This case stands as an important contribution to the process of modifying XYZ's business, adjusting the corporate strategy to the changing needs of traditional customers. If not used in its entirety it should be used to stimulate debate about where the company is and what it should do to remain competitive.

Disclaimer

The data used for this business case is a snap shot in time and represents facts as they are know to date and are based on inexact information. The cost of goods (COGs) for example is based on updates to the prices paid for parts and labor which are only updated periodically. Time studies for assembly labor are not accomplished on a scheduled basis and it would not be surprising if some estimates were only done once and not updated at all unless a major change occurred in the assembly process.

Facts regarding competition sales and margins are not known with any certainty. Since this data is not part of public record, it would be impossible to legally obtain such information. Estimates are gleaned from the results of competitive bids and knowledge about customer size known to be solely or partially supplied by each competitor. Gut feel has been the guide as long standing sales associates have been queried for their input.

The events of 911 dramatically impacted the company's performance in the years after 2001. Economic recovery for the business was extremely slow as customers focused resources and budgets to deal with an increased manpower demand to cover large societal events such as sports events etc… This impact can be seen in the metrics collected for this business case and could obscure the cause and effects attributed to competition and business strategy decisions.

Executive Summary

XYZ, Inc. has been in the business of Appliance-A products for more than XX years and has been a high-end product leader for most of this time. Due to a systemic lack of attention to the low-end of the market, new entrants to the market have emerged with one competitor, [Name withheld], taking over the number one position.

As one input to the company strategy, this business case introduces the idea of Lean Thinking and promotes the implementation of Lean Design. A full understanding of the pit falls to implementing lean design are discussed in order to steer the committee toward a cautious, understanding approach to the changes.

Decreasing the cost of the Appliance-A products from the top down using economies of scale, know as product platforms, will make the company more competitive in price and function. It will shore up the low-end and drive out new entrants, along with improving the ability to out price at the top end.

A pilot project, using Lean Design at its base, is proposed and shows the maximum-potential and most-likely scenario for implementation. This pilot project is low-risk with positive cash flow gain. At a cost of $X the project generates payback in Y years providing first year cash flow of $Z. It is a must do project, if the company is to maintain and recapture its market lead.

Executing this pilot project is low-risk with terrific gain and will lead the way for more of the same. It will show others how to implement Lean Thinking and create credibility for future projects.

Assumptions and Methods

Figures for Fiscal Year Planned (FYP) 2006 are projected amounts used by management to plan the 2006 performance budget and do not represent actual figures for the year, see Appendix A. Planned quantities are of benefit because they show the expectations for the business and illustrate developing product introductions. For example, the Widget-H product was introduced in June of 2006 with total projected sales for 2006 of X units. The dates before 2006 show Widget-H sales of zero. The Widget-C was introduced as a new product in 2002, thus the number of units are zero for 2000 and 2001 with a ramp-up in sales for 2002, 2003, and 2004.

An across the board dip in the units sold for 2002 with a slow recovery for the following years, is a direct indication of the impact of the 911 attack. The reason for this is that many [Name withheld] focused funds toward a stronger

presence at public events and around the communities rather than buying new equipment. A large upturn in the Service business indicates that many customers opted for the cheaper approach of fixing aging equipment rather than investing in new systems.

Introduction

Company Overview

XYZ, Inc. is one of the leading suppliers of Widgets in the United States. The primary products include Appliance-A Widget-A's, Appliance-A Widget-B's, Widget-K's, Appliance-A Widget-D's, and Widget-J's.

XYZ's strategy is to maintain its XX year leadership role in Appliance-A by focusing on customer needs and bring the best-quality, customer-oriented products to this market. The company is seeking continual, incremental improvements to its products, as well as advanced-strategic initiatives to create new innovative products that fit the customer needs in an ever-changing and dynamic world.

Products and services are sold direct to [Name withheld] including [Names withheld]. Overseas sales are directed to foreign [Name withheld] and include sales in more than 20 countries. Sales in the [Country withheld] and [region withheld] are routed through the [Name withheld], 123 divisions, located in each country.

Manufacturing (X employees), Human Resources (Y employees), Engineering (Z employees), and Customer Service (Q employees) are located in

[Name withheld] and consists of an assortment of degreed Electrical Design Engineers, Software Engineers, Mechanical Engineers, Manufacturing/Industrial Engineers, Engineering Managers, Technologists, Technicians, Accountants, Managers, Technical Assistants, Manufacturing Assemblers, and Manufacturing Technicians. The [Name withheld] facility is able to design, manufacture, service, and ship product all over the world. Executive management, domestic sales, foreign sales, and marketing are coordinated from the [Name withheld] office (X employees).

[Reporting structure withheld].

XYZ is privately held and owned by ABC out of [Name withheld], which is subsequently owned by 123 out of the [Name withheld]. [Reporting structure withheld].

XYZ's products are designed and certified by the [Name withheld] and meet standards set forth by the [Name withheld].

XYZ, Inc. remains committed to complying with community requirements including local, county, state, federal, and international requirements for employee safety and product safety and compliance.

Appliance-A Product Line Market:

The Appliance-A products market consists of a high-end and a low-end. The high-end products are characterized by feature-rich options and more complex technology for the customer. The products must be the top-of-the-line best-in-class systems. Appendix B illustrates XYZ's Appliance-A products and

Appendix C illustrates many of the competitors Appliance-A products. The low-end products are characterized by simple operations with few features and low cost. Figure 1 shows how XYZ, Inc. Inc. is positioned in this market and clearly demonstrates the aging characteristics of some of its low-end products.

A hole can clearly be seen at the low-end of the market, due to the fact that the company has not invested in updating its products, in this area, for many years. This over sight is the fertile ground, allowing new entrants a foot-hold into the market. Once established, new entrants can challenge the market all levels.

[Diagram intentionally withheld due to sensitive nature of the information]

Figure 1

XYZ, Inc. must pay attention to this problem, in order to maintain leadership in the Appliance-A products market. A new strategy should seriously consider the possibility of operating at a loss, at the low-end, in order to protect the more lucrative top-end. In addition, any strategy that allows the company to leverage its low-end products off its high-end components will greatly benefit all products. Thus a low-cost manufacturing approach must remain a primary business objective.

[Diagram intentionally withheld due to sensitive nature of the information]

Figure 2

[Diagram intentionally withheld due to sensitive nature of the information]

Figure 3

XYZ, Inc. Inc. occupies just less than X% of the market in both Appliance-A and Appliance-B. See Figure 2 and Figure 3 for management's estimate of the Appliance-A products market. XYZ products are considered a high-end Appliance-A. In the Appliance-A market, the company has maintained this position by building higher-quality product with more features at a higher price. In recent years, low-end competitors in Appliance-A ([Names withheld]) have slowly increased their quality and product features while maintaining a rock-

bottom price. With the budget stress applied due to the 911 event, [Name withheld] are hard-pressed to buy higher-end units and are opting to buy better-bargain systems to meet the expanded needs of society. The recovery from 911 in the past few years has been slow with the trend to buy lower-cost products becoming more of a standard.

The following are quotes collected via phone interviews with some of the major customers in the Appliance-A products market. The survey was conducted by OC&C for the benefit of XYZ, Inc. Inc. These quotes give some understanding about the pervasive attitude toward Appliance-A products and help show why previous strategies have focused on being the Cadillac of the industry.

- *"If they don't meet our rigid specs, we don't think twice about rejecting their bid: simple as that. These things need to work properly and consistently pretty much all the time."*

  - [Name withheld]

- *"Money is not the issue here. The budget allows us to purchase necessary equipment, so we have to be with the best product ([Name withheld])"*

  - [Name withheld]

- *"Appliance-A equipment doesn't give us problems. Come to think of it, that's probably because we buy the premium ones even though they run us a bit more"*

  - [Name withheld]

- *“You have to buy from the big companies, because the smaller ones can’t make reliable equipment that passes certification specs.”*

  - [Name withheld]

- *“Those big guys ([Name withheld] and XYZ) continue to get the most business because people have been going with them for so long… like McDonalds”*

  - [Name withheld]

While the top-end of the market remains the most coveted position of the market place, its important to realize that competitors can enter at the low-end, as did [Name withheld] about X-years ago. During this period, XYZ, Inc. owned the majority of the Appliance-A products market and now XYZ, Inc. is second to [Name withheld].

Appliance-A products have always been the solid product for XYZ, characterized by a stable market with little growth but steady income. The steady decline in margins is showing a slow deterioration and loss of market due to competitor tactics. These tactics are ratcheting down the price in a continual progression of declining prices as bids are won on ever lower prices. A clear indication of the erosion in product margins can be seen in Figure 4 for the top-end market and Figure 5 for the low-end market.

[Diagram intentionally withheld due to sensitive nature of the information]

Figure 4

[Diagram intentionally withheld due to sensitive nature of the information]

Figure 5

XYZ's Appliance-A product margins can be seen to be on a steady decline with no end in sight. The overall market has been relatively flat at about $X for the past X years and combined with the decline in margins spells a sinking income stream for the business.

To insure that the falling margins are not related to rising prices, it is important to examine the unit cost over the same period of time, see Figure 6 and Figure 7. It's clear that the cost to build each unit has remained flat or even decreased slightly. A decrease in cost means that margins are eroding even faster than the margin data indicates.

[Diagram intentionally withheld due to sensitive nature of the information]

Figure 6

[Diagram intentionally withheld due to sensitive nature of the information]

Figure 7

The obvious problem of sinking margins is a warning to the business that low-cost is soon to be a deciding factor in who leads the industry. One way to

revitalize the product line and better compete in this market is to change the competitive factors in the high and low-end markets at the same time.

This should allow the company to drive out low-end market entries and out-price and out-perform on the high-end. Both segments could be impacted with a low-risk strategy at making products cheaper and more efficient to build. If XYZ can manufacture and develop products with less-waste then they could out perform the competition. A terrific formula for achieving such a strategy is the enterprise-wide concept of Lean Thinking.

Lean Thinking

Many companies are struggling to compete. Numerous methods exist to help companies become more competitive and win in their market. Several of the most popular choices are creating product innovation, designing new features, improving quality, and cost reduction. Companies that push toward the "bleeding edge" of innovation take on a large amount of risk and suffer form the high-costs associated with new product development. In some industries, it is imperative to innovate in order to survive. In most industries, companies can adopt the philosophy of "Lean Thinking" and improve market share without the nail biting risk.[2]

Lean Design is a holistic approach to the entire design process and is an important element of "Lean Thinking".[1] A constant attention to reducing waste and inefficiencies throughout an organization, can reveal some real productivity improvements that would otherwise never get attention. For example, many organizations create a formal process for their product development but few examine the efficiencies of each step in the process or stream line the process. More importantly, many companies design multiple products without a focus toward shared modularity and the reduction in manufacturing waste. A process that goes beyond Design for Manufacturing and Assembly (DFMA) and Design for Six Sigma (DFSS).[2]

The implementation of Lean Design within an organization should be done with an awareness of the potential for de-humanizing the work force. Past

failures have occurred due to the high-pressure and extreme-focus on maximizing productivity. "…lean should be regarded as more than a set of mechanistic hard tool and techniques and the human dimension of motivation, empowerment and respect for people are very important"[4] With a proper understanding of Lean Design and a look at past mistakes in implementation, companies can put into practice a strategy with low-risk, low cost, and high potential for market improvement.

History of Lean

Lean thinking has spanned the past 25 years and has contributed to the success of many businesses. Figure 8 details some of the major events that have occurred during this period.

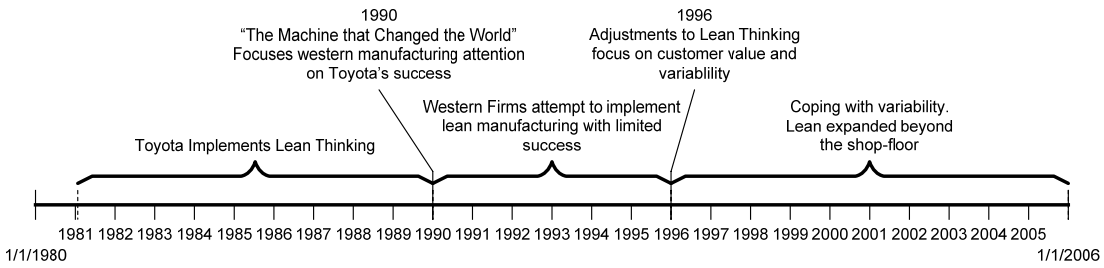

Figure 8

Lean Timeline[4]

Lean thinking started on the shop floor at Toyota Motor Corporation during the early 1980's. This implementation focused on the elimination of waste in the production flow which is characterized by:

1. Just-In-Time (JIT)
2. Kanban – production pull
3. Respect for employees
4. Employee problem solving

Everyone knows the success that Toyota achieved over the past 20-years and the lean philosophy of the company remained under wraps until the book "*The Machine that Changed the World*" came out in 1990.[4] This book highlighted the production philosophy of Toyota and detailed the concepts of lean production. Western companies took note and some began to implement Toyota's idea of lean manufacturing.

Unfortunately for some companies, the Toyota formula did not account for the variability of demand with some types of product. Automobiles have a fairly constant production flow and the dynamic nature of other markets created a need to add some capacity to materials flow. In addition, others neglected to account for the human component to the implementation, which created problems in setting the correct mind set within each company. Early lean manufacturing in western companies generated limited success.

By 1996, lean manufacturing had evolved to better suit the different types of manufacturing environments. The improved lean manufacturing can be characterized by:[4]

1. Identifying customer value.
2. Value stream management.
3. Developing the capability to flow production.
4. Using pull to support production flow.
5. Reducing all forms of waste to zero.

Today, lean has expanded beyond the shop floor and encompasses an entire organization to create a powerful toolset for successful product design and manufacturing. Combining this toolset with a respect for the employees generates a significant synergy to bring value to customers and win in the market.

Lean Design

Waste is defined as any activity that adds cost but does not add value to the customer.[3] This simple but important concept is the heart of Lean Design. Lean Design begins with a focus on the customer and can be summarized into five principles:

1. Listen to the Customer to Satisfy Functional Needs.
2. Design Products Utilizing a Flexible Set of Preferred Solutions.
3. Incorporate Processes That Support Lean Manufacturing.
4. Leverage Product Platforms for Simplified Sourcing.
5. Select the Optimal Product Solution Based on Total Throughput Cost.

Principle 1

To satisfy customer functional needs it is important to stop asking “What” and ask “Why”. Using a concurrent design team of sales, procurement, design engineering, and manufacturing the team can create an optimal solution that is focused toward addressing the customer’s actual need. Fundamentally this process does more to design for the customer than the traditional design process shown in Figure 9 below.

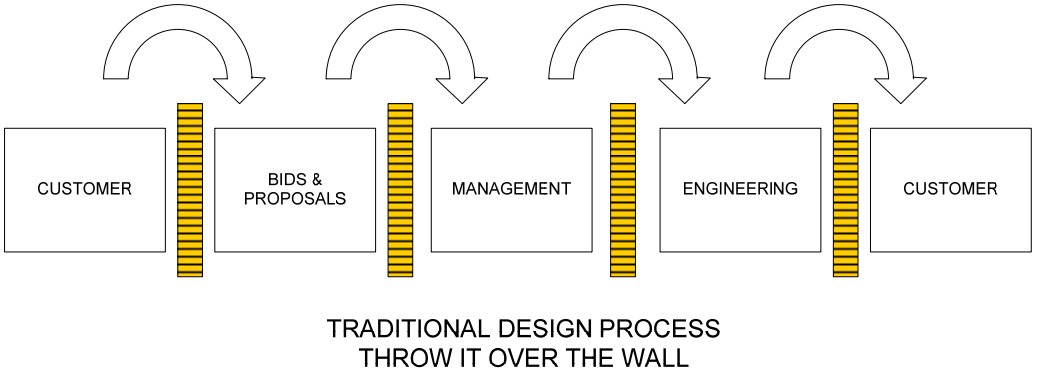

Figure 9

Principle 2

Product design must focus on creating robust, modularized components that are known about and reusable for any new designs. The culture of “not designed here” must be eliminated and a culture of design reuse must be cultivated and encouraged. Leveraging proven, robust designs into future products improves the quality and reliability of products in the early stages of release when customer perception is formed.

Principle 3

Products that are designed to eliminate waste and variation during manufacturing will be more successful at improving the production process than products where waste and variation elimination was not considered. It's less efficient to tailor the manufacturing around the product then to optimize the product to the manufacturing process.

Principle 4

Products that are designed to be modular and find reuse in multiple products can be used to leverage economies of scale with suppliers. In addition, products that are designed with global sourcing in mind can expand the supplier choices to improve the quality and price of sourced materials. This approach does not suggest that strategic supplier relations are unnecessary but encourages the design of materials that can be globalize to leverage the benefits where possible.

Principle 5

It is imperative to understand ALL of the costs associated with a design solution. In some cases, even though the materials cost may be higher than any other solution, the overall cost of labor and overhead may be less and thus the total cost is less. Most importantly, it is crucial to quantify and understand soft-costs especially as they relate to customer satisfaction. A slightly more expensive product that has fewer problems creates better customer perception and results in more sales which can be related back as creating more profit for the company.

The overall purpose of Lean Design is to:

1. Enable lean enterprise.
2. Deliver customer solutions.
3. Minimize variation that causes waste.
4. Optimizes total product and process cost.

Designing products to support lean enterprise is the best way to ensure that the benefits of waste reduction and creating customer value can be accomplished in product manufacturing. Molding the manufacturing process around an already designed product is much less effective than designing a product to fit naturally in a lean-manufacturing process. The principles of lean thinking go beyond the traditional focus on continual improvements and quality and extend into customer-focused design, creating customer value, and eliminating waste in all areas.

The concept of lean enterprise is fairly simple, resulting in products that customers want at lower price. It is easy to implement and creates a winning strategy of becoming more competitive in the market without a lot of risk. Many companies can benefit from lean enterprise with the engineering department adopting Lean Design and operations adopting Lean Manufacturing.

Pilot Project Proposal

Introduction

To justify the capital investment of implementing Lean Design at XYZ, Inc., it is important to demonstrate the effectiveness of the approach without the disruption of using radical change. One way to accomplish this is to institute a pilot program, which is low-risk and uses limited resource. This allows the entire organization to become accustomed to the changes in a more gradual fashion and gives everyone the feedback of the strategies success and purpose. This educates managers and hourly workers alike.

The purpose of this pilot program is to examine the possibility of applying product platforms to create economies of scale and reduce a component price. The proposed pilot project will endeavor to create a single Main Processing Board that is common to all Appliance-A product units. Increasing the volume of boards from the supplier will reduce the unit price, improve manufacturability, and increase product reliability.

Two projects will be explored; Project A and Project B. Project A will examine the possibility of implementing a product platform initiative on every system in the Appliance-A products business unit. Project B takes a more reasoned approach, limiting the risk followed by maximizing the economies of scale.

Engineering input indicates that creating a common board between the Widget-A and Widget-B products is extremely difficult. Risk of project failure is

high. Project B employs the engineering recommended approach of creating economies of scale in the Appliance-A Products only. Project A is not impossible, but has considerable risk with potential outcomes being delays or even project cancellation during execution. This would create a negative image of lean implementation and miss the point of this exercise.

Project Costs

To examine this pilot project proposal, we begin with the current costs for manufacturing the Main Processing Boards in each Appliance-A product model. Table 1 illustrates the number of units expected for 2006 with board cost and calculates the total yearly expenditures. The total expected Main board expense across the Appliance-A Products line is $801,060.

Table 1

[Table intentionally withheld due to sensitive nature of the information]

The Project A information of Table 2 shows the expected project costs and resources. It details the quoted cost for producing 7996 Main Processor boards from a single supplier, provides a yearly amortization for the tooling needed to implement this project, and provides project costs due to labor and materials. The shaded box shows the expected yearly saving for this project, which is the difference between Table 1 total yearly expenses and expected yearly expenses from Table 2. The expected development for this project is approximately 1 year.

Project A, Resources:

	Effort
Electrical Engineer	26-weeks
Mechanical Engineer	26-weeks
Technician	4-weeks
Manufacturing Engineer	26 hours
Materials	26 hours
Quality Assurance	26 hours
Service Tech	26 hours
PCB Layout	Outsource
Tooling	Outsource
PCB Assembly	Outsource

Table 2

Project A Conversion of All Units Main Boards			
Quoted Cost For Entire Board Package	$ 75.00	Expected Yearly Expense	$ 599,700.00
Yearly Tool Amortization (10 Year Flat Line)	$ 3,000.00	Expected Yearly Savings From Project	$ 201,360.00
Project Costs			
Electrical Engineering Labor	$ (67,600.00)		
Mechanical Engineering Labor	$ (67,600.00)		
Technician Labor	$ (4,800.00)		
Concurrent Engineering Labor	$ (10,140.00)		
Prototype Costs	$ (10,000.00)		
Tooling Costs	$ (30,000.00)		
Total Project Costs	$ (190,140.00)		

Table 3 shows the Project B detail. The number of Main Processors boards has been reduced from 7996 to 5786 because Widget-B products are no longer included. Due to the reduction in total boards, the quoted price per board has increased to $80. The overall costs including tooling are reduced because there is less effort on the project and the work is not as difficult as Project A. The expected development time for this project is approximately 6-months creating a faster time to market.

Project B, Resources:

	Effort
Electrical Engineer	20-weeks
Mechanical Engineer	20-weeks
Technician	4-weeks
Manufacturing Engineer	20 hours
Materials	20 hours
Quality Assurance	20 hours
Service Tech	20 hours
PCB Layout	Outsource
Tooling	Outsource
PCB Assembly	Outsource

Table 3

Project B Conversion of Radar Unit Main Boards			
Quoted Cost For Entire Board Package	$ 80.00	Expected Yearly Expense	$ 462,880.00
Yearly Tool Amortization (10 Year Flat Line)	$ 2,000.00	Expected Yearly Savings From Project	$ 126,330.00
Total Radar only Units	5786	Yearly Expense of Radar Boards	$ 589,210.00
Project Costs			
Electrical Engineering Labor	$ (52,000.00)		
Mechanical Engineering Labor	$ (52,000.00)		
Technician Labor	$ (4,800.00)		
Concurrent Engineering Labor	$ (7,800.00)		
Prototype Costs	$ (10,000.00)		
Tooling Costs	$ (20,000.00)		
Total Project Costs	$ (146,600.00)		

Business Impacts

Figure 10 and Figure 11 show the expected cash flow over the next five years for both projects. The first year shows the project development period followed by the in market period bringing in new savings.

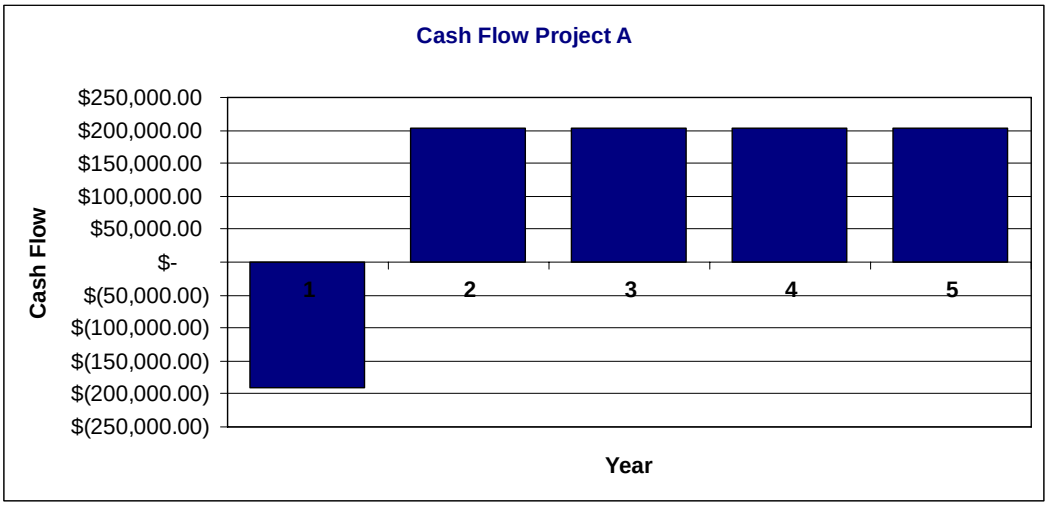

Figure 10

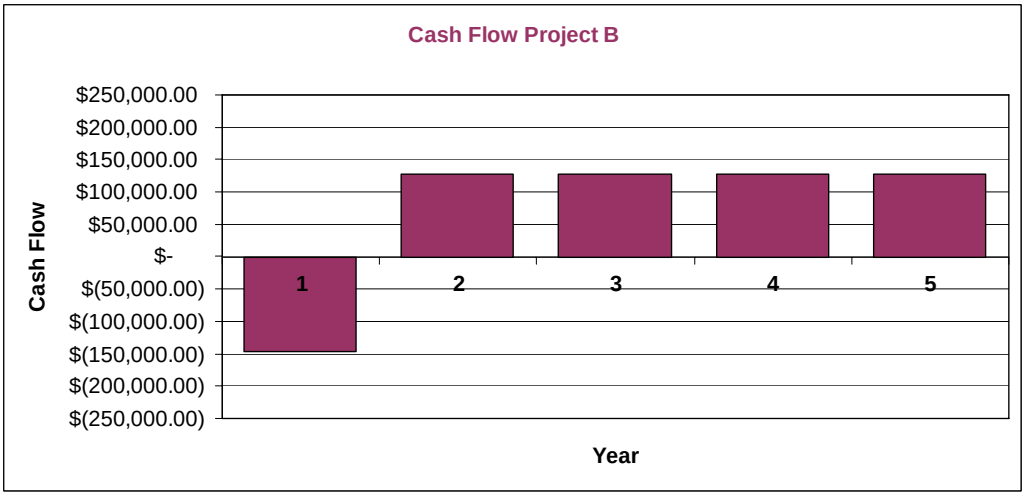

Figure 11

Table 4 details the time value of the maximized project over a 6 year period and details the Internal Rate of Return (IRR) and Net Present Value (NPV) for years 3, 4, 5, and 6. The expected rate of return required of projects for the 2006 and 2007 time period is 10%. The payback period is 1.93 years and should

be coupled with the risk, due to complexity, that this project will see delays and payback will probably be further in the future.

Table 4

Project A					
				10%	
Year	Cash Flow	Cumulative Cash Flow	Payback Period Years	PV Factor	Present Value of Cash Flows
1	$(190,140.00)	$(190,140.00)		1	$(190,140.00)
2	$ 204,360.00	$ 14,220.00	1.93	0.909090909	$ 185,781.82
3	$ 204,360.00	$ 218,580.00		0.826446281	$ 168,892.56
4	$ 204,360.00	$ 422,940.00		0.751314801	$ 153,538.69
5	$ 204,360.00	$ 627,300.00		0.683013455	$ 139,580.63
6	$ 204,360.00	$ 831,660.00		0.620921323	$ 126,891.48
	3 Year IRR	71%		3 Year NPV	$149,576.71
	4 Year IRR	92%		4 Year NPV	$289,157.34
	5 Year IRR	101%		5 Year NPV	$416,048.82
	6 Year IRR	104%		6 Year NPV	$531,404.71

A graphical presentation of the cash flows for the Project A is given in Figure 12 below. Shown are the depreciated cash flows based on management's expectations and the non-depreciated cash flows

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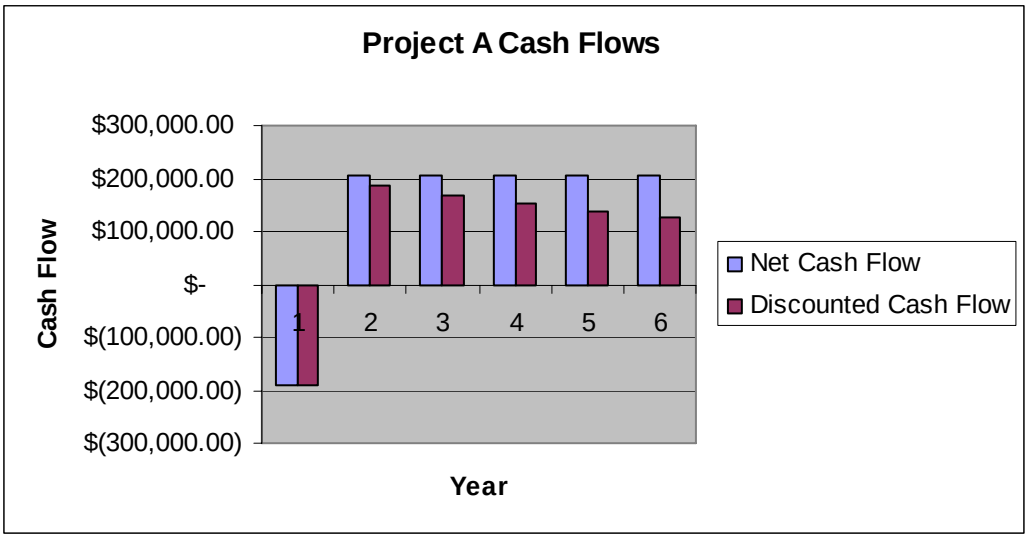

Figure 12

The time value for Project B is show in Table 5, which shows a payback period slightly more than the maximized project at 2.14 years. If the faster time to market is accounted for then the payback would occur in 1.64 years, which actually makes the project better compared to the maximized project at 1.93 years. Combined with the much lower risk factors for completion and delays Project B is the better choice.

In comparison to typical projects at XYZ, Inc. Inc., Project B has great return for the investment with low-risk and an attractive payback period. When compared to funding product innovation, most new product development projects come with the added risk of product returns and warranty rework costs due to product introduction problems and customer acceptance. In addition most new products have a ramp-up period where the first year only realizes 100 units followed by ever increasing amounts. Cost reduction projects see gain almost immediately if coordinated properly with material flow.

A graphical presentation of the cash flows for Project is given in Figure 13, which shows the non-depreciated and depreciated cash flow.

Table 5

Project B					
				10%	
Year	Cash Flow	Cumulative Cash Flow	Payback Period Years	PV Factor	Present Value of Cash Flows
1	$(146,600.00)	$(146,600.00)		1	$(146,600.00)
2	$ 128,330.00	$ (18,270.00)		0.909090909	$ 116,663.64
3	$ 128,330.00	$ 110,060.00	2.14	0.826446281	$ 106,057.85
4	$ 128,330.00	$ 238,390.00		0.751314801	$ 96,416.23
5	$ 128,330.00	$ 366,720.00		0.683013455	$ 87,651.12
6	$ 128,330.00	$ 495,050.00		0.620921323	$ 79,682.83
	3 Year IRR	47%		3 Year NPV	$69,201.35
	4 Year IRR	70%		4 Year NPV	$156,852.47
	5 Year IRR	79%		5 Year NPV	$236,535.30
	6 Year IRR	83%		6 Year NPV	$308,974.24

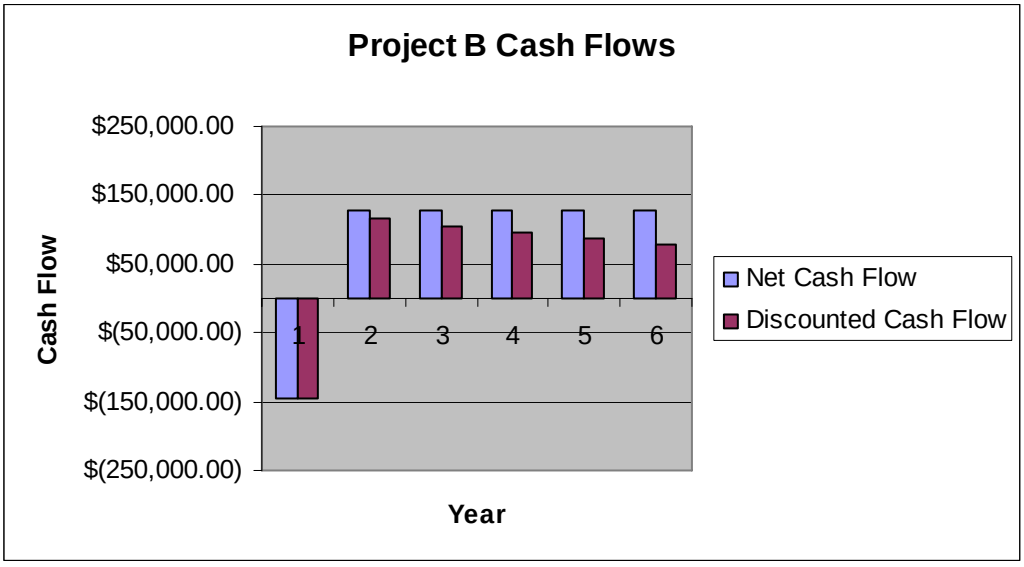

Figure 13

Sensitivity, Risks, and Contingencies

Each project is analyzed based on sensitivity calculations as show in the figures below with data appearing in Appendix D. Inputs are varied around the base from -30 to +30% and new net present values (NPV) calculated. The two projects show very similar sensitivities but differ greatly when it comes to project risk.

For Project A, the table in Appendix D was generated to show the deviation from the base case for each major elements used to calculate the Net Present Value (NPV). The variation of the NPV is plotted in Figure 14 and Figure 15, and shows the sensitivity of the project toward each input. It's clear from this that the board price and quantities has the greatest impacts. This is actually a good thing, since the board price is negotiated in advance of the project and the outcome is virtually certain for this input.

Project A carries a lot more risk, due to the fact that it is extremely difficult to create a common Main Processing board that works for both Widget-A and Widget-B products. Expected problems, in the execution of Project A, would cause delays that move the payback period out in time and make the maximized project much less desirable.

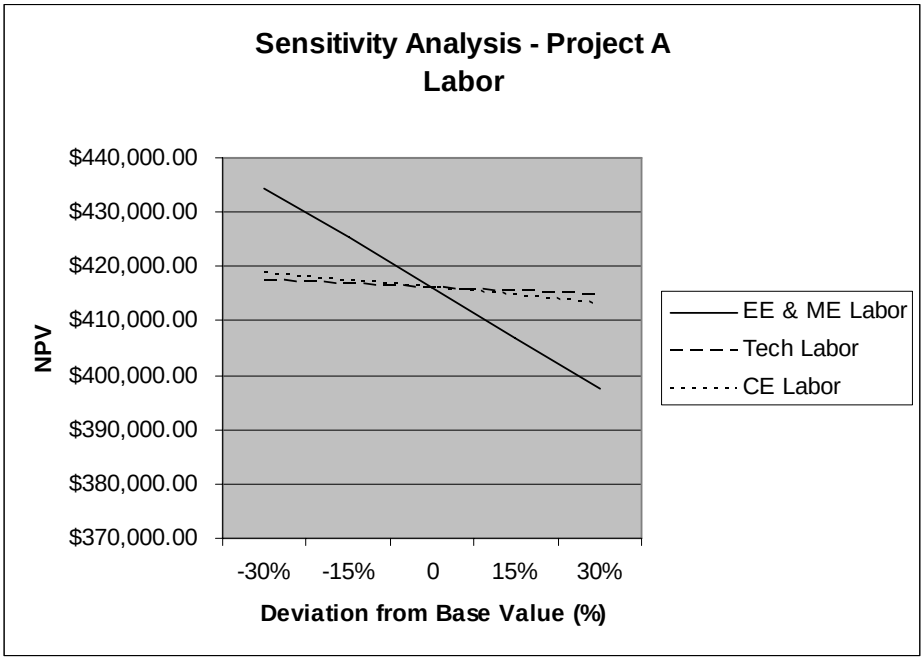

Figure 14

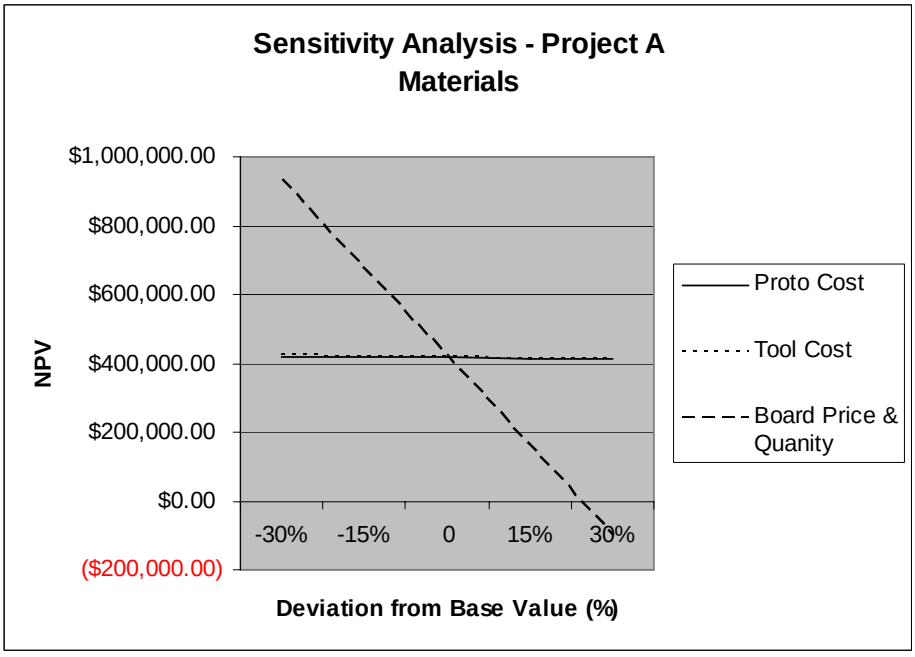

Figure 15

The sensitivity tables and charts, [Chart Removed due to sensitive data] Appendix D, Figure 16, and Figure 17, for the Project B are very similar to Project A. This project is likewise very sensitive to the number of board and board cost. Again, this is unlikely to show any large variance, due to the contractual nature of this purchased component. Risks for this project are very low and predict that this project will be completed on time and result in the adjusted payback of 1.64-years.

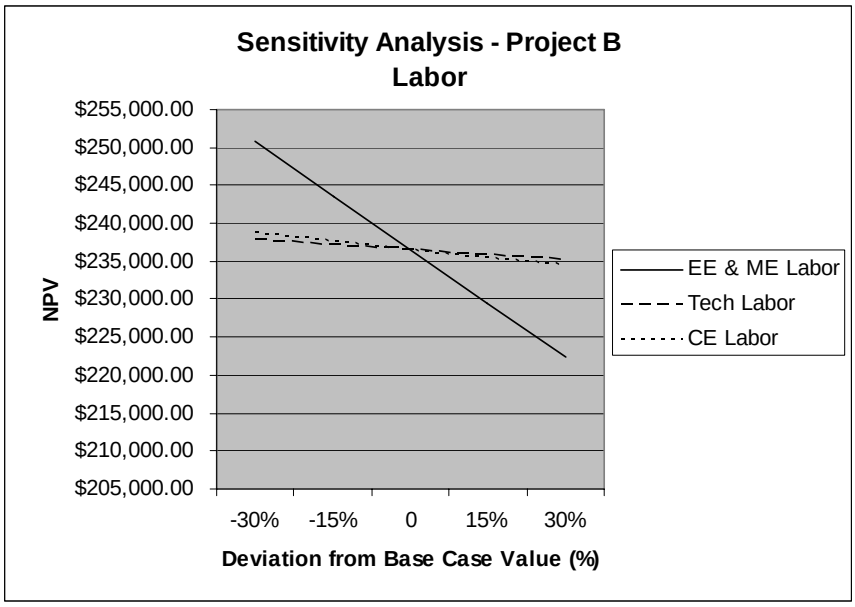

Figure 16

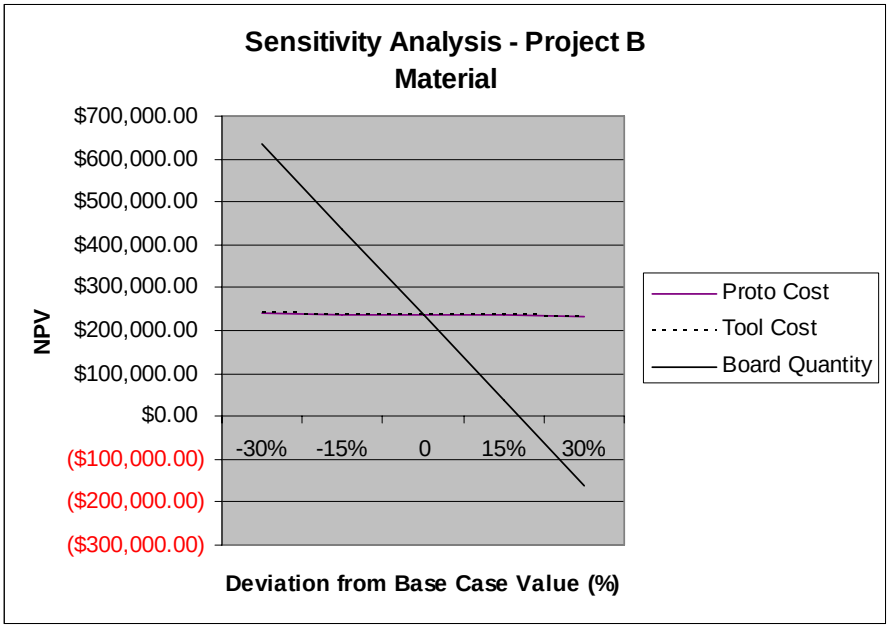

Figure 17

With either of these approaches, it is important that the materials group is closely tied to the project execution. Coordinating existing contracts for boards and materials stock will impact the actual date when new lower cost boards will begin to feed the system. The sensitivity analysis helps the project manager understand this and make the board material coordination a top priority.

One missing factor to the above analysis is the fact that by creating economies of scale for these products the future buying power is repeated into the future. For example when the material group renegotiates contracts in the future they will carry more leverage as prices rise due to inflation. The gap between the new product platform and the old way will continue to widen creating more value than is shown by the discounted cash flows.

Conclusions and Recommendations

From the planning stage, this pilot project definitively shows value to incorporating low-risk strategies in reducing waste throughout the organization. It should make the company more competitive in the market at low cost, low-risk, and in a timely fashion.

It should prove to Executive Management the importance and methods of implementing a Lean Design project. The successful completion of this project will pave the way for implementing similar projects, for other boards in the Appliance-A Product Line and even extending pilot projects into the Appliance-B business unit.

In the end implementing the most likely project you have a low-risk wining scenario for the business.

Chapter 5 - Suggestions for Additional Work

Implementation of Lean Design, Lean Thinking, and Lean Enterprise requires a lot of training. It is important to develop some methods to teach all levels of the business what Lean is, how to implement Lean, and show many of the cases where Lean implementation has gone wrong.

There are many areas where waste can be address in engineering design. These include improving the efficiencies of the design process itself. For example, when a company fully adopts Lean Thinking then areas such as engineers having to do their own printed circuit board layout would be identified as waste. A problem XYZ, Inc. has but ignores. Bills of materials being typed into the ERP system and added to assembly drawing would be identified as waste is another example. The list goes on and on. A real conviction to the process will take the company into realms not yet explored or realized.

This business case only addresses product platforms in the Appliance-A Products business unit. The Appliance-B Product business unit represents just as large a market. The concept of shared parts between the two could magnify the economies of scale even further.

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Appendix A: XYZ, Inc., Business Metrics

Table 6

[Table intentionally withheld due to sensitive nature of the information]

Table 7

[Table intentionally withheld due to sensitive nature of the information]

Table 8

[Table intentionally withheld due to sensitive nature of the information]

Table 9

[Table intentionally withheld due to sensitive nature of the information]

Appendix B: XYZ, Inc. Product Models

[Pictures intentionally withheld due to sensitive nature of the information]

Appendix C: Competition Models

[Pictures intentionally withheld due to sensitive nature of the information]

Appendix D: Project Data

Project A								
	Deviation							
Deviation from Base Case	EE Labor	ME Labor	Tech Labor	CE Labor	Proto Cost	Tool Cost	Board Price	Board Quantity
-30%	$ (47,320.00)	$ (47,320.00)	$ (3,360.00)	$ (7,098.00)	$ (7,000.00)	$ (21,000.00)	$ 52.50	5,597
-15%	$ (57,460.00)	$ (57,460.00)	$ (4,080.00)	$ (8,619.00)	$ (8,500.00)	$ (25,500.00)	$ 63.75	6,797
0	$ (67,600.00)	$ (67,600.00)	$ (4,800.00)	$ (10,140.00)	$ (10,000.00)	$ (30,000.00)	$ 75.00	7,996
15%	$ (77,740.00)	$ (77,740.00)	$ (5,520.00)	$ (11,661.00)	$ (11,500.00)	$ (34,500.00)	$ 86.25	9,195
30%	$ (87,880.00)	$ (87,880.00)	$ (6,240.00)	$ (13,182.00)	$ (13,000.00)	$ (39,000.00)	$ 97.50	10,395
	5 Year NPV							
Deviation from Base Case	EE Labor	ME Labor	Tech Labor	CE Labor	Proto Cost	Tool Cost	Board Price	Board Quantity
-30%	$434,485.18	$434,485.18	$417,357.91	$418,814.28	$418,776.09	$421,637.11	$934,494.72	$934,494.72
-15%	$425,267.00	$425,267.00	$416,703.37	$417,431.55	$417,412.46	$418,842.97	$675,271.77	$675,271.77
0	$416,048.82	$416,048.82	$416,048.82	$416,048.82	$416,048.82	$416,048.82	$416,048.82	$416,048.82
15%	$406,830.64	$406,830.64	$415,394.28	$414,666.09	$414,685.18	$413,254.67	$156,825.87	$156,825.87
30%	$397,612.46	$397,612.46	$414,739.73	$413,283.37	$413,321.55	$410,460.53	($102,397.08)	($102,397.08)

Project A, Sensitivity Calculations

Project B								
	Deviation							
Deviation from Base Case	EE Labor	ME Labor	Tech Labor	CE Labor	Proto Cost	Tool Cost	Board Price	Board Quantity
-30%	$(36,400.00)	$(36,400.00)	$ (3,360.00)	$ (5,460.00)	$ (7,000.00)	$(14,000.00)	$ 56.00	4,050
-15%	$(44,200.00)	$(44,200.00)	$ (4,080.00)	$ (6,630.00)	$ (8,500.00)	$(17,000.00)	$ 68.00	4,918
0	$(52,000.00)	$(52,000.00)	$ (4,800.00)	$ (7,800.00)	$(10,000.00)	$(20,000.00)	$ 80.00	5,786
15%	$(59,800.00)	$(59,800.00)	$ (5,520.00)	$ (8,970.00)	$(11,500.00)	$(23,000.00)	$ 92.00	6,654
30%	$(67,600.00)	$(67,600.00)	$ (6,240.00)	$(10,140.00)	$(13,000.00)	$(26,000.00)	$ 104.00	7,522
	5 Year NPV							
Deviation from Base Case	EE Labor	ME Labor	Tech Labor	CE Labor	Proto Cost	Tool Cost	Board Price	Board Quantity
-30%	$250,717.12	$250,717.12	$237,844.39	$238,662.58	$239,262.58	$240,260.83	$636,699.12	$636,699.12
-15%	$243,626.21	$243,626.21	$237,189.85	$237,598.94	$237,898.94	$238,398.07	$436,617.21	$436,617.21
0	$236,535.30	$236,535.30	$236,535.30	$236,535.30	$236,535.30	$236,535.30	$236,535.30	$236,535.30
15%	$229,444.39	$229,444.39	$235,880.76	$235,471.67	$235,171.67	$234,672.54	$36,453.40	$36,453.40
30%	$222,353.48	$222,353.48	$235,226.21	$234,408.03	$233,808.03	$232,809.77	($163,628.51)	($163,628.51)

Project B, Sensitivity Calculations