

**Development of a lean accounting model for the assembly of temperature sensors  
for biomedical applications**

By

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Project submitted in partial fulfillment of the requirements for the degree of:

MASTER IN BUSINESS ADMINISTRATION

IN

Industrial Management

UNIVERSITY OF PUERTO RICO

MAYAGUEZ CAMPUS

2017

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## **ABSTRACT**

This project focused on the relationship between lean manufacturing and lean accounting. The objective was to develop a lean accounting conceptual model for a production line based on lean techniques but running under standard cost accounting. Interviews to the Finance Manager and the Production Supervisor were made to understand current operating and financial systems. A questionnaire developed by Brian Maskell (2013), subject matter expert, was implemented to determine the current and expected future state of the accounting and operating processes. Recommendations were then made followed by the conceptual model. This project did not examine the feasibility of implementing such recommendations as this decision was reserved by the management of the company.

## **RESUMEN**

Este proyecto se enfocó en la relación entre la manufactura y la contabilidad esbelta. El objetivo fue desarrollar un modelo conceptual de contabilidad esbelta para una línea de producción basada en la manufactura esbelta pero que actualmente mantiene un sistema de costo estándar. Se realizaron unas entrevistas de preguntas abiertas al gerente de finanzas y al supervisor de producción para entender los sistemas actuales de contabilidad y producción. Luego se procedió a utilizar un cuestionario desarrollado por Brian Maskell (2013), experto en la materia para determinar el estado actual y el estado futuro esperado de sus sistemas de contabilidad y manufactura. Esto dio base a una serie de recomendaciones y al modelo conceptual. Por petición de la gerencia de la compañía, este proyecto no tenía como alcance la implantación de las recomendaciones.

This effort is dedicated to...

My inspiration and best friend... my mother

My family, for their unconditional love and support

## **ACKNOWLEDGEMENTS**

First of all, thank you God for giving me the courage and strength needed to complete this challenge. Without Him, nothing is possible.

To my family, thanks for all the encouragement, support, and love needed to be able to get through this task.

Thanks Dr. Roberto Seijo for all the support and knowledge given throughout this project and throughout my master's degree.

To all the members of my committee, Dr. Victor Balaguer and Dr. Mayra Mendez, thanks for your time and knowledge given.

To the employees of the company, thanks for your time.

And to all who supported me in one way or another, my deepest gratitude.

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## **LIST OF ABBREVIATIONS**

VS	Value Stream
OM	Operations Management
P&L	Profit and Loss
HR	Human Resources
R&D	Research and Development
ASQ	American Society of Quality
IMA	Institute of Management Accountants
AR	Accounts Receivable
SAVE	Society of American Value Engineers

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## **GLOSSARY**

- 1. ABC costing:** Allocates overhead based on each product's use of particular activities in making the product (Principles of Accounting, 2011)
- 2. Back flushing:** A method of inventory bookkeeping where the book (computer) inventory of components is automatically reduced by the computer after completion of activity on the component's upper-level parent item based on what should have been used as specified on the bill of material and allocation records (APICS, 2016).
- 3. Balanced Scorecard:** A list of operational measurements used to evaluate organizational or supply chain performance (APICS, 2016).
- 4. Business Strategy:** A plan for choosing how to compete (APICS, 2016).
- 5. Continuous Improvements:** The act of making incremental, regular improvements and upgrades to a process or product in the search for excellence (APICS, 2016).
- 6. Control chart:** Graph used to study how a process changes over time (ASQ, 2016).
- 7. Control Limits:** Values calculated from the data, showing the possible ranking of variation around the mean (ASQ, 2016).
- 8. Direct Cost:** Cost that can be directly attributed to a particular job or operation (APICS, 2016).
- 9. Financial performance measures:** Measuring the results of a firm's policies and operations in monetary terms (Business Dictionary, 2016).
- 10. Focus group:** Idea generation or forecasting technique where several subject matter experts or informed individuals share their point of view on a specific topic or problem (Business Dictionary, 2016).
- 11. Indirect Cost:** Costs that are not directly incurred by a particular job or operation (APICS, 2016).

- 12. Job costing:** Costs are assigned to each job or to each batch of goods (Principles of accounting, 2011)
- 13. Kaizen:** promotes the sustainable continuous improvement as a daily way of life for every member within the organization (Lean Institute, 2016).
- 14. Kanban:** A signaling device that gives authorization and instructions for the production or withdrawal of items in a pull system (Lean Enterprise Institute, 2014).
- 15. Key Performance Index:** A financial or nonfinancial measure that is used to define and assess progress toward specific organizational goals and typically is tied to an organization's strategy and business stakeholders (APICS, 2016).
- 16. Lean Accounting:** is the general term used for the changes required to a company's accounting, control, measurement, and management processes to support lean manufacturing and lean thinking (Maskell, 2006).
- 17. Lean Manufacturing:** A way of thinking and acting for the entire organization to provide customer value through a value creating process that has zero waste. The idea is to maximize customer value with fewer resources. (Lean Institute, 2016).
- 18. Manufacturing Overhead:** Costs that are indirectly associated with the manufacture of a finished product (Accounting Principles, 2013)
- 19. Mass Production:** Production of large number of identical parts (Roser, 2017). High quantity production characterized by specialization of equipment and labor (APICS, 2016). A business system developed in the 20th century to organize and manage product development, production operations, purchasing, and customer relations. Typically:...materials are delivered infrequently in large batches, information is managed through high-level systems instructing each production step what to do next and pushing products downstream, and customers often are subject to push selling to meet quotas and clear inventories produced to erroneous forecasts (Lean Enterprise Institute, 2017).

- 20. Non-financial performance measures:** Any quantitative measure of either an individual's or an entity's performance that is *not* expressed in monetary units (The Financial Times (2016).
- 21. Operations Management:** Set of activities that creates value in the form of goods and services by transforming inputs into outputs (Heizer & Render, 2011)
- 22. Process costing:** Costs are accumulated for a period of time instead of assigning costs to specific products or job orders (Principles of Accounting, 2011)
- 23. Target Costing:** The determining of a target cost for a product or service following its initial design, as a way to satisfy a customer need (Chartered Institute of Management Accountants, 2009).
- 24. Value Engineering:** A disciplined approach to the elimination of waste from products or processes through an investigative process that focuses on the functions to be performed and whether such functions add value to the good or service (APICS, 2016).
- 25. Value Stream Mapping:** A simple diagram of every step involved in the material and information flows needed to bring a product from order to delivery (Lean Enterprise Institute, 2014).
- 26. Value Stream:** All of the actions, both value-creating and nonvalue-creating, required to bring a product from concept to launch and from order to delivery (Lean Institute, 2016).



# 1. INTRODUCTION

## 1.1 Introductio

This project consists of the development of a lean accounting model for a production line in a manufacturing company in Puerto Rico with the purpose of aligning financial metrics with the manufacturing strategy within the line. The main focus of the project is on the benefits that switching from standard cost accounting methods to lean accounting has on a manufacturing company that has recently implemented lean techniques on assembly processes. This first chapter is focused on a brief topic introduction, justification, objective, and methodology.

## 1.2 Background

Operations management is the set of activities that creates value in the form of goods and services by transforming raw materials into final products (Heizer & Render, 2011). Just like any other manager, operations managers perform the same basic functions of the management process which are planning, organizing, staffing, leading, and controlling (Heizer & Render, 2011). Planning involves defining a goal and determining the most effective course of action needed to reach that goal (Roberts, 2015). Once plans have been made and are ready to be implemented the next step is to organize by assigning tasks and responsibilities to employees with the specific set of skills needed to complete the tasks (Roberts, 2015). In staffing the main purpose is to hire the right people for the right jobs to help achieve the objectives of the organization (Roberts, 2015). Leading requires managers to motivate employees to achieve business objectives and goals (Norman, 2015). Controlling is a function of management that involves measuring achievement against established objectives and goals, and when necessary it also requires managers to be able to identify sources of deviation from successful accomplishment and to provide a corrective course of action (Norman, 2015).

Cost accounting involves techniques necessary to determine the product costs, processes, and projects that are required to report the correct amounts on the financial statements; therefore, assisting management in the decision making and control of an

organization (Averkamp, 2015). Cost accounting provides management with the tools to analyze cost behavior, cost-volume-profit relationships, operational and capital budgeting, standard costing, variance analyses for costs and revenues, transfer pricing, activity-based costing, and more (Averkamp, 2015). It measures, analyzes, and reports financial information and non-financial information related to the costs of acquiring and using resources in an organization (Datar & Rajan & Monte, 2014).

The goal of production management in mass production is to anticipate, reduce and eliminate all sources of change that may result in additional costs (Dugay, Landry, Pasin, 1997). It is mainly concerned with reducing costs by increasing the volume of production which is known as economies of scale (Dugay, Landry, Pasin, 1997). Such manufacturing processes attain high rates of output at low unit cost, with lower costs expected as volume rises (Holstein, 2004). However, the creation of excessive inventory is a major contributor for waste under mass production. On the other hand, lean companies are primarily concerned with creating more customer value and eliminating waste in every aspect of the business (Kennedy & Brewer, 2006). They seek to continuously improve processes which results in a smoother flow, more effective processes, extra capacity, and lower costs (Maskell & Kennedy, 2007). As a result, the organization becomes more responsive to customer changes and expectations. According to Maskell & Kennedy (2007), companies that have switched to lean manufacturing must change their accounting, control, and measurement methods. Lean manufacturing breaks the rule of mass production; therefore, standard cost accounting and management methods are unsuitable for lean accounting (Maskell, 2006).

### **1.3 Justification**

About four years ago, the production line under study changed its manufacturing strategy to lean manufacturing but costing methods and financial reports still run under standard cost accounting. The company wishes to switch its standard cost accounting methods to lean accounting methods to be better aligned with its manufacturing strategy.

The article “Why do we need lean accounting and how does it work” (Maskell & Kennedy, 2007) states that contrary to lean manufacturing goal of reducing inventory, traditional cost accounting measurements such like machine utilization and overhead absorption motivate people to build more inventory. According to lean thinking, profit increases by maximizing the flow of material, information, and cash. This assumption leads to very different measurements. Instead, measurements for production cells, value, and processes within the Value Stream (VS) provide excellent control of lean processes (Maskell & Kennedy, 2007). Lean companies are less concerned about the costs of each individual product and are more concerned about the costs of the VS as a whole. Although the process yields many individual products, the costing system is designed around the process as a whole. Instead of having complex calculations of product costs, lean companies gather and present actual, direct VS cost information (Maskell & Kennedy, 2007).

Since lean manufacturing results in the reduction of waste, additional capacity is created and it can be used as a growth strategy to grow the business. In lean manufacturing, the cost of a product is not related to the amount of labor or machine time expended; it is instead based upon the rate of flow in the VS. With this in mind, the use of labor or machine time is no longer the principal driver of cost. If standard cost accounting is used, products will be priced wrongly, orders that are highly profitable will be turned down, and products will be outsourced when they should be made in house. (Maskell & Kennedy, 2007).

Authors Maskell and Kennedy (2007) mention six reasons why standard cost accounting methods need to change following lean manufacturing implementation: wrong measurements, wrong costs, better decision making, understandable information, complex systems, and focus on customer value.

#### **1.4 Company Background**

The company under study located in Puerto Rico, is linked to the electronics industry and it manufactures a wide ranking of products for the aerospace, automotive,

healthcare, and industrial markets. In order to comply with the confidentiality policy of the company, this project will refer to APR Company as the name of the organization.

### **1.5 Objective**

The main objective of this project is to develop a lean accounting model for the assembly of biomedical sensors. Currently, the company has a lean manufacturing process, but it is still running under standard cost accounting. In order to complete the assessment, lean accounting tools suggested by subject-matter subject matter experts were suggested, and a questionnaire was administered to determine the current and future state of the company regarding lean accounting methods.

### **1.6 Summary**

This document is organized in five (5) chapters or main sections. The introduction consists of a brief summary of basic concepts related to this project, the justification, the objective, and the background of the company under study. The next section includes the literature review in which relevant concepts and definitions from subject-matter subject matter experts are explained with the purpose of helping the reader understand basic concepts related to the study. The third section is the methodology in which it details the analysis and tools used so that the project's objective could be reached. The fourth section includes the analysis in which the lean accounting conceptual model was developed along with the recommendations which are suggested taking into consideration models and suggestions found in different articles by subject matter experts in lean accounting and manufacturing. The fifth and final chapter includes the conclusions and some limitations that were encountered during the study.

This chapter gave a brief introduction as to what the scope of the project is along with some explanations and definitions of lean accounting and lean manufacturing concepts like operations management, and the difference between lean and cost accounting. The topics covered will be discussed further in the Literature Reviewed along with other operations management and accounting concepts. Literature and articles from subject-

matter subject matter experts are referenced so that there is a clear understanding of the topics discussed throughout this study.

## 2. LITERATURE REVIEW

### 2.1 Introduction

This section details the main topics that are covered in this project including operations management, cost accounting, mass production, lean manufacturing, and lean accounting. It also includes literature from subject matter experts in the field of lean accounting and lean manufacturing such as Brian Maskell and James P. Womack.

### 2.2 Operations Management

Rusell and Taylor, in their book “Operations Management: Creating value along the value chain” (2011) define Operations Management (OM) as a transformation process where inputs (such as labor, materials, machines, and capital) are transformed into outputs (goods and services). Requirements and feedback from customers are used to adjust factors in the transformation process (Figure 1). They state that this transformation process consists of a series of activities along the value chain that goes from supplier to customer. “OM tries to ensure that the transformation process is performed efficiently and that the output is of greater value than the sum of the inputs. It is in charge of the design, operation, and improvement of productive systems” (Rusell & Taylor, 2011).

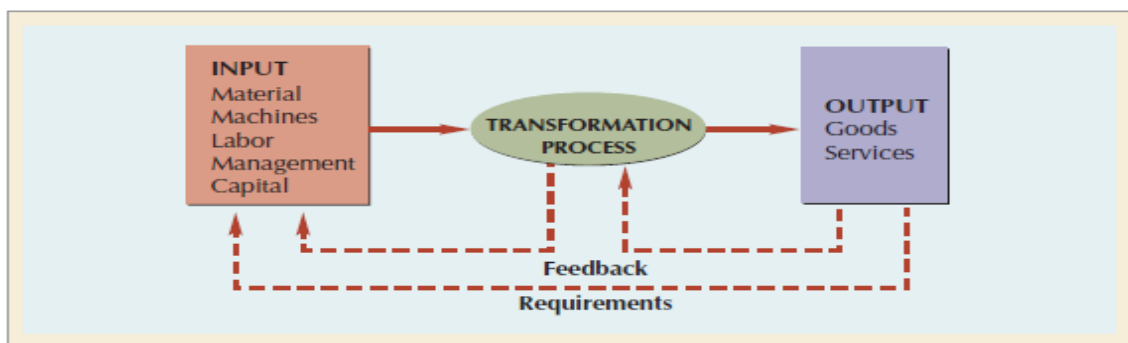


Figure 1: Operations as a Transformation Process (Russell & Taylor, 2011)

The role of operations is to create value; hence activities in OM include service and product design, quality management, process and capacity design, locating facilities, layout design, human resources and job design, supply-chain management, inventory

management, scheduling, and maintenance. Operations managers need good technical, conceptual, and behavioral skills because they deal with people, technology, and deadlines. They perform a variety of tasks including interacting with other departments and suppliers to produce goods and services to the customer. For example, in the finance department, operations need monetary resources for production and marketing provides the operations department with sales forecast. Operations managers interact with suppliers to communicate production and delivery requirements, certify quality, and negotiate contracts. (Rusell & Taylor, 2011)

### **2.3 Cost Accounting**

According to authors Carnes and Hedin (2005), “full absorption and standard costing methodologies arose at the turn of the 20<sup>th</sup> century, when mass production had revolutionized the manufacturing process and made the United States an economic powerhouse. During this time, production was organized into large batches with many standardized parts or products; setup times were high, and production runs long. In this environment, an appropriate accounting system maximized work center efficiency by tying most costs to labor and encouraged workers to keep their center running. For that time, cost accounting mirrored the organization and economy; indirect costs associated with production were assigned to unit product. This methodology permitted management to know if each product was carrying its share of overhead and that all costs were being covered by price. Performance measures such as productivity, efficiency, breakeven, and product costs became standards by which companies evaluated their internal performance”. Cost accounting began in manufacturing businesses and is often used to aid in decision making (Datar & Rajan & Monte, 2014).

There are a multitude of tools that the cost accountant uses to accumulate and interpret costs, including job costing, process costing, standard costing, activity-based costing, throughput analysis, and direct costing (Bragg, 2013). Currently, the company is under standard costing which is the practice of substituting an expected cost for an actual cost in the accounting records, and then periodically recording variances showing the

difference between the expected and actual costs (Bragg, 2014). According to the book “Cost Accounting Fundamentals: Essential Concepts and Examples” (Bragg, 2014), standard accounting involves the creation of estimated costs for some or all activities within a company. The core reason for using standard costs is that there are a number of applications where it is too time-consuming to collect actual costs, so standard costs are used as a close approximation to actual costs (Bragg, 2014).

## **2.4 Mass Production**

The concept of mass production emerged in the nineteenth century with three basic characteristics: division of labor, interchangeable parts, and mechanization. It is a system of manufacturing based on principles such as large-scale production and the high-volume assembly line (Dugay, Landry, Pasin, 1997). In the 20<sup>th</sup> century, the concept of mass production began to develop thanks to Henry Ford. (Dictionary of American History, 2003). Due to his success in producing the Model T automobile, Ford set the standard in the industry for what mass production could achieve. This success was achieved by applying scientific management to the production of the Model T, reducing the time required to assemble a car from 728 hours to a couple of hours. (Heizer & Render, 2006). He achieved this by moving a Model T frame slowly down a conveyor belt with six workers walking alongside it, picking up parts from carefully spaced piles on the floor and fitting them to the frame. As a result, mass production quickly became the dominant form of manufacturing around the world. (Taylor & Francis, 2011)

## **2.5 Lean Manufacturing**

Contrary to mass production, lean thinking provides a way to specify value, identify value-creating actions, conduct these activities, and perform them more effectively. It also provides a way to do more with less while providing customers with what they want (Womack & Jones, 2003). Lean thinking is focused on value, and value can be defined by the customer. For this, it is essential that lean thinking starts with an attempt to define value in terms of specific products with specific capabilities offered at specific prices through a dialogue with customers (Womack & Jones, 2003). James Womack and Daniel Jones in



their article: “Lean Thinking: Banish Waste and Create Wealth in your corporation” (1996) state that there are five fundamental lean manufacturing principles:

1. Define value and identify the VS for each product
2. Eliminate all unnecessary steps in every VS
3. Make the value flow continuously
4. Base flow on customer pull
5. Pursue perfection continuously.

The first step in lean thinking is specifying value accurately followed by identifying the Value Stream (VS). According to Womack and Jones (2003) the VS is the set of all the specific actions required to bring a product through three critical management tasks in any business: (1) the problem-solving task which goes from concept through design and engineering and ending in production launch, (2) the information management task running from order-taking through detailed scheduling to delivery, and (3) the physical transformation task proceeding from raw materials to a finished product in the hands of a customer. Figure 2 summarizes how lean thinking compares with mass and lean production.

**Comparison of Mass and Lean Production Processes**

	<i>Mass Production</i>	<i>Lean Production</i>
The goal	<ul style="list-style-type: none"> <li>• Achieve the lowest possible cost per unit and the highest possible employee and equipment productivity</li> </ul>	<ul style="list-style-type: none"> <li>• Meeting customer demands</li> </ul>
Organizing resources	<ul style="list-style-type: none"> <li>• Align resources (people and equipment) functionally to achieve the goal of high-volume repetitive production.</li> </ul>	<ul style="list-style-type: none"> <li>• Align resources to mirror value streams</li> </ul>
Defining the flow	<ul style="list-style-type: none"> <li>• Batch-and-queue, larger batches are preferable</li> </ul>	<ul style="list-style-type: none"> <li>• Cellular-based one-piece flow</li> </ul>
Defining the trigger	<ul style="list-style-type: none"> <li>• Forecast acts as an internally generated “push” trigger</li> </ul>	<ul style="list-style-type: none"> <li>• Customer orders trigger a “pull” system</li> </ul>
Defining the human element	<ul style="list-style-type: none"> <li>• Intense supervision and adversarial supplier relationships</li> </ul>	<ul style="list-style-type: none"> <li>• Empowered workers and long-term supplier relationships</li> </ul>

Figure 2: Comparison of Mass and Lean Production Processes (Kennedy & Brewer, 2006)

The Kaizen Institute states that a VS mapping is a method of visually mapping a product's production path (materials and information). It can serve as a starting point to help management recognize waste and identify its causes. This process includes mapping

your "current state" while also focusing on where you want to be, or your "future state" (Kaizen Institute, 2016). This VS analysis will almost always show that many steps will be found to unambiguously create value, other steps will be found to create no value but to be unavoidable with current technologies and production assets, and many traditional steps will be found to create no value and be immediately avoided (Womack & Jones, 2003).

Figure 3 displays a water-use VS map for a product that contains water (a medical IV bag). This VS map includes a materials line summarizing the amount of water used and needed by each process. There are arrows showing the flow of waste water from each process to the sewer and another arrow depicting the flow of information about wastewater discharges to regulatory agencies. This type of detailed examination of material flows can help find hidden sources of waste in the VS. (United States Environmental Protection Agency, 2007)

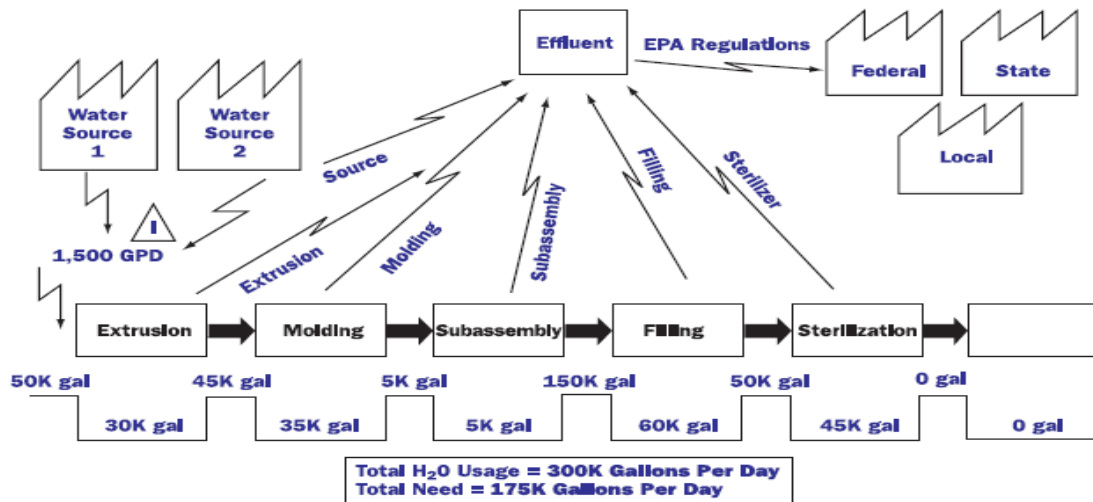


Figure 3: Water Use VS Map (United States Environmental Protection Agency, 2007)

In the article “The Lean Enterprise and Traditional Accounting- Is the Honeymoon over?” by Kennedy and Brewer (2006), state that since the 1980’s, Toyota’s performance has exceeded companies like General Motors, Ford, and Daimler Chrysler. Toyota’s success is derived from the principles of lean thinking, which they developed and applied to outshine their rivals and dismiss the myths of mass production. Many other companies have learned from Toyota’s experience and have applied lean thinking in a diverse ranking of manufacturing and service industries.

According to The Economist, lean methods have enabled U.S. manufacturers to significantly increase their pace of productivity improvement in the last years. Increased competition may be forcing companies to make the switch to lean manufacturing. As a way to improve productivity, reduce costs, enhance flexibility, create better value for customers, raise profits, cash flow, and stock price, American manufacturers are making the switch to lean manufacturing. (Maskell & Kennedy, 2007).

Lean manufacturing is a way of thinking that focuses on providing value to customers, organizing the business around the VS, and focusing operation activities on improving the flow of products and services along the VS (Maskell & Kennedy, 2007). Lean manufacturing aims to reduce waste while increasing customer value (Carnes & Hedin, 2005). With lean, the entire process revolves around delivering customer value and there is no production until a customer expresses a desire for a product through a customer order. Resources are aligned around the VS and VS teams are established to manage and continuously improve the flow of products from customer order to shipment. In terms of flow, as work on a product is finished at one station, it is moved into the next area only when space is available. This way, a one-piece flow is established so that waiting time, production time, and customer delivery time are reduced and at the same time, it lowers costs, because fewer resources are required. Workers in the lean approach are empowered to make quality related decisions and to collaborate with one another in a team environment to improve the process. Critical metrics are established to help maintain an even flow while at the same time providing quality products to customers in a timely manner. (Kennedy & Brewer, 2006).

## **2.6 Lean Accounting**

Keeping in mind the concept of lean manufacturing, lean accounting is the general term used for the changes made to a company's accounting processes so that they can support lean thinking (Maskell, 2006). In a lean environment, customer's orders trigger production. Only when an order is received does the cell begin production and no finished goods inventory is built without an order (Kennedy & Brewer, 2006). "In standard cost accounting systems, increased volume lowers unit costs, which is why strategic decisions

are focused on volume and place importance on inventory”. Also, traditional reports focus on the efficiency of people, the utilization of machines, variances in labor rate and usage, materials price and usage, and overhead absorption. These standard absorption costing methodologies were appropriate to manufacturing processes of the early 20<sup>th</sup> century because they are based upon mass production thinking (Carnes & Hedin, 2005). However, some of these methodologies can prevent the continuous flow of the VS. Since lean manufacturing breaks the rule of mass production, standard absorption costing is not necessarily the most convenient in today’s lean manufacturing environment (Kennedy & Brewer, 2006).

According to Maskell & Kennedy (2007), there are differences between standard cost accounting and lean accounting. For example, lean accounting simplifies the financial system reporting and understanding by using simple visual means. Information is presented as simple direct costs and VS profitability, and costs are shown clearly where and when they are expended. Lean accounting strives to provide information with a VS perspective, to make waste visible at all levels, and to drive the company forward in the pursuit of perfection (Maskell, 2000).

In standard cost accounting, few people can truly understand what is being presented in the financial reports. According to Orest Fiume and Jean Cunningham in their book *Real Numbers* (2003), “the average recipient of a standard cost-based profit and loss statement does not understand the document in his hands because it communicates nothing. Worse still, for those few that do understand it, these statements fail to give meaningful information about what is really happening in the operation”.

In a lean environment, the company simplifies the financial system and reporting so that the financial reports are user-friendly and not just understood by people in the finance department. The financial information is presented as direct costs and VS profitability. Information that has no effect in the business is simply not shown and instead is presented as “below the line” adjustments for Generally Accepted Accounting Principles (GAAP) purposes (Maskell & Kennedy, 2007). Figure 4 shows a comparison between a

traditional income statement and a lean income statement.

Lean Income Statement				
	Period 1		Period 2	
Customer Sales	\$998,977		\$1,039,440	
Systems Sales	\$1,002,466		\$1,009,246	
<b>TOTAL REVENUE</b>	<b>\$2,001,443</b>		<b>\$2,048,686</b>	
Materials	\$829,936	41%	\$609,526	30%
Direct Labor	\$305,767	15%	\$312,984	15%
Support Labor	\$340,245	17%	\$342,421	17%
Machines	\$113,862	6%	\$116,550	6%
Outside process	\$60,043	3%	\$53,731	3%
Facilities	\$40,250	2%	\$41,200	2%
Other Costs	\$12,009	0.6%	\$9,664	0.5%
<b>TOTAL COST</b>	<b>\$1,702,112</b>		<b>\$1,486,076</b>	
<b>GROSS PROFIT</b>	<b>\$299,331</b>	<b>15%</b>	<b>\$562,610</b>	<b>27%</b>
Inventory Adjustment	(\$41,593)		(\$401,426)	
Corporate Allocations	\$60,043		\$61,461	
<b>NET PROFIT</b>	<b>\$197,695</b>	<b>10%</b>	<b>\$99,723</b>	<b>5%</b>

Traditional Income Statement				
	Period 1		Period 2	
Customer Sales	\$998,977		\$1,039,440	
Systems Sales	\$1,002,466		\$1,009,246	
<b>TOTAL REVENUE</b>	<b>\$2,001,443</b>		<b>\$2,048,686</b>	
Cost of Goods Sold	\$1,621,169	81%	\$1,687,800	82%
<b>GROSS MARGIN</b>	<b>\$380,274</b>	<b>19%</b>	<b>\$360,886</b>	<b>18%</b>
<b>ADJUSTMENTS</b>				
Purchase Price Variance	(\$60,466)		(\$59,467)	
Materials Usage Variance	\$94,533		\$96,733	
Labor Variance	(\$19,718)		(\$93,895)	
Overhead Absorption Variance	\$38,341		\$182,577	
SG&A	\$129,889	6%	\$135,215	7%
<b>NET PROFIT</b>	<b>\$197,695</b>	<b>10%</b>	<b>\$99,723</b>	<b>5%</b>

Figure 4: Traditional and Lean Income Statements (Maskell & Kennedy, 2007)

Standard cost accounting uses complex systems for data reporting and collection. These include timesheets and work orders, detailed inventory tracking systems, and complicated purchasing practices (Maskell & Kennedy, 2007). Lean management accounting aims to provide information useful to the people in production plans that are actively implementing and sustaining lean manufacturing. This includes the development of performance measurements to allow employees, and managers to understand and monitor production processes and their improvements (Maskell, 2000). Lean accounting is low waste, visual, and makes more time available for the finance and accounting department so that they can be actively involved in the lean change (Maskell & Kennedy, 2007). Also, these simple visual systems reveal any problems as they occur so that they may be corrected and eliminated (Maskell & Kennedy, 2007).

Changing traditional mass production thinking to lean thinking requires changes in the way companies control, measure, and account for their processes. Some companies, when switching to lean manufacturing, discover that their standard cost accounting systems create problems for their lean programs. They often find that traditional standard cost

accounting promotes non lean behavior such as manufacturing large batches, building high inventories, hiding waste, and focusing on financial rather than operational performance measures (Carnes & Hedin, 2005).

## **2.7 Summary**

This chapter discussed the basic concepts of lean accounting and lean manufacturing. It included topics such as the difference between lean and cost accounting, what is lean manufacturing, operations management, and the difference between lean and mass production. The next chapter will focus on the methodology used for this project.

### **3. METHODOLOGY**

#### **3.1 Introduction**

This chapter presents the methodology used to determine the current and future state of the company and provide recommendations so that the project's objective could be achieved. To be able to accomplish the objectives of this investigation, and to better analyze the company's current financial, operational, and capacity performances, a series of interviews were arranged and a questionnaire was administered to the managers of the company. Based on findings, literature was reviewed from articles written by subject matter experts in lean accounting and manufacturing.

The triangulation method explained in section is also part of this project. Triangulation means using more than one method to collect data on the same topic. This is a way of assuring the validity of research through the use of a variety of methods to collect data on the same topic. Triangulation is one of the tools that qualitative research uses to add validity and quality to these studies. Triangulation refers to the use of various qualitative and quantitative methods (such as interviews and focal groups) when completing an investigation. This way the study will be analyzed in different perspectives and in this matter increase the validity and quality of the investigation (Okuda & Gomez, 2005).

It will be noted that the company provided authorization for the realization of the project. Copies of these authorization forms can be found in Appendix E and F as well as proof from the author of the questionnaire granting permission to use his work (Appendix I).

#### **3.2 Methodology**

The triangulation method was used to study current financial and operational processes and to suggest process improvements to the same. There were a series of interviews scheduled and a questionnaire based on the "Lean Accounting Diagnostic Questionnaire" developed by Maskell (2013) that was administered in order to be able to achieve the project's objective. The following steps were followed:

1) The interviews with the finance manager and the financial information gathered were part of the primary data of the investigation. Open ended questions were administered to the company's finance manager with the objective of understanding the company's current financial state and to the supervisor of the production line under study with the purpose of determining the current operational processes and metrics. This allowed to validate if financial metrics were aligned with operational processes.

2) Descriptive information about the company's current financial and operational processes and the desired future state, was gathered from Maskell's lean accounting questionnaire. This questionnaire involves nineteen (19) questions in six (6) categories regarding the performance measurements, value stream costing, measuring financial benefits, value stream profitability, eliminating transactions, and value stream management. For each of these categories, the questionnaire defined a current and future state. This questionnaire was individually administered by paper to the plant manager, materials manager, finance manager, and the supervisor of the production line under study. The questionnaire was used with the purpose of determining the current and future state of the company according to their roles. It also included subcategories in each topic along with a ranking going from 1 to 8. This ranking identifies the present and future states of the company as follows: rankings 1 and 2 refer for Standard cost accounting; rankings 3 and 4 refer for Developing a Framework; rankings 5 and 6 were Managing by Value Stream; and rankings 7 and 8 were Lean Business Management. After evaluating the results, it was found that not all managers were in agreement about the current state and the future state of the company. A copy of this questionnaire can be found on appendix A.

3) Because of the differences observed in step number two, as a result of the different perspectives each manager had, the questionnaire was administered again but this time using the methodology of a focal group. In the focal group, categories which had significant difference between the rankings each manager chose were presented. Each manager explained why he or she chose a particular ranking in those categories and after discussing it with each other, managers were convinced on choosing a specific ranking in each category. Results were then tabulated and graphed in a spider chart in which a better alignment is shown in contrast to the first questionnaire that was administered (refer to



Appendix B). Improvements to the accounting system based on lean accounting were defined with this information. A transcript of this focal group can be found in Appendix J.

4) Once the results from the focal group was obtained, according to what managers agreed the current state and the desired future state of the company should be, existing tools supported by literature review were developed and were aimed at assessing the performance and operational aspect of the production line under study to be able to achieve desired future state. These can be found in the recommendations section in the next chapter. There is one recommendation for each category in the questionnaire mentioned above and it details the necessary steps to take the production line and accounting procedures to the desired future state. With these results, it was then proceeded to develop the lean accounting conceptual model for the production line under study. The conceptual model basically summarizes all the recommendations made in each subcategory into one simple easy to read model.

### **3.3 Summary**

This chapter presented the methodology in which this project was based. The interviews and questionnaires administered to the company's management had the purpose of determining the current and future state of the company in terms of lean accounting and lean manufacturing. The next chapter will present the results and recommendations of this study.

## 4. ANALYSIS AND RESULTS

### 4.1 Introduction

This chapter presents the results of this investigation. Section 4.2 presents the information obtained from the finance manager and the production supervisor with the purpose of understanding current processes. The next section (4.3) shows the results of the questionnaire. Spider web charts were developed to give the reader a better view on answers given by top management. The fourth section (4.4) presents recommendations supported by literature review for all nineteen (19) subcategories on how to achieve the desired future state. The final section (4.5) shows the developed conceptual model based on all recommendations presented in section 4.4.

### 4.2 Open-ended questions interviews

This research started with a series of interviews performed to the finance manager and the production supervisor. The main objective of the interview with the finance manager was to determine the financial performance measures that the company was using to support decision making. It was found that decision making was based primarily on the Profit & Loss (P &L) statement. There were mainly three metrics used by the finance manager for decision making:

- Productivity - measured as units produced /hours worked.
- Margin - measured as *Gross Margin/Net Sales* as it indicates inventory and productivity problems.
- Quality cost (overall cost of both internal and external failures) - measured against sales.

It was also discovered that the company currently uses some Lean performance measures as mentioned in Kennedy & Brewer (2006):

- Request kept percent measured as *On Time Shipment/Number of Orders*: used to determine the percentage of orders shipped on time.

- Inventory turnover measured as *Sales /Inventory*. Adjustments must be made if inventory turnover falls behind an expected goal.
- Sales per employee measured as *Sales/Number Value Stream Employees*.

The second interview was made to the supervisor of the production line under study to determine which operational metrics the company was currently using. The following information was obtained:

- Production reports are generated daily. The Materials Manager generates a monthly report where production goals for each production line are specified. These goals are visually presented using a blackboard that is kept in the production area. The Production Supervisor also mentioned that productivity must be kept above 90% even though no productivity related project was being executed.
- Quality metrics are reported weekly when quality personnel meets to discuss all issues using a blackboard. There is also peer to peer quality training.
- There is no specific metric that promotes a continuous flow throughout the operation. Operators must achieve 850 pieces of daily production.
- Metrics used are in line with lean manufacturing but they do not use these metrics to drive continuous improvement metrics.

#### **4.3 Lean Accounting Diagnostic Questionnaire (Maskell, 2013)**

As mentioned in chapter 3, a questionnaire was administered to the Finance Manager, Plant Manager, Materials Manager, and the Production Line Supervisor to determine the current state and future state of the system. This questionnaire consisted of nineteen (19) subcategories among the following categories: performance measurements, value stream costing, measuring financial benefits, value stream profitability, eliminating transactions, and value stream management. Managers were asked to rank each subcategory by assessing the current and desired future state using the following scale: 1 and 2 meaning that the assessment fell within the definition of the “Traditional Category”; 3 and 4 referring to the definition of “Developing a Framework”; 5 and 6 referring to the definition of “Managing

by Value Stream”; and 7 and 8 referring to the definition of “Lean Business Management”. A copy of this questionnaire can be found in appendix A.

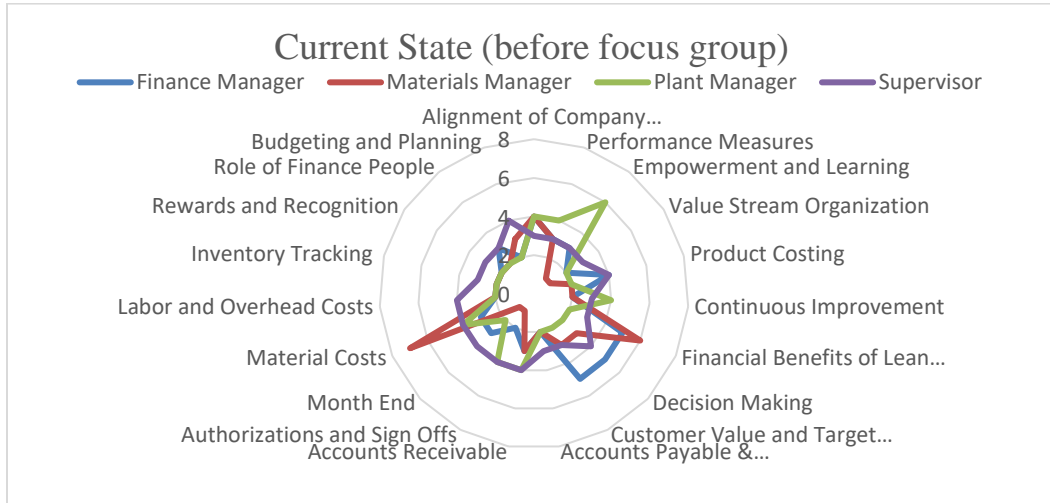


Figure 5: Spider Web Chart for Current State (before focus group)

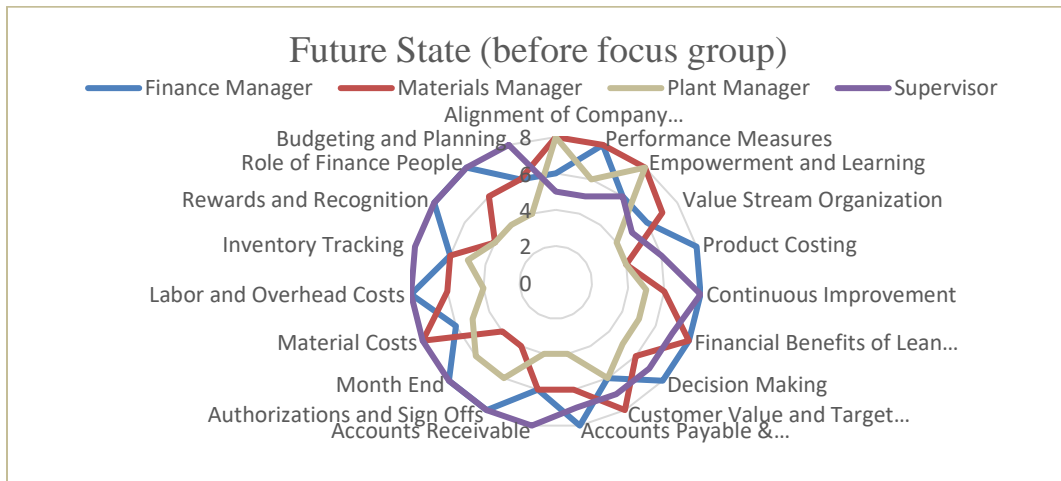


Figure 6: Spider Web Chart for Future State (before focus group)

As shown in Figure 5 and Figure 6, spider web charts were constructed to verify the alignment of the assessments done by the managers. Spider web charts are a visual way of comparing multiple quantitative variables to identify the ones with similar values or outliers amongst each variable (The Data Visualization Catalogue, 2017). For the purpose of this research, all subcategories of the questionnaire were displayed around a circle each having an axis emanating from the center. The axes ranking from 0 to 8 representing the scale used in the questionnaire. Figure 5 shows a misalignment with respect to the current

state and Figure 6 shows a misalignment with respect to the future state. These results are believed to occur since each manager answered the questionnaire individually. The process was repeated following a focus group approach with all managers in order to reassure the alignment of their assessments with respect to the current and future states. Figures 7 and 8 show a better alignment as a result of the focus group approach.

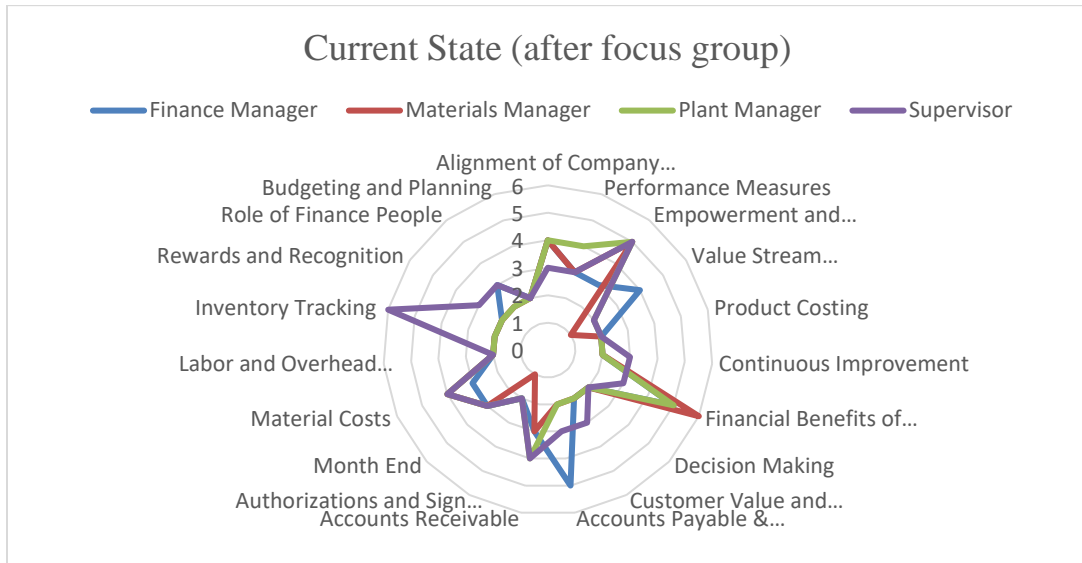


Figure 7: Current state (after focus group)

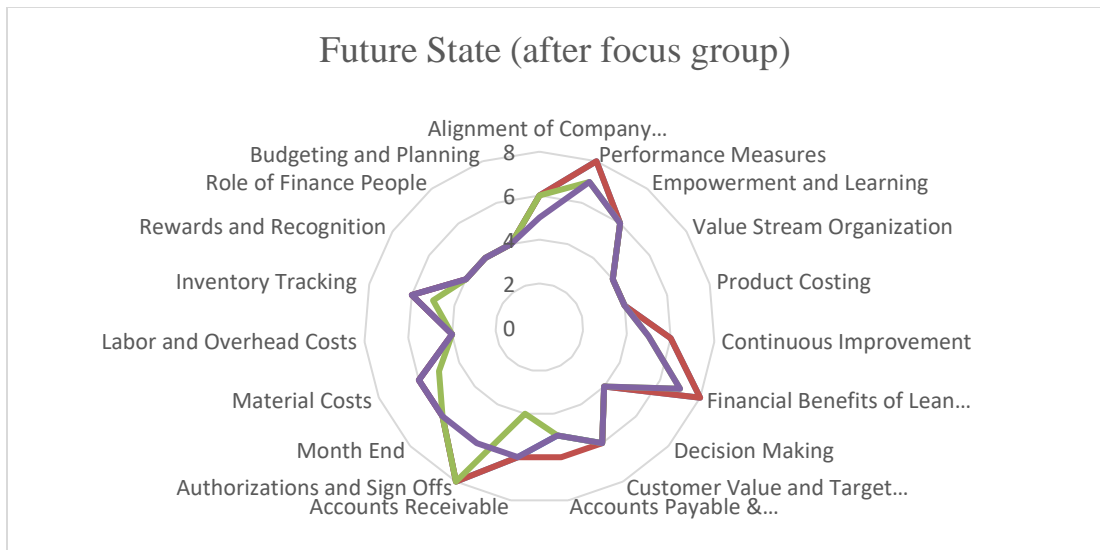


Figure 8: Future State (after focus group)

Table 1: Average questionnaire results after focus group

		Average Results (after focus group)	
Category	Subcategory	Current state	Future State
Performance Measurements	Alignment of Company Strategy	4	6
	Performance Measures	3	8
	Empowerment and Learning	5	6
Value Stream Costing	Value Stream Organization	2	4
	Product Costing	2	4
Measuring Financial Benefits	Continuous Improvement	2	6
	Financial Benefits of Lean Changes	5	8
Managing Value Stream Profitability	Decision Making	2	4
	Customer Value and Target Costing	2	6
Eliminating Transactions	Accounts Payable & Procurement	3	5
	Accounts Receivable	4	6
	Authorizations and Sign Offs	2	8
	Month End	3	6
	Material Costs	4	6
	Labor and Overhead Costs	2	4
	Inventory Tracking	3	6
Value Stream Management	Rewards and Recognition	2	4
	Role of Finance People	3	4
	Budgeting and Planning	2	4

The information presented in Table 1 was reorganized in Table 2 to show the current and desired future state for each category. The letter “C” represents the current state and the letter “F” represents the future state. In the categories of Empowerment and Learning, Financial Benefits of Lean Changes, and Role of Finance People managers would like to stay in the current state. For the future state, they would like to be in the “Managing by Value Stream” in twelve categories, “Developing a Framework” in five categories, and “Lean Business Management” in two categories.

Table 2: Current state vs Desired Future State

<b>Categories</b>	<i>Traditional</i>	<i>Developing a Framework</i>	<i>Managing by Value Stream</i>	<i>Lean Business Management</i>
Alignment of Company Strategy and Lean Goals		<b>C</b>	<b>F</b>	
Performance Measures		<b>C</b>		<b>F</b>
Empowerment and Learning			<b>C, F</b>	
Value Stream Organization	<b>C</b>	<b>F</b>		
Product Costing	<b>C</b>	<b>F</b>		
Continuous Improvement		<b>C</b>	<b>F</b>	
Financial Benefits of Lean Changes			<b>C, F</b>	
Decision Making	<b>C</b>	<b>F</b>		
Customer Value and Target Costing	<b>C</b>		<b>F</b>	
Accounts Payable & Procurement		<b>C</b>	<b>F</b>	
Accounts Receivable		<b>C</b>	<b>F</b>	
Authorizations and Sign Offs	<b>C</b>		<b>F</b>	
Month End		<b>C</b>	<b>F</b>	
Material Costs		<b>C</b>	<b>F</b>	
Labor and Overhead Costs	<b>C</b>	<b>F</b>		
Inventory Tracking		<b>C</b>	<b>F</b>	
Rewards and Recognition	<b>C</b>		<b>F</b>	
Role of Finance People		<b>C, F</b>		
Budgeting and Planning	<b>C</b>	<b>F</b>		

#### 4.4 Literature Revision and Recommendations

This section will present the current and future states for each of the nineteen (19) subcategories as described by Maskell (2013) and chosen by the management of the APR Company. Literature about lean accounting and lean manufacturing was researched to suggest recommendations so that the company can reach the desired future state. At the end of this section the lean accounting conceptual model developed for APR Company will be presented.

#### 4.4.1 Alignment of Company Strategy and Lean Goals

In the category of Alignment of Company Strategy and Lean goals managers agreed on using driver-based performance measurements that are linked to the development of continuous improvement targets (refer to Table 3).

Table 3: Alignment of Company Strategy and Lean Goals Recommendation

<b>Current State</b>	<b>Desired Future State</b>	<b>Recommendation</b>
“We have aligned our performance measures to company strategy and lean goals and have eliminated all unnecessary measures and meetings to discuss the measures”.	"We have introduced driver-based performance measurements throughout all VS. We have linked the performance to the development of continuous improvement targets for both cost and performance."	Include recommended lean metrics that improve flow throughout the production line (Davidson, 2013)

To be able to reach this desired future state, it is recommended to include metrics that improve the flow throughout the production line. These metrics can be better identified by developing a strategy map.

Epstein (2013) mentions the importance of the strategy map to graphically identify driver-outcome relationships at the level of strategic goals and objectives. The strategy map helps identify relevant measures that will show driver-outcome relationships that managers can use to analyze performance. It also links non-financial and financial performance measures. As part of this project, a strategy map was developed for APR Company (Table 4). For a detailed explanation of the strategy map the reader can go to appendix B.



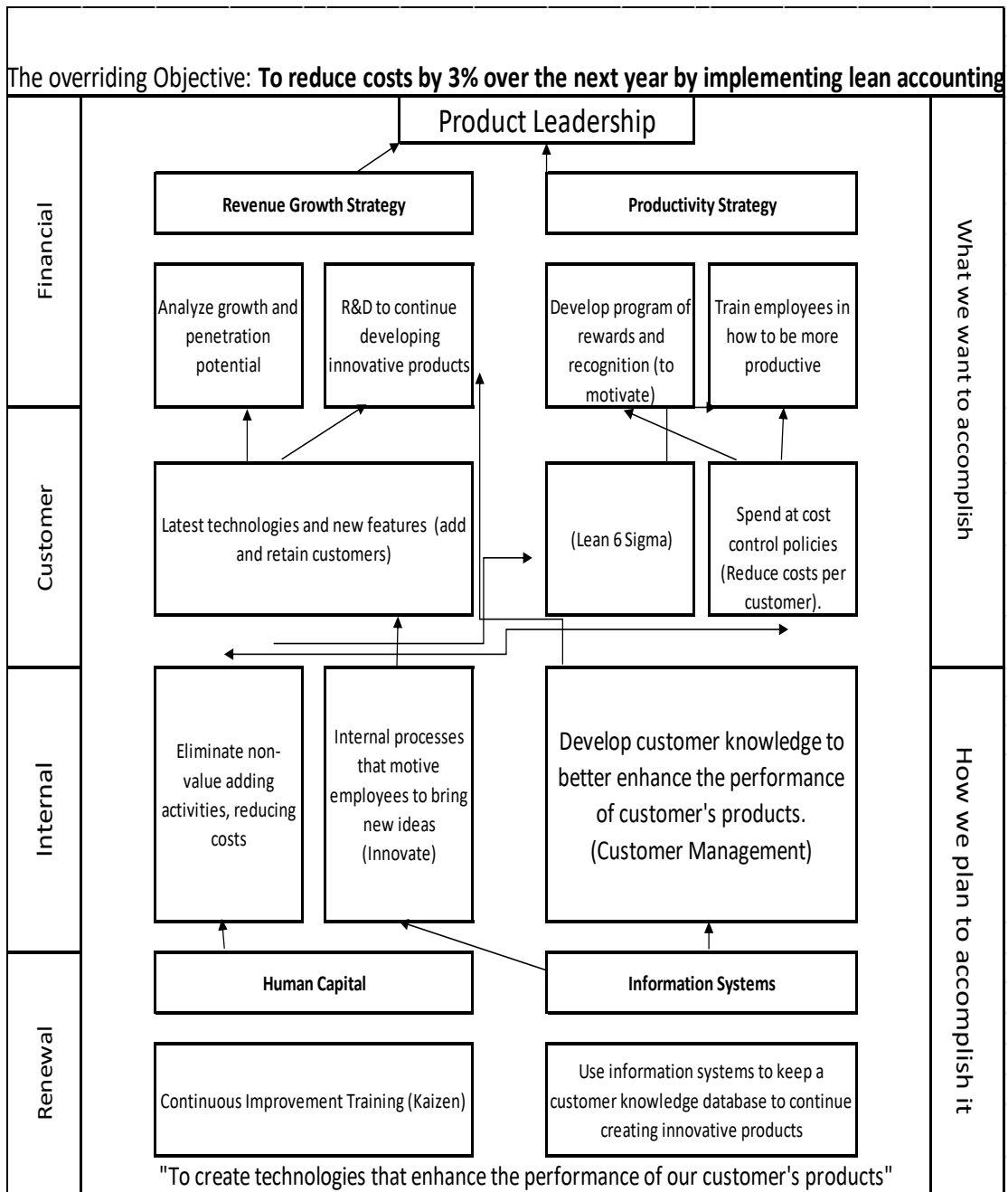


Figure 9: APR Company Strategy Map

The following Table (Table 4) presents a summary of the strategy map shown in Figure 9 (above) so that the reader can have a better understanding.

Table 4: Summary of the APR Company Strategy Map

<b>Specify and overriding objective</b>	<b>Choose the value proposition</b>	<b>Choose the financial strategies</b>
To reduce cost by 3% by implementing lean accounting	Product leadership in the market	Analyze growth and penetration potential
<b>Choose the customer strategies</b>	<b>Execute through the internal perspective strategies</b>	<b>Plan the learning and growth strategies</b>
Add and retain customers by using the latest technologies and new features in the products.	Motivate employees to bring new ideas to the Table	Attracting and retaining the right type of skills (through Human Resources talent acquisition), and providing the appropriate coaching, mentoring, and opportunities for developing the “know-how” necessary to execute specific strategies (Kaizen, Lean 6 Sigma Training)

Based on the strategy map shown in Figure 9, a series of performance measurements are recommended.

Process improvements metrics (Morestream, 2016)

1. Operational equipment effectiveness (OEE):  
Plant Availability x First time through x performance efficiency. Identifies the percentage of planned production time that is truly productive.
2. Workin process inventory turns: *Cost of Goods Sold / (Average Inventory Levels – Finished Goods)*. Materials that have been partially converted through the production process.
3. Employee turnover: *number of terminations / average employment during the period*

Value Stream Measurements and diagrams (Leankit, 2016):

4. Throughput: average number of units processed per time unit.

5. Cycle Time: *Work in process/Average completion rate.*
6. Average cost per unit: *total costs/ number of units shipped.*
7. Cost of poor quality: costs of internal (waste, scrap, rework, failure analysis) and external (warranty claims, repairing, and servicing) failures
8. Takt time: *Available time for production / required units of production.*
9. Queues: it is important to understand where work waits between different stages. Limiting the time that work spends in queues can help reduce overall cycle time and keep work flowing through the system.
10. Cumulative Flow Diagrams: a graphical representation of work in process as it flows through the Kanban system. It helps understand what might need to be done to speed up the pace of delivery.
11. Labor cost reduction (labor savings): reduction in labor hours needed to perform processes.

#### **4.4.2 Performance Measures**

In the category of Performance Measurements (refer to Table 5), managers agreed on incorporating statistical analysis such as control limits to performance measurements. For APR Company to keep control of its processes and be able to achieve continuous improvement, a control chart is recommended for metrics that improve flow throughout the production line (i.e. takt time, cycle time, throughput, and WIP Inventory turns). Continuous improvement projects should be developed whenever the control graph shows that it is not in control.

Table 5: Performance Measurement Recommendation

Current State	Desired Future State	Recommendation
<p>"We have introduced lean performance measurements into the production cells. These measures are focused on the production of the cell on a day-by-the-hour basis to ensure that the cell manufactures to its TAKT time. Goals and targets for the cell are established both in financial and non-financial terms related to our lean strategies and objectives"</p>	<p>"We have incorporated statistical analysis into our performance measurement process. We regularly establish control limits for all measures and establish our targets to meet our Six Sigma objectives. In doing so we have significantly reduced the variability of the VS and cell outputs"</p>	<p>Begin plotting control charts for processes including metrics (for example TAKT time, cycle time, throughput, and WIP Inventory turns) that improve flow along the production line to ensure minimal variability in processes (ASQ, 2016)</p>

#### 4.4.3 Empowerment and Learning

In the Empowerment and Learning category (Table 6), managers want to drive continuous improvement projects based on financial and non-financial performance measurements. For these reasons the use of a balanced scorecard is recommended for APR Company.

Table 6: Empowerment and Learning Recommendation

<b>Current State</b>	<b>Desired Future State</b>	<b>Recommendation</b>
“We have educated management and the work force on the use of performance measurement in a lean environment”	“We support continuous improvement with financial and non-financial performance measurements that drive improvement and continuous learning”.	Create a balanced scorecard to be able to develop financial and non-financial performance measurements (Kaplan & Norton, 1992)

The American Institute of CPAs (2012) states that Financial Key Performance Indexes (KPIs) are generally based on the income statement or the balance sheet and may also report changes in sales or in expense categories. Non-financial KPIs are measures used to evaluate the activities that an organization sees as important to the achievement of its strategic objectives. Typical non-financial KPIs include measures that relate to customer relationships, employees, operations, quality, cycle-time, and the organization’s supply chain. KPIs can improve strategy execution by aligning business activities and individual actions with strategic objectives.

To be able to assess clearly both financial and non-financial performance metrics, the balance scorecard is recommended. This methodology was originated by Drs. Robert Kaplan and David Norton as a performance measurement framework that adds strategic non-financial performance measures to traditional financial metrics to give managers a more balanced view of organizational performance. The scorecard provides performance metrics and helps identify what should be done and what should be measured. (Balanced Scorecard Institute, 2016).

As shown on Figure 10, the balanced scorecard proposed by Kaplan and Norton consists of four quadrants each obtaining objectives and measures from a different perspective: financial, internal, customer, and learning and growth. The scorecard’s

objective is to move managers away from focusing only on financial outcomes and to consider financial and nonfinancial measures linked to strategic objectives (Mackay, 2004).

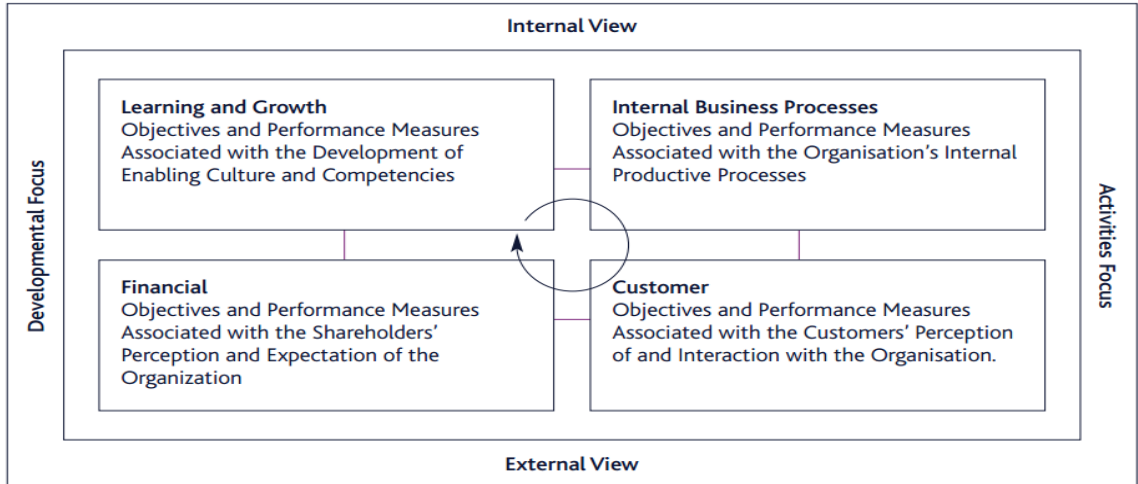


Figure 10: “The balanced scorecard quadrants” (Mackay, 2004)

A balanced scorecard for APR Company (Figure 13) was developed, taking into consideration the strategic objective and driver-based performance measures suggested in section 4.4.1. In the financial quadrant the suggested objectives are higher return on investment measured by return on investment formula and higher profit margins measured by profit margin percent formula. In the internal quadrant the suggested objectives are to compete on product reliability measured as cost of internal and external failures and maximize operational efficiency measured as operational effectiveness rate. In the learning and growth quadrant the objectives are to develop a skilled workforce measured as number of lean training hours and to maximize productivity measured as units produced by labor hours. In the customer quadrant objectives are to have a responsive supply chain measured as on time delivery and to delight targeted customers measures with a customer satisfaction survey.

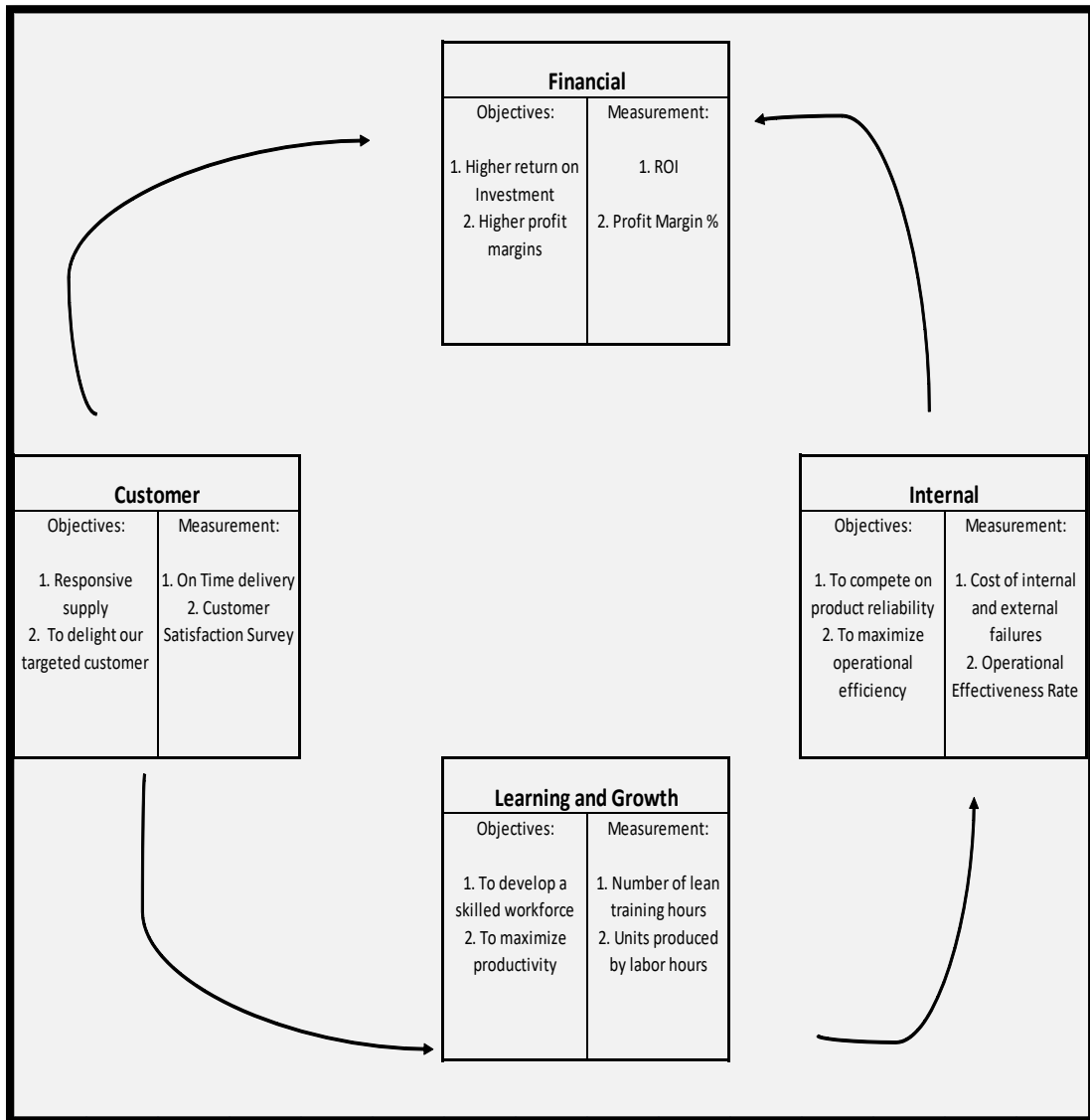


Figure 11: APR Company's Balanced Scorecard

#### 4.4.4. Value Stream Organization

In the value stream organization category (Table 7), managers agreed on reporting costs for each product line by VS. Cross-training needs to become operational strategies for the production line so that each employee can perform VS work. The kaizen methodology for continuous improvement is recommended along with examples on how to report costs by VS.

Table 7: Value Stream Organization Current and Future State Recommendations

Current State	Desired Future State	Recommendation
<p>“The company is organized by functional department and reporting of performance is based on this organization structure”.</p>	<p>“We manage the business by VS. Almost everyone is assigned (either directly or as a matrix) to a specific VS. There is considerable cross-training so that all tasks can be performed by VS people. There are some remaining business sustaining departments that do non-VS work. We report all costs and performance information by VS.”</p>	<ul style="list-style-type: none"> <li>•Organize continuous improvement events (Kaizen, Lean Six Sigma training) for the production line in study (Lean Enterprise Institute, 2016)</li> <li>•Switch cost reporting from standard cost accounting to VS reporting (Maskell &amp; Kennedy, 2014)</li> </ul>

### **Kaizen Events**

According to the Lean Enterprise Institute (2016), the Kaizen methodology promotes continuous improvement as a daily way of life for every member within the value stream organization. It supports the flow, implementation and recognition of improvement suggestions made by all collaborators and converts them into applied changes that have a positive impact in the way people perform their work. Kaizen events include visual elements (kaizen boards, kaizen rewards system, monthly metrics reporting, etc.) that help to support continuous improvement. (Lean Enterprise Institute, 2016). Figure 12 shows an example of a Kaizen event road map that can be implemented in APR Company. This Kaizen plan consists of 4 phases: Plan, do, check, and act. Each phase has a recommended checklist.



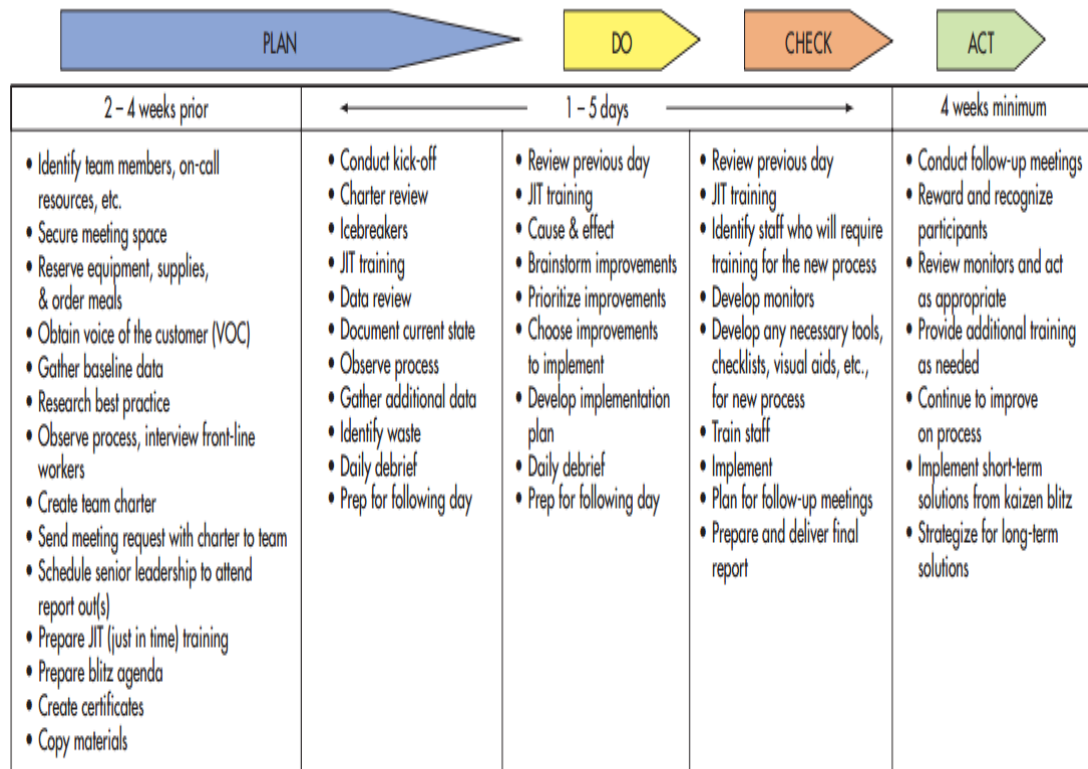


Figure 12: Kaizen blitz road map to continuous improvement (Jacobsen, 2010)

## VS Reporting

VS costing is based on actual costs being charged directly to the VS with little or no allocation. The fundamental difference from traditional product costing is that costs are associated to the VS and not to work orders for specific products (Strothmann, 2008). An example of VS reporting is shown in Figure 13 where the traditional income statement is compared to a lean income statement that VS employees can understand. While traditional income statements present information on cost of goods sold, applied overhead, and manufacturing variances, VS statements highlight material purchases, employee and equipment costs, and facility costs. (Kennedy & Maskell, 2007).

<b>Traditional statement:</b>			<b>Lean statement:</b>		
	<b>This year</b>	<b>Last year</b>	<b>This year</b>	<b>Last year</b>	
<b>Net sales:</b>	100,000	90,000	<b>Net sales:</b>	100,000	90,000
<b>Cost of sales:</b>			<b>Cost of sales:</b>		
Standard cost	48,000	45,000	Purchases	25,300	34,900
Purchase price variance	(3,000)	10,000	Inventory material: (increase)/decrease	6,000	(6,000)
Material usage variance	(2,000)	5,000	<b>Total material costs</b>	<u>31,300</u>	<u>28,900</u>
Labor efficiency variance	7,000	(8,000)	<b>Processing costs:</b>		
Labor rate variance	(2,000)	9,000	Factory wages	11,000	11,500
Overhead volume variance	2,000	2,000	Factory salaries	2,100	2,000
Overhead spending variance	(2,000)	8,000	Factory benefits	7,000	5,000
Overhead efficiency variance	<u>16,000</u>	<u>(17,000)</u>	Services and supplies	2,200	2,500
Total cost of sales	64,000	54,000	Equipment and depreciation	2,000	1,900
<b>Gross profit</b>	36,000	36,000	Scrap	2,000	4,000
<b>Gross profit percentage</b>	36%	40%	<b>Total processing costs</b>	<u>26,300</u>	<u>26,900</u>
			<b>Occupancy costs:</b>		
			Building depreciation	200	200
			Building services	2,200	2,000
			<b>Total occupancy costs:</b>	<u>2,400</u>	<u>2,200</u>
			<b>Total manufacturing costs:</b>	60,000	58,000
			Inventory/labor, overhead: (increase)/decrease	4,000	(4,000)
			<b>Cost of sales</b>	<u>64,000</u>	<u>54,000</u>
			<b>Gross profit</b>	36,000	36,000
			<b>Gross profit percentage</b>	36%	40%

Figure 13: Traditional vs Lean Income Statement (Cunningham & Fume, 2003)

#### 4.4.5 Product Costing

In the Product costing category (refer to Table 8), managers agreed on the following: the use of VS costing, the use of features and characteristics costing when the costs of individual products are required, and the use of target costing. This section will focus on features and characteristic costing and target costing since VS costing was covered in section 4.4.4 of this chapter.

#### Features and characteristic costing

Features and characteristic costing creates a cost for individual products by understanding what truly affects the cost of one product as it flows through the VS (Maskell, 2006). It recognizes that VS are designed based on common processes used to make similar products. Therefore, it is necessary only to define how an individual product departs from the standard, and then to understand how significantly that differs from the average. To know the individual cost of a product, these questions need to be answered (Maskell & Baggaley & Grasso, 2011):

- What are the product features that create cost?
- How much do product features add to the cost of the product?

- How do these features relate to product design decisions?
- How do these features relate to the value that customers place on our products?
- What features do we need to modify or improve in order to create greater value for customers?

Table 8: Product costing recommendations

<b>Current State</b>	<b>Desired Future State</b>	<b>Recommendation</b>
<p>“We still use the standard costs for financial reporting and inventory valuation. But we have created Value Stream Cost reporting (summary direct costing of the value stream) and use this information for value stream management and decision making”.</p>	<p>“VS costing (summary direct costing of the VS) is widely used. When the costs of individual products are required we use features &amp; characteristics costing. There is wide use of Target Costing to establish the customer value and target cost of the products. These, together with the average actual VS product costs are powerful drivers of improvement for the VS continuous improvement team.”</p>	<ul style="list-style-type: none"> <li>• Begin by identifying actual value stream costs within the production line (BMA Inc, 2010)</li> <li>• Prepare a VS costing report (Maskell &amp; Kennedy, 2007)</li> <li>• Use features and characteristics costing when pricing for individual products (Brimson, 1998)</li> <li>• Use Target costing to establish target product costs (Maskell, 2000)</li> </ul>

In the article “Feature costing: Beyond ABC”, Brimson (1998), mentions 7 steps on how to conduct feature costing:



Figure 14: How to conduct feature costing (Brimson, 1998)

### Target Costing

According to the Institute of Management Accountants (IMA, 1998), the fundamental objective of target costing is to enable management to run the business to be profitable in a very competitive marketplace. Costs are planned and managed out of a product and business early in the design and development cycle, instead of during the latter stages of product development and production. Finance and marketing people work together to understand what a customer will pay for the products and services and how the price will change according to the different features and characteristics (Maskell, 2000). The formula for determining the target cost of a product is:

$$\text{Market price} - \text{desired profit} = \text{Target cost}$$

#### 4.4.6 Continuous Improvement

In the Continuous Improvement category (Table 9), managers agreed they would like the company involved in weekly continuous improvement projects with visual representation boards across the organization. This section will focus on two ways examples of how visual management can help identify where performance needs to be improved, freed up capacity, and waste elimination.

Table 9: Continuous Improvement Recommendations

Current State	Desired Future State	Recommendation
<p>“The financial reports are organized by resource line item and reflect waste through the cost of these items versus budget. Budgets and standards are based on historical performance and frequently include reserves for waste and inefficiency”</p>	<p>“Continuous improvement is now a way-of-life within the organization. Almost everybody is actively involved in week-by-week continuous improvement projects. We have an on-going process of visually reporting waste elimination, performance improvement and cost impacts, freed up capacity and achievements against lean targets. These are posted on the VS Tracking Board”.</p>	<ul style="list-style-type: none"> <li>• Prepare visual representation boards for continuous improvement projects (BMA Inc, 2006)</li> <li>• Create a box score and set operational, capacity, and financial goals (Maskell &amp; Kennedy, 2007).</li> </ul>

Visual management is a way to communicate information as soon as it is needed in a simple, easy to understand manner to guide decisions and demonstrate operational control. This ensures everyone is working with the same information and that it is available when needed. These types of visual information are found throughout the lean organization as VS tracking boards (BMA, Inc). Figure 15 shows an example of a VS Tracking board

where VS projects and improvements are posted. The board contains simple information such as the current and future state value stream map, weekly performance metrics, and continuous improvement projects.

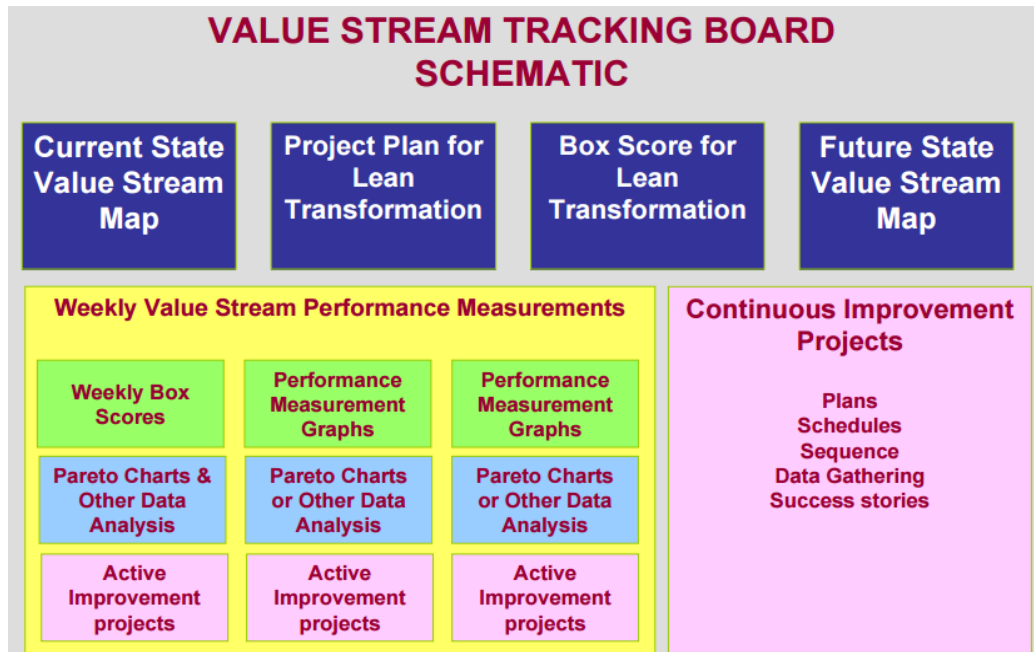


Figure 15: Value Stream Tracking Board, BMA, Inc (2006)

Another example of visual management is the box-score. The box score helps identify areas for improvement by displaying current and future state of three areas: capacity information, operational performance, and financial performance. The capacity information shows how much of the VS resources are used productively, how much is used nonproductively, and how much available capacity is within the VS (Maskell & Kennedy, 2007). This information is presented in a single piece of paper so that it is easier to highlight problem areas and identify areas that need to change. Figure 16 shows an example of a box score adapted for APR Company. It shows relevant measurements that go along with the company's strategy.

		1/1/2016	1/8/2016	1/15/2016	1/22/2016	1/29/2016	2/5/2016	2/12/2016	2/19/2016	2/26/2016	Goal
Operational	Units per person										
	On-Time Shipment										
	First time through										
	Dock to dock days										
	AR Days										
	Inventory Turns										
	Average Cost per unit										
Capacity	Productivity										
	Non- Productive										
	Available Capacity										
Financial	Revenue										
	Material Costs										
	Conversion Costs										
	Value Stream Profit										

Figure 16: Box Score for APR Company

Performance metrics above are calculated as follows (Maskell & Baggaley & Grasso, 2011):

- Units per person: number of units produced by one person in an eight hour day.
- On-time shipment: calculated as the percentage of the scheduled customer order volumes actually shipped on schedule.
- First time through: calculated as the percent of total units that pass through the value stream on the first pass without being repaired, reworked, or scrapped.
- Dock to dock days: calculated by the amount of time from material receipt to shipment of the finished product to the customer.
- Accounts Receivable Days: number of days that a customer invoice is outstanding before it is collected. The formula for accounts receivable days is:  $(\text{Accounts receivable} / \text{Annual revenue}) \times \text{Number of days in the year}$ .
- Inventory Turns: how much inventory is sold over a period of time. It is calculated as  $\text{Sales} / \text{Inventory}$
- Average Cost per Unit: calculated as the total value stream costs for a period, divided by the number of units shipped during the period.

- Revenue: invoiced amounts for shipments from the value stream during the period, as recorded in the company's books.
- Material cost: amount the company spent for production materials during the period.
- Conversion costs: includes expenses incurred during the period to run the value stream.
- Value stream profit: is the difference between revenues and costs of sales.
- Productive: labor or machine time spent creating product at the pull of the customer.
- Nonproductive: all other uses of time. For example: non-value adding activities, time spent on changeovers rework/remake, material movement, inspection, repair, maintenance, waiting for resources, scheduling, planning, procurement, management, administration, etc.
- Available: machine and labor time left over after accounting for productive and nonproductive time.

#### **4.4.7 Financial Benefit of Lean Changes**

In the financial benefit of lean changes category (Table 10), managers agreed they want to drive business strategy based on the financial information obtained from sales and operations. To be able to achieve this, a box score adapted to the company's strategy is recommended (Maskell, 2006).

Lean accounting recognizes that the primary impact of waste elimination is the creation of available capacity and what the company does with that newly available capacity (Maskell, 2006). When using the Box Score as a planning tool, the box score has two important purposes: the first is as a planning tool to understand the effectiveness of lean from a business perspective and the second is to monitor the progress toward achieving the plans. The box score provides a framework for evaluating the financial and operational effects of lean (Maskell, & Baggaley & Grasso, 2011).



Table 10: Financial Benefit of Lean Changes Current and Future State

Current State	Desired Future State	Recommendation
“We regularly monitor the achievement of actual benefits of lean changes. As we identify the potential for eliminating waste and making capacity available, we create strategies for the profitable use of this capacity”.	“We use the financial benefits information related to freed up resource capacity in our Sales, Operations, & Financial Planning to drive business strategy”	<ul style="list-style-type: none"> <li>Adapt the box score using strategic decisions (Maskell &amp; Baggaley &amp; Grasso, 2011)</li> </ul>

Figure 17 shows an example using the same metrics as the box score presented on section 4.4.6, of the financial impact of lean changes when comparing between two proposed business strategies\*.

		Current Value Stream Jan 2016	Remove "low margin products" Jun 2016	Introduce "new features" Nov 2016
Operational	Units per person	400	355	513
	On-Time Shipment	91%	95%	99.5%
	First time through	70%	80%	85%
	Dock to dock days	12	10	9
	AR Days	42	35	30
	Inventory Turns	5.8	7.6	9.5
	Average Cost per unit	\$34	\$31	\$29
Capacity	Productivity	22%	15%	30%
	Non- Productive	53%	40%	45%
	Available Capacity	25%	45%	25%
Financial	Revenue	\$9M	\$7M	\$14M
	Material Costs	\$5,754.00	\$5,132.00	\$4,399.00
	Conversion Costs	\$3,766.00	\$3,766.00	\$3,766.00
	Value Stream Profit	\$5,874.00	\$4,578.00	\$7,844

Figure 17: Box Score showing strategic decisions

\*Numbers are hypothetical

#### 4.4.8 Decision Making

In the decision making subcategory (Table 11), managers agreed to use value engineering to evaluate the trade-offs of cost, quality, and function during the design stage and on-going production. Since other concepts applied in this section have been previously explained, this section will focus on value engineering.

Table 11: Decision making recommendation

Current State	Desired Future State	Recommendation
<p>“All routine decisions are made using lean decision-making methods based upon value stream cost information. These include profitability of orders or quotes, make/buy, new product introductions, product rationalizations, etc. Standard costs are never used for these kinds of decisions. We have a capital acquisition process that supports lean thinking”.</p>	<p>“We use VS profitability &amp; cash flow for all key decisions. We use VS cost analysis and Box Scores to assess strategic decisions. We use product features and characteristics to link customer needs to product features. We use target costs to determine allowable costs and we use value engineering to evaluate the trade-offs of cost, quality, and function during the design stage and on-going production”.</p>	<p>Apply the suggested Value Engineering Job Plan workshop for decision making (SAVE International, 2007)</p>

A traditional approach to pricing is to develop a product and then set a price to recover the costs of production and realize a profit. However, in a competitive marketplace this approach is often impractical because a business must usually set prices close to those of its competitors. Value engineering could allow the company to optimize its processes and achieve the target cost (Basu, 2016). It is defined by the Chartered Institute of Management Accountants as the functional analysis and redesign of products and services to provide value to the customer. Value engineering helps businesses achieve cost efficiencies and meet their cost and profitability targets.

Value engineering is a planned approach to cost reduction. It involves reviewing the material composition of planned or existing products and re-engineering product designs to reduce costs and increase value without sacrificing quality. An article published by Society of American Value Engineers (SAVE, 2007), states that the value engineering process involves gathering information, analyzing and clarifying the product functions, generating and evaluating alternative solutions and selecting the best alternative for improving value. Engineers can execute this by following the formal approach to value engineering known as the job plan.

The job plan consists of six phases (Figure 18): Information phase, Function Analysis Phase, Creative phase, Evaluation phase, Development phase, and Presentation phase.

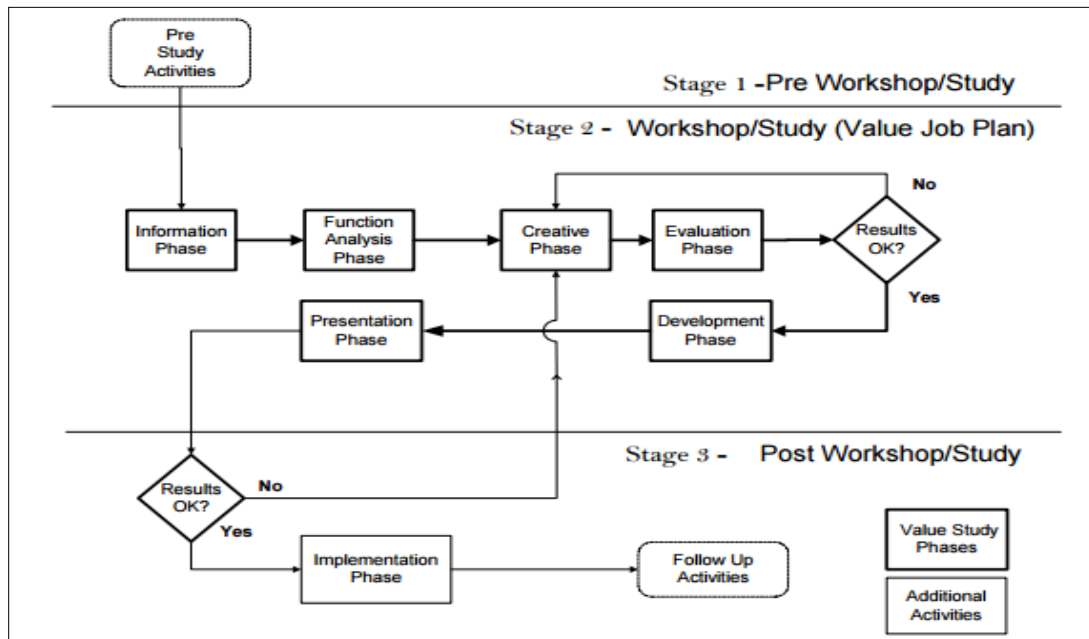


Figure 18: Value Study Process Flow diagram, SAVE International (2007)

SAVE International (2007) has developed a Value Standard and Body of knowledge intended to provide a practical guide for applying the principles of the value methodology (job plan). For the benefit of the reader, a summary of this standard can be found in appendix C. This workshop consists of a series of questions, related activities, and the expected outcome from each phase workshop.

#### 4.4.9 Customer Value and Target Costing

In the customer value and target costing subcategory (Table 12), managers agreed to use target costing for each value stream. For APR Company, it would require an analysis of their costing techniques so they can make the switch to target costing since they are currently using product costing. As mentioned in above sections, target cost is obtained by subtracting the desired profit from the market price.

Table 12: Customer Value and Target Costing recommendation

<b>Current State</b>	<b>Desired Future State</b>	<b>Recommendation</b>
“Costs are determined from internal standard cost information and are not related to customer value, profitability margins are calculated from sales prices and standard costs”.	“We regularly use cross-functional, VS Target Costing. We have developed target costs for each VS, product family, and customer group. We use target costs to set allowable product family costs and costs of product features. All new products or major product line changes go through target costing”.	Implement target costing following recommended steps (Institute of Management Accountants, 1998)

Using the recommended value engineering job plan, the value created by a product for the customer can be understood and with this, calculate the target cost for the product. This target cost is driven down through the VS to initiate improvement and cost reduction projects to bring the VS costs in line with the target costs. This way it provides high levels of customer value and the right level of profitability for the company (Maskell, 2006).

The Institute of Management Accountants developed a target costing process involving six steps (Figure 19) which represent a standard work plan, a framework for training, and implementation. An organization’s actual implementation will most likely

include all six steps (not necessarily in the same order). Since the last two steps involve the design of a new product, for APR Company it is recommended they focus on the first four steps to be able to move from product costing to target costing.

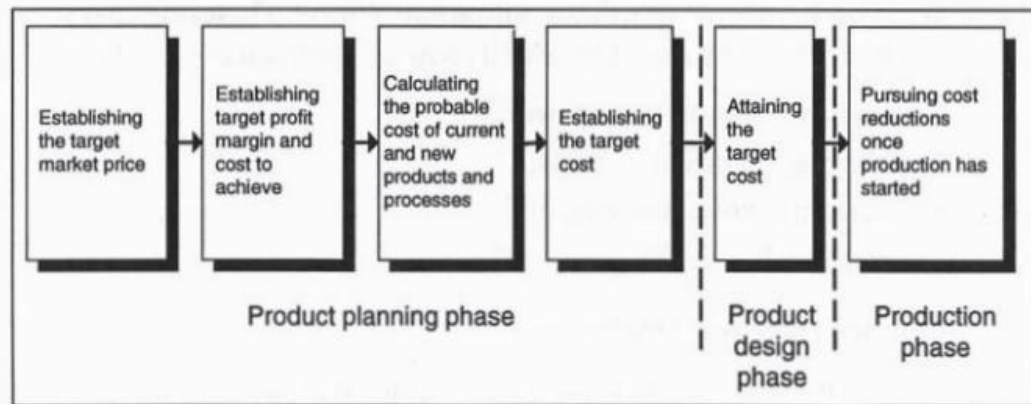


Figure 19: Target costing process steps, IMA (1998)

#### 4.4.10 Accounts Payable and Procurement

In the accounts payable and procurement subcategory (Table 13), managers agreed to make electronic payments and use backflushing. To be able to make automatic payments to vendors, a series of steps are suggested.

Backflush is a single step inventory process that occurs at the end of the production line. Costs are "flushed" back at the end of the production run and assigned to the goods. This eliminates the detailed tracking of costs throughout the production process, which is a feature of traditional costing systems. This simplifies costing and inventory transactions since it ignores labor variances and work in progress. Backflush accounting is better suited to a just in time philosophy and where the overall cycle time is relatively short and inventory levels are low. Material variances are calculated regularly through physical counts and labor variances are calculated monthly by comparing the labor absorbed at standard cost to the actual payroll expense. (Loucka, 2006)

Table 13: Accounts payable and procurement recommendations

<b>Current State</b>	<b>Desired Future State</b>	<b>Recommendation</b>
<p>“All orders of materials and supplies are documented with a requisition and a purchase order. All materials and supplies received are checked and documented. We perform a 3- way match to ensure the accuracy of invoices prior to payment authorization. High value purchases require senior management authorization. AP is controlled within the finance department”.</p>	<p>“Materials are either paid on receipt when the materials are expensed to the VS, or they are paid for by backflushing when the products are shipped. Most payments are electronic and the AP process is used only for exceptions form the normal process”.</p>	<p>Include vendors in automated payments following suggested steps, therefore eliminating transactions (Maskell &amp; Baggaley &amp; Grasso, 2011)</p>

A study conducted by US Bank shows that many organizations are transforming accounts payable (AP) processes through electronic payments. Electronic payments offer numerous benefits including reduced payment costs, improved cash management, decrease risk of payment fraud, diminished paper from AP department, and increased operational efficiencies. For APR Company, one major obstacle the company faces is supplier’s resistance to accept payment in electronic form.

VS costing, and the methods associated with it, allow to eliminate transactions from the company’s business processes. By making automatic payments, AP processes reduces significantly bringing huge savings of time, effort, money, and it frees up people to do useful, continuous improvement, instead of non-value adding work (Maskell & Baggaley & Grasso, 2011). The most critical step to success is the implementation of the automated AP system. Girling (2015) in the article “6 Steps to Move Your AP to Electronic

Payments...And New Profitability” states the 6 steps for a successful implementation shown in Figure 20.

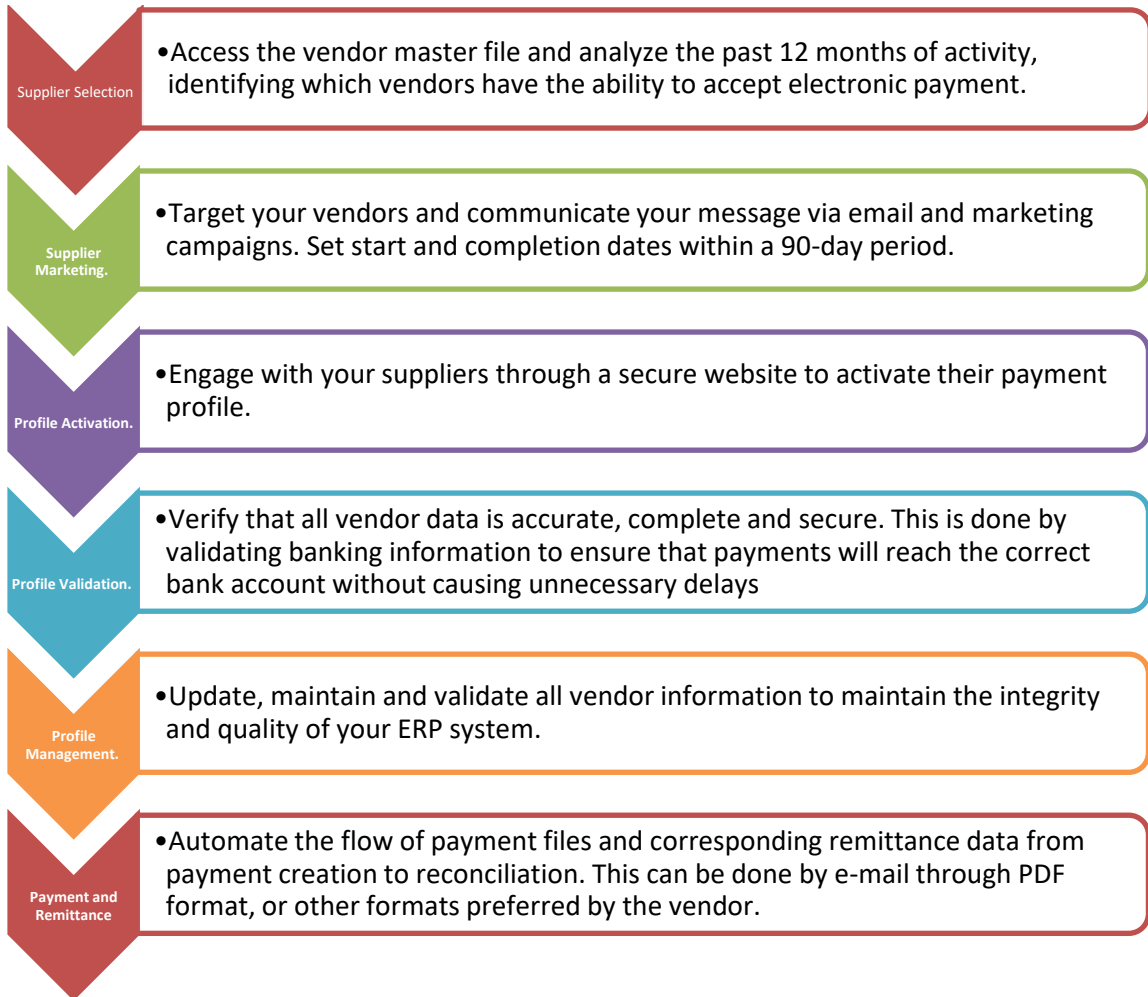


Figure 20: Step-by-step process to onboard vendors for electronic payments, (Girling, 2005)

#### 4.4.11 Accounts Receivable

In the accounts receivable department (Table 14), managers want to simplify processes by shifting from a process with a huge load of transactions to one with minimum transactions and built in controls. Since APR Company already has a Kanban system implemented, this section will focus on the steps necessary to simplify the accounts receivable.

Table 14: Accounts Receivable recommendations

<b>Current State</b>	<b>Desired Future State</b>	<b>Recommendation</b>
<p>“We have greatly simplified our accounts receivable and order fulfillment processes by encouraging blanket sales orders from our key customers and by invoicing directly from shipping”.</p>	<p>“We have made steps toward eliminating the need for invoicing our key customers by encouraging them to pay us upon receipts of the materials. Increasingly we are delivering daily to customers’ production lines based upon Kanban orders”.</p>	<p>Follow suggested six step for transaction elimination (Maskell, Baggaley, Grasso, 2011)</p>

Authors Maskell, Baggaley and Grasso (2011) mention six steps to achieve the goal of eliminating transactions (Figure 21). According to the authors, during the lean pilot phase, it is practical to initiate the first three steps. The use of blanket sales orders requires coordination between the Sales, Order Processing, and Accounts Receivable departments. This step sets the stage for Step 3, Invoicing from the Shipping Department, because the billing information can be taken from the blanket sales order data on file. The authors also state that it is appropriate to begin to encourage customers to pay on receipt of the materials, rather than depending on processing of the invoices. For this, we have to assume that customers are also engaged in the lean manufacturing process and that:

- The customers have selected the company as a key supplier of the commodity in question.
- The company has been selected as a certified supplier.
- The company has agreed to deliver daily to the customers’ production lines based on pull signals.

In return for performing these functions, the customer pays on receipt of the materials, or on their use in production. As more and more customers begin to pay on receipt, the volume of invoices that need to be prepared gets reduced. Accounts receivable can still be



posted on shipment, but no invoice is sent to the customer. The savings in time following up with delinquent customers frees up accounts receivable personnel for other, more value-creating tasks. (Maskell, Baggaley & Grasso, 2011)

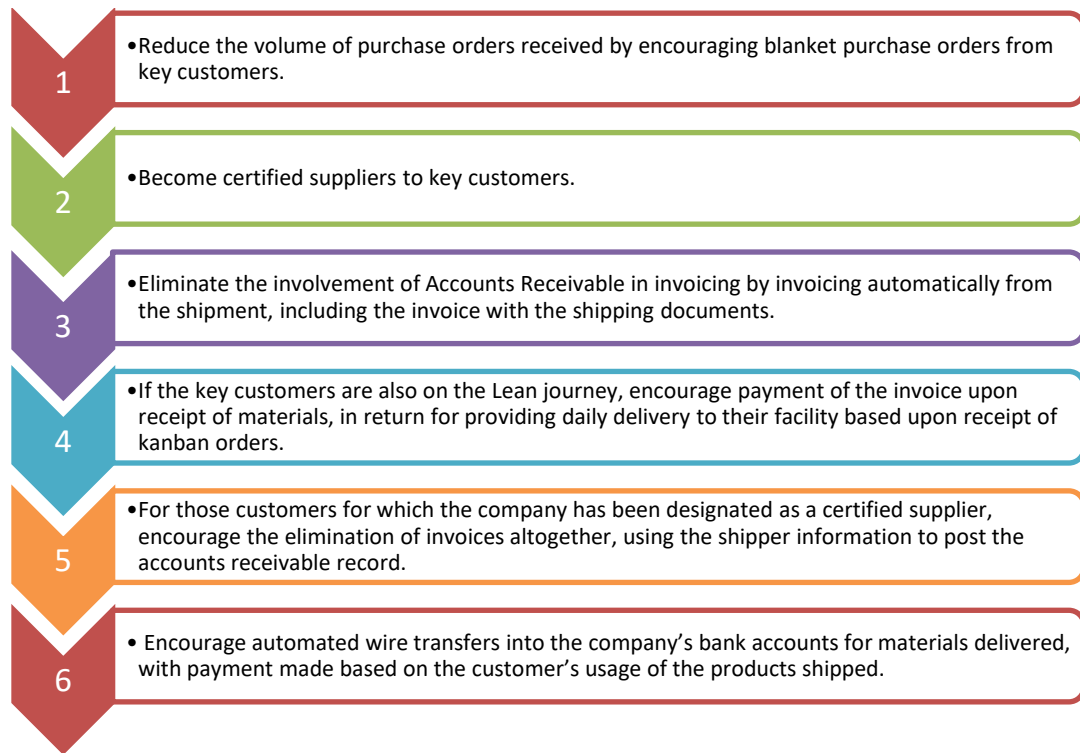


Figure 21: Steps to simplify accounts receivable processes (Maskell, Baggaley, Grasso, 2011)

#### 4.4.12 Authorizations and Sign-offs

In the authorizations and sign-offs subcategory (Table 15), managers want VS managers to be able to authorize transactions and to only require approval from top managers on major capital expenditures. For APR Company, depending on the materiality the finance manager or the material manager needs to approve every order.

Table 15: Authorizations and Sign-offs Recommendation

Current State	Desired Future State	Recommendation
<p>“We require sign offs on all requisitions and purchases of supplies and materials. All transactions and journal entries affecting the financial statements require review and sign-off by an appropriate member of management depending on the size of the transaction. Larger items require multiple levels of approval”.</p>	<p>“We have pushed most of the transaction authority down to the VS managers and have eliminated the requirement for prior approval except on major capital expenditures”.</p>	<p>Answer each question to determine if process needs approval from management. In doing so, it will eliminate the requirement for prior approval (Maskell, Baggaley, Grasso, 2011).</p>

Authors Maskell, Baggaley, and Grasso (2011) suggest asking a series of questions to see where waste can be reduced and transactions can be eliminated. The suggestion for the management of the company is to establish specific actions according to the answers from above questions.

- Why is that report or process or sign-off necessary?
- Does the report provide useable knowledge for making decisions or is it retained because of management familiarity?
- Do we really need to continue requiring that transaction or can we accomplish our goal a simpler way?
- If we eliminate the approval or report, what is the risk of errors for some or for all transactions?
- Do we know of companies that have eliminated these controls? What have been their results?

#### 4.4.13 Month End

In the month end subcategory (Table 16) managers agreed on having automated all month end and quarter end processes. The process of closing the books every month can be very time consuming. Especially if the company has a large number of accounts since these accounts require a lot of analysis to ensure the correct posting of items and therefore, making sure financial statements are classified.

Table 16: Month end recommendations

Current State	Desired Future State	Recommendation
<p>“We have greatly simplified the monthly closing process by standardizing our chart of accounts and cost centers across all operating units. In the process we have eliminated accounts in which the costs are not material to the company as a whole. We have been able to eliminate much of our month end accruals due to the simplification of our AP, AR and inventory processes”.</p>	<p>“We have automated all month-end and quarter end processes, allowing preparation of financial statements without closing the books at any time during the month”.</p>	<p>Simplify month-end closing by automating financial processes and follow the steps to get from traditional account closing to lean (Maskell, Baggaley &amp; Grasso, 2011)</p>

Authors Maskell, Baggaley, and Grasso (2011) show the flow of steps (Figure 22) it takes to change from traditional month end closing to lean. In an automated system, all invoices are automatically stored in a centralized database so it can be easier to reconcile invoices, satisfy vendor requests, and produce management reports on demand (Frazier, 2015).

- Lengthy and late close every month
- Simplify and standardize the month-end process
- Reduce cost centers, simplify the chart of accounts, eliminate the accruals and adjustments
- Move to quarterly closes
- Expand sales & operations planning to provide relevant month-end information ahead of time
- Automate the month-end and quarterly close
- Outsource if necessary

Lean Thinking:

Move from lengthy & wasteful month-end closes to simplified & automated quarterly closes.

Figure 22: The flow of steps from traditional account closing to fully lean (Maskell & Baggaley & Grasso, 2011)

#### 4.4.14 Material Costs

After meeting with APR's top managers, it was agreed that the first of three methods (backflushing the finished products as they are completed or shipped) will be the most convenient. Since the backflushing technique has been explained in section 4.4.10, this section will focus on the steps necessary to track material costs in a lean accounting environment.

Maskell, Baggaley & Grasso (2011) mention 5 steps in order to track material costs in lean accounting:

- Eliminate detailed material tracking
- Automate the assignment of materials through backflushing using standard material costs and actual production
- Keep track of scrap and rework
- Apply material costs directly to the value stream at the time of receipt. There is very little inventory in the plant and the cycle times are so short that they are used as they are received
- Eliminate work orders or other production tracking documents

Table 17: Material costs recommendation

Current State	Desired Future State	Recommendation
<p>“We now have updated and improved the accuracy of our bills of materials so they now accurately reflect the material content in our products at each stage of production. This has allowed us to backflush all material costs through the production process to relieve inventories at each stage”.</p>	<p>“Material costs are tracked in one of three ways. We either backflush the finished products as they are completed or shipped; this together with scrap reporting provides the material costs. Or we expense the materials to the value stream on receipt from the suppliers. Or - if the inventory level is high - we expense the materials to the value stream as they are issued to the shop floor”.</p>	<p>Follow the steps provided in order to track material costs in lean accounting (Maskell &amp; Baggaley &amp; Grasso, 2011).</p>

#### 4.4.15 Labor and Overhead Costs

In the labor and overhead costs subcategory (Table 18), managers agreed on charging labor and overhead costs directly to the VS. Since this was explained in section 4.4.4, this section will briefly describe what labor and overhead costs are.

Manufacturing overhead costs are the expenses a business incurs to manufacture a product that do not fall in the category of direct material, labor, marketing, or administrative categories (Strain, 2016). When value stream costing is introduced, labor and overhead costs must no longer have to be backflushed. The value stream costs are typically collected weekly with little or no allocation of overhead costs (Maskell & Kennedy, 2007).

Table 18: Labor and Overhead Costs

Current State	Desired Future State	Recommendation
<p>“All production costs are tracked and controlled using a job costing system to monitor the amounts of labor used. The actual quantities of labor used are posted to a work order at each operation. We make extensive use of variance reports to monitor the actual labor costs against the standard costs”.</p>	<p>“We charge labor and overhead costs in summary directly to the value stream (VS Costing) instead of applying them directly to production”.</p>	<p>Apply direct labor and overhead cost directly to VS costing (Baggaley, 2008) as suggested in section 4.4.4.</p>

#### 4.4.16 Inventory Tracking

In the inventory tracking recommendation subcategory (Table 19), managers agreed to track less inventory items and to implement Kanban for inventory control purposes. Since the company already has a Kanban system, this section will focus on lean inventory management.

Lean inventory management uses the concepts of lean six sigma to reduce costs and improve quality. Lean inventory management relies on the following five principles (Intrieri, 2015):

- Value- What value will the company get from lean inventory management?
- Flow- How does inventory flow in the production line? If there is not a continuous flow, apply lean techniques to improve flow.
- Pull- Only move inventory when requested by customer by use of Kanban inventory control
- Responsiveness- Being able to adapt to change
- Perfection- Continuously refine inventory management processes to improve quality, efficiency, and cost.

Table 19: Inventory tracking recommendation

Current State	Desired Future State	Recommendation
<p>“We keep detailed track of our inventory--raw materials, work in process and finished goods. We enter transactions for receipts, issues, adjustments, and miscellaneous usage of materials. Every year we do a full physical inventory to help get our stock figures accurate and to satisfy the auditors. Often there are many adjustments to our inventory”.</p>	<p>“We track a lot less items on inventory. Many of our raw material &amp; components are expensed on receipt and no longer tracked as perpetual inventory. We have implemented kanban-style pull control of inventory through-out the value stream. We have eliminated cycle counting because we have good visual controls of inventories in the value stream”.</p>	<p>Use lean inventory principles as a guide on how to manage inventory in the company (Intrieri, 2015).</p>

#### 4.4.17 Rewards and Recognition

In the rewards and recognition subcategory (Table 20), managers agreed on implementing a program that can reward everyone financially for the achievement of lean goals. Currently, APR Company does not have a rewards and recognition program.

In an organization, a rewards and recognition program must be able to measure the effect on behavior, improve results, and deliver both tangible and intangible awards that everyone can earn and enjoy. People should feel good about what they receive and the organization should benefit from a more positive workforce.

Table 20: Rewards and Recognition recommendation

Current State	Desired Future State	Recommendation
<p>“We measure and reward based on achievement of targets established in our annual budget. Our department managers receive salary increases and bonuses based upon meeting and/or exceeding these targets in their departments”.</p>	<p>“We have implemented a gainsharing program to fairly reward everyone financially for the achievement of lean goals”.</p>	<p>Follow the 9 steps to establish a rewards and recognition program.</p>

Author Andrew Matty (2016) recommends establishing a rewards and recognition program using Lean principles. Some of the things included in a lean rewards and recognition program are:

- Improvement Ideas- Create a form that employee can fill out with a problem and their solution.
- Create rules and a review panel- These ideas create process ownership and engagement.
- Project Completion- Celebrate when a project is complete. Share with the organization and post the results.
- Birthdays, anniversaries, etc.- They are non-performance based and ultimately include everyone.

The author recommends simple, low cost or no cost rewards like food, gift cards, giveaways, and branded gear. One final step to tie the rewards and recognition program with lean manufacturing is to have boards that show what is being celebrated, where the company stands on goals, birthdays, anniversaries, and the outline of the program itself. This puts it in front of everyone and assures that leaders are maintaining the program.



#### 4.4.18 Role of finance people

In the role of finance people subcategory (Table 21), managers want to engage finance employees in the value streams.

Table 21: Role of finance people

Current State	Desired Future State	Recommendation
<p>“We have assigned finance people to work on specific value stream assignments. They have become subject matter experts in that area of the business. At least one finance person has been trained in the techniques of statistical quality control”.</p>	<p>“Finance people are fully integrated into the value streams and are integral components of the value stream teams”.</p>	<p>Include finance employees in continuous improvement teams, They will be responsible for monitoring, reviewing, and presenting results from the value stream teams to ensure financial control of the business (Maskell &amp; Baggaley &amp; Grasso, 2011).</p>

Finance members are often part of continuous improvement teams. This team is responsible for the operational improvement, growth, and profitability of the value stream to improve financial and performance measurements. They are responsible for increasing value for customers; eliminate waste within the value stream, increase the amount of money the value stream earns, for monitoring, and reviewing regularly performance measurements to ensure financial control of the business (Maskell & Baggaley & Grasso, 2011).

#### 4.4.19 Budgeting and Planning

In the budgeting and planning subcategory (Table 22), managers want to eliminate department budget and create monthly rolling budgets that include financial and non-financial metrics.

Table 22: Budgeting and planning recommendations

Current State	Desired Future State	Recommendation
<p>“We have extensive and detailed budgeting for every department and cost center, and for every account and sub account. This way we can plan and control our expenditures. We have a formal annual budget development process in which each department manager develops his own budget for approval. Budget vs. actual reports are prepared monthly by department and reviewed in meetings”.</p>	<p>“We have eliminated department budgets. We create monthly (periodic) rolling budgets for each value stream from our Sales, Operations, &amp; Financial Planning process. Our budgeted values include both financial and non-financial performance. We regularly include value stream targets for elimination of waste and for increasing available capacity through the application of lean initiatives”.</p>	<p>Plan a rolling budget for VS following 4 steps in creating a rolling budget (Lettin, 2016)</p>

A rolling budget is continuously updated to add new budget periods as the most recent period is completed (Accounting Tools, 2016). By doing so, the business can always look one year into the future. A rolling budget calls for more management attention since budgeting activities must be repeated every month (Bragg, 2010). Changes that occur within the business can be taken into account and worked in more easily than when using a more traditional budgeting approach.

Although creating a rolling budget does not differ much from a traditional budget (main difference is the time frame), here are the basic 4 steps in creating a rolling budget (Lettin, 2016):

1. **Decide the budget period.** Will the projected budget be every two months? Every quarter? Every 6 months?

2. **Estimate gross profit.** Subtract the cost of goods from total sales. Based on previous years, estimate what sales should be.
3. **Estimate net profit.** Take the estimated gross profit number and subtract from it the day-to-day costs of running business. The more detailed, the more accurate the number will be which will make the budget far more effective.
4. **Perform a review.** At the specified intervals, review the budget and reevaluate. The rolling budget will only stay accurate as long as it is maintained and kept up-to-date.

#### **4.5 Lean Accounting Conceptual Model**

After having explained the recommendations for each nineteen subcategories, the conceptual model for lean accounting at APR Company was developed. Figure 23 shows the conceptual model and it summarizes the recommendations made in each subcategory for a successful transition from standard cost accounting to lean accounting APR Company.

In the category of managing value stream profitability there are two subcategories: Decision making and Customer Value and Target Costing. To be able to reach the desired future state in the subcategory of decision making the company must rely on the Value Engineering Job Plan. In the customer value and target costing, APR Company should implement target costing.

The category of performance measurement has three subcategories. In the subcategory of alignment of company strategy and lean goals the company should follow suggested strategy map and implement suggested lean performance metrics. For performance measures subcategory, the company can implement control charts for measures that improve flow throughout the production line. In the subcategory of empowerment and learning APR Company can develop a scorecard with financial and non-financial performance measurements.

The VS Costing category has two subcategories. In the product costing subcategory, the company can implement target costing, features and characteristic costing and VS reporting to report product costs. In the VS organization category, the company can host continuous improvement events and report by using lean financial statements.

The eliminating transactions category has seven subcategories. In the accounts payable and procurement subcategory, the company can switch from manual to automated payments. In the accounts receivable subcategory, the company can simplify processes by following suggested steps. In the authorizations and sign offs subcategory, the company can answer suggested questions to see if a top manager sign-off is necessary. In the month end subcategory the company can automate financial processes, therefore reducing transactions. In the material costs subcategory, the costs of materials should be backflushed. In the labor and overhead costs subcategory, the company should report costs by using VS costing. In the inventory tracking, the company should follow lean inventory management principles.

The measuring financial benefits category has two subcategories. In the continuous improvement subcategory, the company can use visual representations boards across the company including a box score. In the financial benefits of lean changes, the company can use suggested strategic decision box score.

The VS Management has three subcategories. In the rewards and recognition subcategory, the company can follow suggested plans and implement a rewards and recognition program. In the subcategory of role of finance people, finance managers can be involved in continuous improvement teams and report, monitor, and review VS costs. In the budgeting and planning subcategory, the company can switch to rolling budgets.

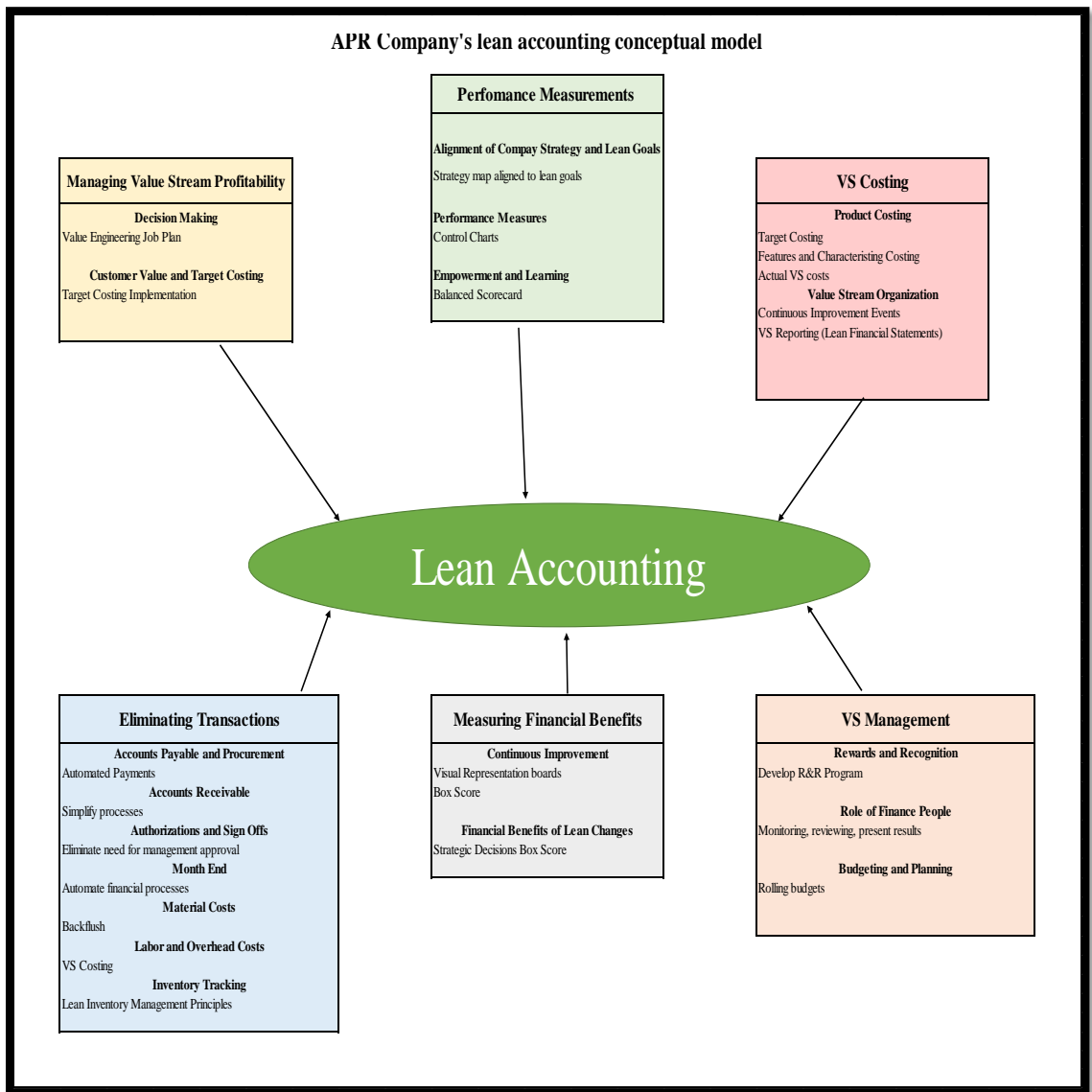


Figure 23: APR Company's lean accounting conceptual model

## 4.6 Summary

This chapter presented the results and recommendations. These were suggested according to what managers answered in the lean accounting diagnostic questionnaire. The chapter included suggestions supported by literature about what the company must do to reach the desired future state. The following chapter will present the project conclusion along with limitations and recommendations for future projects.

## **5. CONCLUSION**

### **5.1 Introduction**

This chapter presents the conclusions of this project based on the lean accounting conceptual model developed for the company under study. The chapter ends with recommendations for future studies at the same company, and limitations encountered during the development of the project.

### **5.2 Conclusion**

This project consisted of developing a lean accounting conceptual model for a biomedical sensors assembly line. The production line under study currently follows lean methodology but the financial reporting is still under standard cost accounting. After thorough literature research, a conceptual model was developed specifically for the company. This conceptual model was based on answers given by management after completing a lean accounting diagnostic questionnaire and literature review. The conceptual model summarizes the steps the company must follow to make the conversion from standard cost accounting to lean accounting.

With the implementation of lean accounting the company will have financial information presented as simple direct costs, profitability will be in terms of the VS, and costs will be shown clearly where and when they are expended. Lean accounting makes waste visible at all levels, and drives the company in the pursuit of perfection. If the company decides to implement lean accounting, it should follow recommendations and conceptual model explained in chapter 4. It is also important to note that for a successful implementation, not only operational and financial processes need to change, but also it is important to train employees in lean concepts.

### **5.3 Project Limitations**

This project has various limitations. First, the operational, financial, and information system capabilities to be able to support suggested recommendations were not

taken into consideration. Another limitation was the supplier's and customer's ability to adapt to lean processes.

#### **5.4 Recommendations for future projects**

This project presented a lean accounting conceptual model specifically designed for the biomedical sensor production line in the company under study. To be able to implement suggested recommendations management will have to allocate appropriate resources including financial resources, pursue changes in information systems, and train personnel including management itself in concepts related to lean manufacturing and lean thinking.

Also, this project did not consider implementation of suggestions as part of the scope. An opportunity for future projects is to continue this investigation to see if suggestions can be implemented.

Despite the many lean accounting articles and books that say that standard costing and variance analysis will be eliminated in mature lean manufacturing companies, field reports suggest that many companies are retaining standard cost accounting (Manjunat & Bargerstock, 2011). Another recommendation for futures projects is to analyze whether lean accounting will benefit the company under study.

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## **APPENDIX**



# Lean Accounting

*Diagnostic Questionnaire of  
Accounting, Control, & Measurement Capability*

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## ***ACCOUNTING, CONTROL AND MEASUREMENT QUESTIONNAIRE***

The purpose of this questionnaire is to help the company assess where the accounting and measurement methods stand with regard to their support of the company's transition to a lean environment.

There are six major categories:

- Performance Measurement
- Value Stream Costing
- Measuring Financial Benefits
- Managing Value Stream Profitability
- Eliminating Transactions
- Value Stream Management

*ACCOUNTING, CONTROL AND MEASUREMENT QUESTIONNAIRE***INSTRUCTIONS**

i. Read all four statements carefully--the left hand statement defines 1-2 on the scale; the second statement covers the 3-4 range on the scale, the third covers 5-6 and the right hand statement 7-8 on the scale. Please note: the statements and the numerical ratings do not precisely align. Some judgment is needed.

ii. Honestly evaluate the present position of your organization in terms of the four statements by marking an **X** ( one of 1, 2, 3, 4, 5, 6, 7, 8) over the number which best represents your present position.

If you are using a computer, change the number you choose to **X** in the "Current" row.

If you are doing this analysis manually, write the number that corresponds to your choice under "Current" at the right.

iii. Decide where you would like your organization realistically to be in the foreseeable future by marking an **O** on the scale (one of 1, 2, 3, 4, 5, 6, 7,8). This goal should be challenging yet realistic.

If you are using a computer, change the number you choose to **O** in the "Future" row.

If you are doing this analysis manually, write the number that corresponds to your choice under "Future" at the right.

To illustrate this and the previous point, the following diagram shows a typical and valid response:

<b>Current</b>	1	<b>X</b>	3	4	5	6	7	8
<b>Future</b>	1	2	3	4	5	<b>O</b>	7	8



<b>CATEGORY: Performance Measurement</b>									
<b>Subcategory/ Goal</b>	<b>Traditional</b>		<b>Developing a Framework</b>		<b>Managing by Value Stream</b>		<b>Lean Business Management</b>		
<p><b>Alignment of Company Strategy and Lean Goals</b></p> <p>Shift from efficiency based goals and measures to goals and measures tied to lean</p>	<p>The company goals are primarily financial. These financial goals are developed in detail by department in the annual budget, with a focus on meeting the budget line-item cost goals. Lean is viewed as a manufacturing program. The lean goals of flow, pull, perfection and value creation are not reflected in the goals and measurement systems</p>		<p>We have aligned our performance measures to company strategy and lean goals and have eliminated all unnecessary measures and meetings to discuss the measures.</p>		<p>We have introduced driver-based performance measurements throughout all value streams. We have linked the performance to the development of continuous improvement targets for both cost and performance.</p>		<p>We are using statistical method such as "Design of Experiments" to understand the factors that cause variability in value stream results and to quantify the risks inherent in our business.</p>		<p>Current</p>
									Future
<b>Current</b>	1	2	3	4	5	6	7	8	
<b>Future</b>	1	2	3	4	5	6	7	8	
<p><b>Performance Measures</b></p> <p>Shift from historical results-based measures to predictive, causal based measures</p>	<p>The company's primary performance measurement is done by the accounting department. We make extensive use of variance analysis, financial ratios, and other financially based measures. We are very concerned about productivity and use measures like direct labor productivity and equipment utilization. We report these measures monthly.</p>		<p>We have introduced lean performance measurements into the production cells. These measures are focused on the production of the cell on a day-by-the -hour basis to ensure that the cell manufactures to its TAKT. Goals and targets for the cell are established both in financial and non financial terms related to our lean strategies and objectives</p>		<p>We have introduced value stream-level and corporate level measures all linked to our strategies and goals for lean and integrated with the cell-level measures. Our continuous improvement teams use the value stream measures to drive their continuous improvement efforts.</p>		<p>We have incorporated statistical analysis into our performance measurement process. We regularly establish control limits for all measures and establish our targets to meet our Six Sigma objectives. In so doing we have significantly reduced the variability of the value stream and cell outputs.</p>		<p>Current</p>
									Future
<b>Current</b>	1	3	3	4	5	6	7	8	
<b>Future</b>	1	2	3	4	5	6	7	8	

<b>CATEGORY: Performance Measurement</b>									
<b>Subcategory/ Goal</b>	<b>Traditional</b>		<b>Developing a Framework</b>		<b>Managing by Value Stream</b>		<b>Lean Business Management</b>		
<b>Empowerment and Learning</b>  Shift from the use of performance measures as an evaluative tool to one that empowers employees for continuous learning and improvement	We use performance measurement to measure the impact of departments and individual in contributing to company profitability. Our system is based around our annual budgets, and rewards and recognition are focused toward meeting the cost targets in thus budgets.		We have educated management and the work force on the use of performance measurement in a lean environment		We support continuous improvement with financial and non-financial performance measurements that drive improvement and continuous learning		We use value stream cost management pro-actively to create and deploy available capacity		
<b>Current</b>	1	2	3	4	5	6	7	8	
<b>Future</b>	1	2	3	4	5	6	7	8	

<b>CATEGORY: Value Stream Costing</b>									
<b>Subcategory/ Goal</b>	<b>Traditional</b>		<b>Developing a Framework</b>		<b>Managing by Value Stream</b>		<b>Lean Business Management</b>		
<b>Value Stream Organization</b>  Shift from organizing by functional department to organizing by value stream	The company is organized by functional department and reporting of performance is based on this organization structure.		We have clearly identified all value streams, including the organizational units, functions, and accounting information to be included. We have assigned value stream managers, who have current and future state value stream maps that are used to guide business change, and we have value stream performance measurement boards in place.		We manage the business by value streams. Almost everyone is assigned (either directly or as a matrix) to a specific value stream. There is considerable cross-training so that all tasks can be performed by value stream people. There are some remaining <i>business sustaining</i> departments that do non-value stream work. We report all costs and performance information by value stream.		We have either reorganized the company along value stream lines and have largely eliminated functional departments, or we have established an effective matrix organization providing clear value stream management. Value stream managers are key to our operations and our lean improvement.		Current
									Future
	<b>Current</b>	1	2	3	4	5	6	7	8
	<b>Future</b>	1	2	3	4	5	6	7	8
<b>Product Costing</b>  Shift from allocation of overheads to product costs to summary direct costs using features and characteristics	We calculate product costs individually by exploding the material and labor costs from the bills of materials and routings, and by applying overheads. We allocate overhead costs to products using overhead rates based upon production labor hours. We calculate standard costs for each item and report variances against actuals.		We still use the standard costs for financial reporting and inventory valuation. But we have create Value Stream Cost reporting (summary direct costing of the value stream) and use this information for value stream management and decision-making.		We have eliminated standard costing. We cost the value stream not the products. Value stream costing is used for financial reporting. Value stream costs are reported weekly using the visual Box Score on the Value Stream Performance Board. Business sustaining costs and other external costs are no longer allocated to value streams or products.		Value stream costing (summary direct costing of the value stream) is widely used. When the cost of individual products are required we use <i>features &amp; characteristics</i> costing. There is wide use of Target Costing to establish the <i>customer value</i> and <i>target cost</i> of the products. These, together with the average actual value stream product costs are powerful drivers of improvement for the value stream continuous improvement team.		Current
									Future
	<b>Current</b>	1	2	3	4	5	6	7	8
	<b>Future</b>	1	2	3	4	5	6	7	8

<b>CATEGORY: Measuring Financial Benefits</b>									
<b>Subcategory/ Goal</b>	<b>Traditional</b>		<b>Developing a Framework</b>		<b>Managing by Value Stream</b>		<b>Lean Business Management</b>		
<p><i>Continuous Improvement</i></p> <p>Shift from hiding waste in financial statements and standard costs to making disclosure of the cost and drivers of waste a primary goal to support continuous improvement</p>	The financial reports are organized by resource line item and reflect waste through the cost of these items versus budget. Budgets and standards are based on historical performance and frequently include reserves for waste and inefficiency		We have established value stream continuous improvement teams. These teams use the value stream costing and value stream performance measurement information to drive their improvement efforts. We have developed a suggestion program to identify and implement many small improvements.		Continuous improvement is now routine within the value stream. We have a well-developed <i>value stream cost analysis</i> model that shows how capacity is used and how the costs flow through the value stream. The value stream continuous improvement team uses the performance measurements, the value stream cost information, and the Box Score to drive their improvement work.		Continuous improvement is now a way-of-life within the organization. Almost everybody is actively involved in week-by-week continuous improvement projects. We have an on-going process of visually reporting waste elimination, performance improvement and cost impacts, freed up capacity and achievements against lean targets. These are posted on the VS Tracking Board.		<i>Current</i>
									<i>Future</i>
<b>Current</b>	1	2	3	4	5	6	7	8	
<b>Future</b>	1	2	3	4	5	6	7	8	
<p><i>Financial Benefits of Lean Changes</i></p> <p>Shift from assessing the benefits of lean changes based upon cost reduction and efficiency to evaluating the extent to which capacity freed up by lean is put to productive uses</p>	Lean is generally viewed as a manufacturing program to increase efficiency and reduce cost. Consequently the success of lean is evaluated by the extent to which cost reduction is achieved. Frequently there is disappointment with results achieved because cost have not been reduced.		We calculate the benefits of lean improvement projects using the information provide in the current and future state value stream maps. We use this information to evaluate how the freed up resources and improved working capital can be deployed.		We regularly monitor the achievement of actual benefits of lean changes. As we identify the potential for eliminating waste and making capacity available, we create strategies for the profitable use of this capacity.		We use the financial benefits information related to freed up resource capacity in our Sales, Operations, & Financial Planning to drive business strategy		<i>Current</i>
									<i>Future</i>
<b>Current</b>	1	2	3	4	5	6	7	8	
<b>Future</b>	1	2	3	4	5	6	7	8	

<b>CATEGORY: Managing Value Stream Profitability</b>									
<b>Subcategory/ Goal</b>	<b>Traditional</b>		<b>Developing a Framework</b>		<b>Managing by Value Stream</b>		<b>Lean Business Management</b>		
<b>Decision Making</b>  Shift from evaluating key decisions by looking at product line profitability using standard costs to evaluating the impact of the decision on value stream profitability, focusing on the true costs of the value stream.	The costing system supports the calculation of the values of inventory and cost of sales of the products sold. As such we rely on this data to provide accurate pictures of the profitability of the products sold. We use this data extensively in setting product prices and in evaluating the performance of operating units.		We have established Value Stream Costing (summary direct costing of the value stream). We have also developed a Value Stream Cost analysis to understand the current state costs of the use of productive, non productive and available capacity. As part of this analysis we have identified the costs of waste for each product family. We use this information for making key decisions.		All routine decisions are made using lean decision-making methods based upon value stream cost information. These include profitability of orders or quotes, make/buy, new product introductions, product rationalizations, etc. Standard costs are never used for these kinds of decisions. We have a <i>capital acquisition</i> process that supports lean thinking.		We use value stream profitability & cash flow for all key decisions. We use value stream cost analysis and Box Scores to assess strategic decisions. We use product features and characteristics to link customer needs to product features. We use target costs to determine allowable costs and we use value engineering to evaluate the trade-offs of cost, quality, and function during the design stage and on-going production.		
	<b>Current</b>	1	2	3	4	5	6	7	8
	<b>Future</b>	1	2	3	4	5	6	7	8
<b>Customer Value and Target Costing</b>  Shift from product management to the management of customer value as the driver of business strategy	Cost are determined from internal standard cost information and are not related to customer value. Profitability margins are calculated from sales prices and standard costs.		We have provided education to everyone with regard to the definition of customer value and how we intend to provide it. Our Sales & Marketing people have a good understanding of lean thinking and the importance of customer value. They have begun to gather <i>voice of the customer</i> data.		We regularly use cross-functional, value stream Target Costing. We have developed target costs for each value stream, product family, and customer group. We use target costs to set allowable product family costs and costs of product features. All new products or major product line changes go through target costing.		We use target costs and value engineering cooperatively with suppliers and partners. We provide measurements beyond the goals of lean as incentives for employees, suppliers and partners experiment, innovate and customize our product offerings to fulfill customer needs		
	<b>Current</b>	1	2	3	4	5	6	7	8
	<b>Future</b>	1	2	3	4	5	6	7	8

<b>CATEGORY: Eliminating Transactions</b>									
<b>Subcategory/ Goal</b>	<b>Traditional</b>		<b>Developing a Framework</b>		<b>Managing by Value Stream</b>		<b>Lean Business Management</b>		
<b>Accounts Payable &amp; Procurement</b>  Shift from high volume and procedurally complex processes to minimum transactions with built in controls	All orders of materials and supplies are documented with a requisition and a purchase order. All materials and supplies received are checked and documented. We perform a 3-way match to ensure the accuracy of invoices prior to payment authorization. High value purchases require senior management authorization. AP is controlled within the finance department.		We have made great strides in simplifying accounts payable. AP credit cards are widely in use for all small purchases, eliminating most of our P.O.s and invoices. We have issued blanket purchase orders for key materials and have started to identify and certify strategic suppliers. We have begun to voucher for payment on receipt of materials.		Most of our key suppliers deliver directly based on kanban pull from the line or vendor managed inventory. Suppliers deliver frequently (daily or twice weekly) and are vouchered on receipt without the need for a PO or PO release. We have largely eliminated the three way match in accounts payable for materials & supplies. Most materials are expensed to the value stream on receipt or on issue to the shop floor.		Materials are either paid on receipt when the materials are expensed to the value stream, or they are paid for by backflushing when the products are shipped. Most payments are electronic and the AP process is used only for exceptions from the normal process.		<b>Current</b>
									<b>Future</b>
	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>	<b>7</b>	<b>8</b>	
<b>Current Future</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>	<b>7</b>	<b>8</b>	
<b>Accounts Receivable</b>  Shift from high volume and procedurally complex processes to minimum transactions with built in controls	We mail order acknowledgments to customers on receipt of a purchase order. We mail invoices to the customer each time we ship a product. We collect cash from late paying customer by phone calls and collection agencies.		We have greatly simplified our accounts receivable and order fulfillment processes by encouraging blanket sales orders from our key customers and by invoicing directly from shipping.		We have made steps toward eliminating the need for invoicing our key customers by encouraging them to pay us upon receipts of the materials. Increasingly we are delivering daily to customers' production lines based upon kanban orders.		We have eliminated all regular accounts receivable processes. Customers wire payments into our bank accounts for materials delivered based upon their usage in products shipped to their customers.		<b>Current</b>
									<b>Future</b>
	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>	<b>7</b>	<b>8</b>	
<b>Current Future</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>	<b>7</b>	<b>8</b>	



<b>CATEGORY: Eliminating Transactions</b>									
<b>Subcategory/ Goal</b>	<b>Traditional</b>		<b>Developing a Framework</b>		<b>Managing by Value Stream</b>		<b>Lean Business Management</b>		
<b>Authorizations and Sign offs</b>  Shift from requiring signoffs and reviews to authorize transactions to building controls into the process itself	We require sign offs on all requisitions and purchases of supplies and materials. All transactions and journal entries affecting the financial statements require review and sign-off by an appropriate member of management depending on the size of the transaction. Larger items require multiple levels of approval.		We have pushed the authority for making expenditures down in the organization and have strengthened the budgetary accountability of departmental managers. Consequently we have been able to eliminate most of the multiple approvals required. For recurring transactions we have established arrangements with suppliers, thereby providing blanket authorization.		We have pushed most of the transaction authority down to the value stream managers and have eliminated the requirement for prior approval except on major capital expenditures.		We have pushed most of the transaction authority down to the value stream managers and have eliminated the requirement for prior approval except on major capital expenditures.		Current
									Future
	<b>Current</b>	1	2	3	4	5	6	7	8
	<b>Future</b>	1	2	3	4	5	6	7	8
<b>Month End</b>  Shift from monthly closings of the books requiring multiple accruals and adjustments to automated quarterly closings requiring few accruals and adjustments	Each operating entity is required to prepare a full package of month-end reports for submission to corporate accounting. Preparing the package is complex and cumbersome. We often do not have the financial reports complete until 2 to 3 weeks into the next month.		We have greatly simplified the monthly closing process by standardizing our chart of accounts and cost centers across all operating units. In the process we have eliminated accounts in which the costs are not material to the company as a whole. We have been able to eliminate much of our month-end accruals due to the simplification of our AP, AR and inventory processes.		We are now closing the books on a quarterly basis due to increased operating controls implemented through lean and the greatly reduced inventory levels. We have adopted enhanced balance sheet and P&L planning through our Sales, Operations, & Financial Planning process. We have reliable month-end financial information ahead of the month-end.		We have automated all month-end and quarter-end processes, allowing preparation of financial statements without closing the books at any time during the month.		Current
									Future
	<b>Current</b>	1	2	3	4	5	6	7	8
	<b>Future</b>	1	2	3	4	5	6	7	8

**CATEGORY: Eliminating Transactions**

<b>Subcategory/ Goal</b>	<b>Traditional</b>		<b>Developing a Framework</b>		<b>Managing by Value Stream</b>		<b>Lean Business Management</b>	
<p><i>Material Costs</i></p> <p>Shift from multiple postings of materials to accumulate product costs to a simple accrual of value stream material costs</p>	<p>All production costs are tracked and controlled using a job costing system to monitor the amounts of materials used. The actual quantities of materials used are posted to a work order at each operation. We make extensive use of variance reports to monitor the actual material costs against the standard costs .</p>		<p>We now have updated and improved the accuracy of our bills of materials so they now accurately reflect the material content in our products at each stage of production. This has allowed us to backflush all material costs through the production process to relieve inventories at each stage</p>		<p>Material costs are tracked in one of three ways. We either backflush the finished products as they are completed or shipped; this together with scrap reporting provides the material costs. Or we expense the materials to the value stream on receipt from the suppliers. Or - if the inventory level is high - we expense the materials to the value stream as they are issued to the shop floor.</p>		<p>We expense the costs of material directly to the value stream at the time of purchase. There is very little inventory in the plant and the cycle times are so short that materials are used as they are purchased.</p>	
<b>Current</b>	1	2	3	4	5	6	7	8
<b>Future</b>	1	2	3	4	5	6	7	8
<p><i>Labor and Overhead Costs</i></p> <p>Shift from multiple postings of labor to recording labor and overhead directly to cost of sales as incurred</p>	<p>All production costs are tracked and controlled using a job costing system to monitor the amounts of labor used. The actual quantities of labor used are posted to a work order at each operation. We make extensive use of variance reports to monitor the actual labor costs against the standard costs .</p>		<p>We have eliminated detailed labor tracking and job-step tracking. The updated and improved accuracy of our routings allows us to automate the assignment of labor through backflushing using our standard labor costs and actual production. We have eliminated the detailed reporting of labor and overhead variances in our costing reports.</p>		<p>We charge labor and overhead costs in summary directly to the value stream (Value Stream Costing) instead of applying them directly to production.</p>		<p>We charge labor and overhead costs in summary directly to the value stream (Value Stream Costing) instead of applying them directly to production.</p>	
<b>Current</b>	1	2	3	4	5	6	7	8
<b>Future</b>	1	2	3	4	5	6	7	8

Current

Future

Current

Future

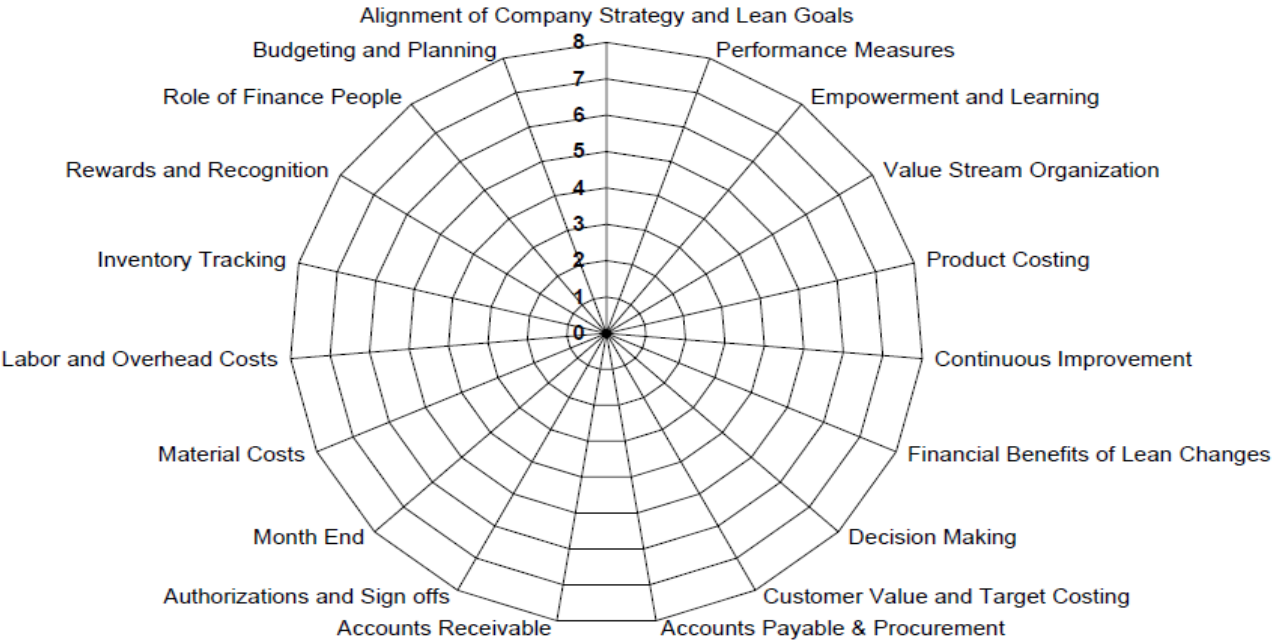
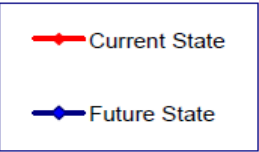


<b>CATEGORY: Eliminating Transactions</b>									
<b>Subcategory/ Goal</b>	<b>Traditional</b>		<b>Developing a Framework</b>		<b>Managing by Value Stream</b>		<b>Lean Business Management</b>		
<p><i>Inventory Tracking</i></p> <p>Eliminate all tracking of inventory through the production process</p>	<p>We keep detailed track of our inventory--raw materials, work in process and finished goods. We enter transactions for receipts, issues, adjustments, and miscellaneous usage of materials. Every year we do a full physical inventory to help get our stock figures accurate and to satisfy the auditors. Often there are many adjustments to our inventory.</p>		<p>We have replaced the annual physical inventory with cycle counting. We use the cycle counting as a way to discover the root causes of the errors created in the inventory balances in addition to maintaining the accuracy of the balances themselves. In this way we are gradually eliminating the error creating problem in our processes.</p>		<p>We track a lot less items on inventory. Many of our raw material components are expensed on receipt and no longer tracked as perpetual inventory. We have implemented kanban-style pull control of inventory through-out the value stream. We have eliminated cycle counting because we have good visual controls of inventories in the value stream.</p>		<p>We have largely eliminated inventory tracking from our computer system.</p>		<p>Current</p>
									Future
<b>Current</b>	1	2	3	4	5	6	7	8	
<b>Future</b>	1	2	3	4	5	6	7	8	

<b>CATEGORY: Value Stream Management</b>									
<b>Subcategory/ Goal</b>	<b>Traditional</b>		<b>Developing a Framework</b>		<b>Managing by Value Stream</b>		<b>Lean Business Management</b>		
<b>Rewards and Recognition</b>  Shift from performance incentives based on cost reduction to delivery of value	We measure and reward based on achievement of targets established in our annual budget. Our department managers receive salary increases and bonuses based upon meeting and/or exceeding these targets in their departments		We have aligned business and personal goals for delivering value and have eliminated the incentives that are opposed to lean thinking		We use team-based incentives (based upon financial and non-financial measurements) for achievement of value stream goals and targets		We have implemented a gainsharing program to fairly reward everyone financially for the achievement of lean goals		
<b>Current</b>	1	2	3	4	5	6	7	8	
<b>Future</b>	1	2	3	4	5	6	7	8	
<b>Role of Finance People</b>  Shift the role of finance from detached evaluators of the lean results to integral members of the value stream teams	The role of the accounting function is to ensure the maintenance of internal controls and the accuracy of information presented in the financial statements. Consequently our accountants analyze financial information and they do not get involved in operational projects other than to provide financial information.		We have assigned finance people to work on specific value stream assignments. They have become experts in that area of the business. At least one finance person has been trained in the techniques of statistical quality control.		All finance activities and reporting have been aligned by value stream. Finance people have moved physically and organizationally in the value streams as team members. They play a significant role as change agents for value stream improvement and innovation.		Finance people are fully integrated into the value streams and are integral components of the value stream teams.		
<b>Current</b>	1	2	3	4	5	6	7	8	
<b>Future</b>	1	2	3	4	5	6	7	8	

<b>CATEGORY: Value Stream Management</b>								
<b>Subcategory/ Goal</b>	<b>Traditional</b>		<b>Developing a Framework</b>		<b>Managing by Value Stream</b>		<b>Lean Business Management</b>	
<p><b>Budgeting and Planning</b></p> <p>Shift from managing by departmental budgets to managing by value stream, driven by the sales and operations planning process</p>	<p>We have extensive and detailed budgeting for every department and cost center, and for every account and sub-account. This way we can plan and control our expenditures. We have a formal annual budget development process in which each department manager develops his own budget for approval. Budget vs. actual reports are prepared monthly by department and reviewed in meetings.</p>		<p>We have greatly simplified the annual budgeting process by eliminating most cost centers and accounting codes from the items that need to be budgeted. We have begun to implement a formal Sales, Operations, &amp; Financial Planning process each month, and we plan by value stream.</p>		<p>We have eliminated department budgets. We create monthly (periodic) rolling budgets for each value stream from our Sales, Operations, &amp; Financial Planning process. Our budgeted values include both financial and non-financial performance. We regularly include value stream targets for elimination of waste and for increasing available capacity through the application of lean initiatives.</p>		<p>The company is managed by value streams both operationally and financially. The monthly rolling budgets are key to the on-going continuous improvement of the value streams and the overall business.</p>	
								<b>Current</b>
								<b>Future</b>
<b>Current</b>	1	2	3	4	5	6	7	8
<b>Future</b>	1	2	3	4	5	6	7	8

# Lean Accounting Diagnostic



## **Appendix B: Steps to develop APR Company Strategy Map (Armitage & Scholey, 2006)**

### **Step 1: Specify an overriding objective:**

This first step links the strategy map with the organization's mission and vision. This step must differentiate between what the organization truly understands as its overriding objective, and the strategies it plans to implement. The objective should have financial impact and a time dimension. Many mission and vision statements are often mistakenly portrayed as the ultimate objective to be achieved — satisfied customers, service excellence, best-in-field, market leader, low-cost provider, etc are all ingredients for success. Success is achieved by significant revenues and/or cost containment that lead to superior economic returns (the overriding objective). It is important to note that for profit making organizations, the overriding objective must be economic.

For APR Company, the suggested overriding objective is to reduce costs by 3% over the next year by implementing lean accounting. As the literature suggests, this objective has both a financial impact and a time dimension.

### **Step 2: Choose the value proposition**

The question to ask in this step is “What do (or will) the customers value?” Many companies that try to do everything ultimately achieves nothing, or very little. To lead the market, companies need to segment the market in new and unconventional ways based on current and expected customer perceptions of value. The idea behind the value proposition is to choose one and provide excellent customer value in it so that it will help lead the market. For M.Treacy and F.Wiersema, in their book “The Discipline of Market Leaders: Choose Your Customers, Narrow Your Focus, Dominate Your Market”, (1995), there are three value propositions that provide a framework for competing in today's market.

- Operational Excellence
- Product leadership
- Customer intimacy

Based on the company's vision statement: "To create technologies that enhance the performance of our customer's products", and after consulting with top management, it was agreed that for APR, the value proposition should be product leadership.

### **Step 3: Choose the financial strategies**

After carefully selecting the value proposition, companies must next plan the strategies involving revenue and costs. These strategies are categorized in three areas:

- **Revenue Growth:** for those organizations following product leadership (as is the case with APR), the revenue growth comes from pricing of their cutting edge innovative products. Revenue growth is the main focus for companies focusing on product leadership, some of the strategies that can be used to grow revenues are:
  - Analyze growth and penetration potential (right now APR Company only has one customer)
  - Spend in R&D to continue developing innovative products (expecting returns on these investments through higher revenues)
- **Productivity:** to be profitable, product leaders need to strike a balance and not put all their effort in productivity.
  - Train employees in productivity strategies
  - Create a program of rewards and recognition to motivate employees
- **Asset Utilization:** Although not the primary focus for companies pursuing product leadership strategy, this refers to getting the most return out of these investments (machinery, buildings, etc).
  - Minimize set up times
  - Take into consideration fixed assets turnover (how able is a company to generate sales from fixed assets investments)

### **Step 4: Choose the customer strategies**

After having established the financial strategies, the next step would be to formalize the established plans to be able to win the marketplace. These are 3 major customer strategies along with the recommended strategies for APR Company:

- Retaining and adding customers
  - By having the latest technologies and new features
- Increase revenue per customer
  - Adding new features to products
- Reduce costs per customer
  - Spending at cost control policies as necessary in pursuit of product leadership (i.e. introducing Lean 6 Sigma as a cost reduction program)

Although organizations must pay attention to each of these strategies, the value proposition will dictate where the firm will put all its effort. For product leaders, the main focus is to offer the latest technologies and features to increase customer volume and revenue. These customer strategies must be closely related to the value proposition that can ultimately lead to revenue growth and the achievement of the overriding objective.

#### **Step 5: Execute through the internal perspective strategies**

After having established financial and customer strategies, organization must next establish the actions and steps that will be taken to realize the plans and strategies to win the marketplace. The main focus here is “What we want to accomplish” and “How are we going to accomplish it”. It’s all about choosing and executing the correct business processes to achieve the desired customer and financial strategies that will lead to achieve the overriding objective. For those organizations pursuing product leadership, the main focus should be on processes that motivate, identify, and develop product innovation since the value proposition is to bring cutting-edge technologies. In this step, the processes to excel at are:

- Internal Operations
  - Eliminate non-value adding activities, reducing costs (Six Sigma)

- Innovation
  - Internal processes that motivate the development of new ideas through R&D (this should be the main focus for product leadership companies).
- Customer Management
  - Develop a database of customer knowledge and build strong relationships, processes for providing convenient order handling, and offering solution portfolios to customers (to enhance the performance of customer's products).

### **Step 6: Plan the learning and growth strategies**

It is important that after having established financial and customer objectives, there are some knowledge and skills needed to be able to execute the chosen strategy. In this final step, the objective is to develop the appropriate learning and growth strategies. Learning and growth can be classified in three areas:

- Human capital
  - Attracting and retaining the right type of skills (through Human Resources talent acquisition), and providing the appropriate coaching, mentoring, and opportunities for developing the “know-how” necessary to execute specific strategies (Kaizen, Lean 6 Sigma Training)
- Information Capital
  - The use of information systems, databases for R&D to continue creating innovative products and gain competitive advantage and to execute the strategy.
- Organization Capital
  - Ability to connect employee goals to corporate goals. Train employees through a high organizational culture to make sure employees goals are aligned with the company's (create and promote).



## Appendix C: SAVE Job Plan

### The Value Standard

The value methodology is a systematic process that follows the Job Plan. A value methodology is applied by a multidisciplinary team to improve the value of a project through the analysis of functions.

**The Job Plan consists of the following sequential phases. (See Figure 1, page 13):**

1. **Information Phase**  
The team reviews and defines the current conditions of the project and identifies the goals of the study.
2. **Function Analysis Phase**  
The team defines the project functions using a two-word active verb/ measurable noun context. The team reviews and analyzes these functions to determine which need improvement, elimination, or creation to meet the project's goals.
3. **Creative Phase**  
The team employs creative techniques to identify other ways to perform the project's function(s).
4. **Evaluation Phase**  
The team follows a structured evaluation process to select those ideas that offer the potential for value improvement while delivering the project's function(s) and considering performance requirements and resource limits.
5. **Development Phase**  
The team develops the selected ideas into alternatives (or proposals) with a sufficient level of documentation to allow decision makers to determine if the alternative should be implemented.
6. **Presentation Phase**  
The team leader develops a report and/or presentation that documents and conveys the adequacy of the alternative(s) developed by the team

and the associated value improvement opportunity.

**In order to qualify as a Value Study, the following conditions must be satisfied.**

- A. The Value Study Team follows an organized **Job Plan** that includes, at a minimum, the six phases identified in this standard. **Function Analysis**, as defined in this document, is performed on the project.
- B. The Value Study Team is a **multidisciplinary group** of experienced professionals and project stakeholders. Team members are chosen based on their expertise and experience with the project. Sometimes individuals who have relevant expertise; but are not directly involved with the project are added to provide a different point of view.
- C. The **Value Team Leader** is trained in value methodology techniques and is qualified to lead a study team using the Job Plan. The SAVE International Certification Board certifies, with the designation Certified Value Specialists (CVS), those individuals who have met specified training requirements and have demonstrated competency in the application of the Job Plan. The Team Facilitator shall be a CVS, or a VMP serving under the guidance of a CVS as defined by SAVE Certification criteria, or shall be the holder other active certification recognized by SAVE International.

## Appendix D: Consent form Company



Universidad de Puerto Rico  
Recinto Universitario de Mayagüez  
Colegio de Administración de Empresas  
Programa Graduado

### Hoja de Consentimiento Informado para la Compañía

Proyecto sobre Desarrollo de un Modelo Conceptual sobre la Contabilidad Esbelta (“Lean Accounting”) para una línea de sensores de temperatura para aplicaciones biomédicas.

Yo, \_\_\_\_\_, Gerente de Planta de la compañía \_\_\_\_\_, localizada en \_\_\_\_\_, Puerto Rico, por motivación propia, libre y voluntariamente, certifico que invité a la estudiante graduada del programa de MBA del Colegio de Administración de Empresas de la UPR, Recinto Universitario de Mayagüez, Jovania I. Ortiz Centeno, a realizar un proyecto relacionado a desarrollar un modelo conceptual de contabilidad esbelta aplicado a nuestras operaciones. Entiendo que este proyecto, en adición a cumplir con unas necesidades prácticas para la empresa, también cumplirá con los requisitos académicos necesarios para que la estudiante obtenga el grado de maestría en Gerencia Industrial de la Universidad de Puerto Rico, Recinto Universitario de Mayagüez.

Como parte de la metodología de investigación, la ejecución del proyecto requerirá el permitirle a la estudiante realizar una serie de entrevistas y cuestionarios con personal voluntario de la empresa, con el objetivo de corroborar, validar información y determinar el estado actual del sistema de contabilidad para la línea de producción de sensores de temperatura. Todo voluntario completará una Hoja de Consentimiento Informado para los Participantes. Se proveerá, de acuerdo a las políticas de confidencialidad de la compañía, toda documentación necesaria para sustentar los hallazgos. En el caso de información sensible, que sea necesario compartir con la estudiante, la misma será provista por la gerencia de manera tal que no se violenten las políticas internas de confidencialidad.

Se me ha orientado que, como parte de los requisitos académicos para otorgar el grado, la estudiante deberá, al final de la investigación, realizar una defensa oral y entregar un reporte escrito, el cual será público y pertenecerá a la UPR. Este reporte será documentado de forma que no violente las políticas de confidencialidad de la empresa, por lo cual, se me ha invitado y he aceptado participar como miembro del Comité Graduado de la estudiante. En adición, toda documentación y evidencia generada a lo largo de la ejecución del proyecto que no se incorpore como parte del reporte final, será devuelta a la empresa para disponer de la misma.

Certifico que este proyecto no tendrá repercusión negativa alguna en el personal que participe de la misma, ya que el enfoque es el de mejorar los procesos del sistema de contabilidad incorporando la teoría de producción esbelta (lean). El estudio no tiene como enfoque ni objetivo medir o tomar decisiones sobre la ejecutoria del personal que pudiera terminar en detrimento de los participantes. En adición, reconozco que el alcance del estudio es de tipo consultivo y no considera la implantación del modelo, ya que la gerencia de la compañía se reserva el derecho sobre el mismo.

Mi firma en este documento certifica que la estudiante ha aclarado todas las dudas relacionadas con el estudio y la forma de consentimiento, que estoy en acuerdo con lo estipulado en la misma, que tengo la capacidad legal para consentir y consiento la participación de la compañía en el proyecto. Acepto que se me ha entregado copia de este documento.

\_\_\_\_\_  
Firma

\_\_\_\_\_  
Fecha

He discutido con el participante esta hoja de consentimiento y le he explicado detenidamente el proceso del proyecto a realizar.

\_\_\_\_\_  
Firma del Estudiante

\_\_\_\_\_  
Fecha

## Appendix E: Consent form participants



Universidad de Puerto Rico  
Recinto Universitario de Mayagüez  
Colegio de Administración de Empresas  
Programa Graduado

### Hoja de Consentimiento Informado para los Participantes

Proyecto sobre Desarrollo de un Modelo Conceptual sobre la Contabilidad Esbelta (lean accounting) para una línea de sensores de temperatura para aplicaciones biomédicas.

Yo \_\_\_\_\_ certifico, que se me ha invitado a participar en el proyecto que realiza la estudiante graduada Jovania I. Ortiz Centeno como parte de los requisitos para la obtención del grado de maestría en Gerencia Industrial del Colegio de Administración de Empresas de la Universidad de Puerto Rico, Recinto de Mayagüez.

Se me solicita la colaboración como empleado(a) de la compañía donde se realizará el proyecto para participar libre y voluntariamente en el proceso, mediante entrevistas y cuestionarios. El tiempo para completar estos instrumentos es de aproximadamente 30 minutos. Mi participación en el proyecto ayudará a determinar el estado actual del sistema de contabilidad y financiero de la compañía, así como la gerencia de operaciones de la línea bajo estudio. Entiendo que el propósito del mismo es ayudar a que la compañía pueda convertir su sistema de contabilidad para la línea de producción bajo estudio en uno esbelto (lean).

Para facilitar el proceso del proyecto, las preguntas de la entrevista y/o el cuestionario se contestarán según la realidad de la situación actual de la compañía. Acepto que los resultados del proyecto serán ofrecidos a la compañía y está tendrá la potestad sobre ellos.

La información considerada como sensitiva y/o confidencial no se divulgará. He leído el contenido de esta hoja de consentimiento y he escuchado la explicación dada sobre el/los cuestionario/s y el proceso del proyecto. Se me ofreció la oportunidad de realizar preguntas y las mismas fueron contestadas.

Mi firma en este documento certifica que tengo capacidad legal para consentir y que consiento mi participación en el proceso del proyecto. Acepto que se me ha entregado copia de este documento.

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Firma

Fecha

He discutido con el participante esta hoja de consentimiento y le he explicado detenidamente el proceso del proyecto a realizar.

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Firma del Estudiante

---

Fecha

## Appendix F: Authorization CPHS



**Comité para la Protección de los Seres Humanos en la Investigación**  
**CPSHI/IRB 00002053**  
Universidad de Puerto Rico – Recinto Universitario de Mayagüez  
Decanato de Asuntos Académicos  
Call Box 9000  
Mayagüez, PR 00681-9000



17 de noviembre de 2015

Jovania I. Ortiz Centeno  
Administración de Empresas  
RUM

Estimada Jovania Ortiz:

Como Director del Comité para la Protección de los Seres Humanos en la Investigación (CPSHI) he considerado su proyecto titulado *Development of a Lean Accounting Model for the Assembly of Temperature Sensors for Biomedical Applications* (# Protocolo 20151119). Luego de evaluar el mismo he determinado que su proyecto no constituye investigación, según está definido ese concepto bajo la reglamentación federal 45 CFR 46. Por tal razón, he determinado que su proyecto se apruebe bajo la modalidad de Exento. La determinación de exención implica que su proyecto no requiere ser re-evaluado ni re-autorizado por nuestro comité. Le recordamos que la aprobación emitida por nuestro comité no lo exime de cumplir con cualquier otro requisito institucional o gubernamental relacionado al tema o fuente de financiamiento de su proyecto.

Sin embargo, recomendamos que se sigan y respeten algunas prácticas básicas de protección de seres humanos que comúnmente se requieren por nuestro Comité. La recomendación responde al hecho de que se va a levantar datos de empleados y suplidores de la empresa, personas que a nuestro juicio están en una posición vulnerable ante la gerencia. Recomendamos lo siguiente:

- El uso de la hoja de consentimiento para todos/as los/as participantes del estudio
- El garantizar un espacio privado para cumplimentar el cuestionario
- El garantizar el anonimato de los participantes y la confidencialidad de sus respuestas
- El manejar confidencialmente los datos y documentos utilizados como parte de la investigación

En fin, recomendamos que se vele por el bienestar de los participantes minimizando las posibilidades de que su participación en el estudio resulte en algún daño personal, como pérdida de empleo o negocio con la empresa.


Cualquier cambio al protocolo o a la metodología que altere los criterios de exención deberá ser revisado y aprobado por el CPSHI ANTES de su implantación, excepto en casos en que el cambio sea necesario para eliminar algún riesgo inmediato para los/as participantes. El CPSHI deberá ser notificado de dichos cambios tan pronto le sea posible al/ a la investigador/a. Igualmente, el CPSHI deberá ser informado de inmediato de cualquier efecto adverso o problema inesperado que surgiera con relación al riesgo de los seres humanos, de cualquier queja sobre la conducción de esta investigación y de cualquier violación a la confidencialidad de los participantes.

Atentamente,

Dr. Rafael A. Boglio Martínez  
Presidente, CPSHI/IRB

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## APPENDIX G: Authorization to use questionnaire

Lean Accounting Thesis  Inbox x



**Jovania I Ortiz Centeno** <jovania.ortiz@upr.edu>

10/24/15



to bmaskell

Hello Mr. Maskell,

Let me start by introducing myself. My name is Jovania and I am a MBA student at the University of Puerto Rico. For the past year I have been working on my thesis which has as a central theme lean accounting. For my thesis, I will be developing a lean accounting model for a manufacturing company here in Puerto Rico.

I have read many of your articles and thanks to them I have learned a lot about lean accounting. On your web page I also found many helpful articles and tools that have been helping me with my literature revision. As part of my methodology I would like to use a questionnaire which I found on your page: "Lean Accounting Diagnostic Questionnaire of Accounting, Control, & Measurement Capability". This brings me to the purpose of this email, I would like ask your permission to use this questionnaire for which I am positive will help me in my thesis. I believe this questionnaire will help me assess the current state of the accounting and finance department in the company.

Thanks for your time,

Regards,  
Jovania.

...



**Brian Maskell** <bmaskell@maskell.com>

10/24/15



to me

Jovania:

Thank you for your email. I am glad that you are working on Lean Accounting for your thesis.

1. I give you permission to use our "Lean Accounting Diagnostic Questionnaire" providing you use the same format from our web-site and that the copyright is fully observed.
2. I will send you some other information that will be helpful working with your manufacturing company.
3. I would be willing to come to Puerto Rico and work with the company or companies that you are working with on Lean Accounting. I would need to be paid for this work, but the companies would gain well developed Lean Accounting and you would have a more thorough case study for your thesis.

All the best,  
Brian