BENCHMARKING PRODUCT RETURN PROCESSES FOR AN ELECTRONICS COMPANY

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ABSTRACT

Xantrex Technology Inc., a manufacturer of advanced power electronics, is suffering from high customer returns on its mobile products. Those returned products have cost Xantrex time, money, and manpower managing RMA, reverse goods distribution, storage and/or scrapping.

Through a review of the company's existing procedures and activities, interviews with focus groups, and analysis of the information/data collected, root causes of the customer return are found to reflect three aspects: the quality of the products, a gap between customer insights and the products, and unbalanced marketing/sales practices, especially while collaborating with retailers.

Best practices to resolve these problems are recommended after benchmarking with one internal procedure, against Xantrex's competitors and manufacturers/retailers in similar industries, and with some best-of-class plants world-wide. Besides long-term practices which should be in line with Xantrex's business strategies and processes continuous improvement, a short-term action plan can be implemented through a cross-functional project team.

DEDICATION

感谢我的爱妻－毛学靖

没有你的支持，哪有我梦寐以求的MBA?

To My Dear Wife – Shirley

Your support is the most important thing that makes my MBA dream come true.

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GLOSSARY

BC: Business Champion

DVT: Design-to-Test

HALT: Highly Accelerated Life Tests

HASS: Highly Accelerated Stress Screens

KPI: Key Performance Index

MBU: Market Business Unit

OEM: Original Equipment Manufacturer

PAC: Product Authorization Committee

RMA: Returned Materials (Merchandise) Authorization

RSC: Returns Steering Committee

SCM: Supply Chain Management

TC: Technical Champion

TQM: Total Quality Management

1 INTRODUCTION: A GROWING CHALLENGE FOR XANTREX

1.1 The Nature of the Challenge

Xantrex Technology Inc., a world leader in advanced power electronics, is facing a growing and significant challenge. Its mobile product return rates are roughly 4 – 6 per cent. These returns have cost the company time, money, and manpower managing RMA[1] procedure, reverse goods distribution, returned products storage, recycling or scrapping. Product return rate is also an important measure of customer satisfaction. It is a component of Xantrex's Corporate Scorecard objects. Under such a situation, Xantrex wants to improve customer satisfaction, reduce costs, and achieve world-class performance by reducing its product return rates.

Having recognized the opportunity to enhance business results by reducing product return rates, the management team at Xantrex has established a Returns Steering Committee (RSC) which is chaired by its Vice President of Marketing. The committee also includes vice presidents of Quality Assurance and Customer Service, Operations, Business Development, and some key persons who are responsible for this issue. To date, the committee has set a goal to reduce returns by 25 per cent each quarter, and eventually get the return rate to less than one per cent. The committee meets weekly to discuss issues, organize cross-functional teams, establish accountability, and ensure product return data is understood and shared across the appropriate organization points.

[1] RMA: Returned Materials (Merchandise) Authorization.

Is the goal set by RSC reasonable and achievable? The Quality Assurance and Customer Service Department, one of the functional departments which is responsible for this specific issue, needs to analyze all relevant situations, and to set an action plan accordingly to decrease the product return rates. The Quality Assurance and Customer Service Department sponsored this project to analyze the root causes behind the customer returns, and then, to benchmark some "best practices" for its action plan to achieve the RSC goal.

1.2 The Aim and Scope of the Project

The majority of off-shore manufactured mobile products of Xantrex are made by suppliers in China and then delivered to North America market directly. In Canada, those products are sold by several main stream retailers such as Canadian Tire, Sears, Costco, and Radio Shack. If end users purchase Xantrex products and later return them to the original retailers, the returned products are sent by the retailers to Xantrex headquarters in Burnaby, British Columbia. The Quality Assurance and Customer Service Department has established certain processes and has performed analysis on these returned products. Through recent investigations and tests, Xantrex found that about 60 – 70 per cent of returned products are "non-fault found" items. So far, Xantrex has not utilized a systematic way to collect useful information and analyze it about the customer behaviour and the specific reasons for product returns yet. Thus, it is important for Xantrex to understand the root causes of those product returns, to know the acceptable return rate in the industry, and to develop better practices to improve customer satisfaction or to decrease product return rates.

With the aim of creating an action plan which is achievable for Xantrex to reduce its mobile product returns, this project will assess the Xantrex business, products, organizational structure, processes, and some company core activities. The project will also collect relevant data from both inside and outside of the company; then perform theoretical modelling and analysis from a systems point-of-view to understand customer behaviours and realistic and acceptable return rates. Finally, the project will provide recommended solutions to the timely resolution of product returns and recommended improvements to relevant processes to support the objective of the company. All of these can be treated as the scope of analysis for this investigation.

1.3 The Structure of the Project

In order to accomplish the above objectives, *Chapter 2* of this project will begin with an overview of Xantrex: its business operation, strategy, and markets. It will also describe the organizational structure of Xantrex and the procedure on new product creation – one of the core activities at Xantrex.

In *Chapter3*, the project will examine quality assurance and customer service process, approaches and activities which could determine one of the main causes of customer returns – the quality (or lack thereof) of the products. This chapter will also introduce some important quality management concepts and methodologies, which reflect the trends in this area, such as Total Quality management, Six Sigma Methodology, Lean Manufacturing System, and their possible application at Xantrex.

Chapter 4 will try to find the root causes for mobile product return by the end customers. This chapter will describe how the survey plans and questionnaires for both

internal and external groups were determined, introduce how the interviews were executed, illustrate what relevant data/information was obtained, and present how principles and methods were utilized to come up with the root causes for customer returns.

In *Chapter 5*, the project will use benchmarking to find the "best practices" which are the basis for formulating an action plan to decrease Xantrex's product return rates. A variety of benchmarking techniques are used to shed light on how Xantrex can improve its product release processes.

The last chapter – *Chapter 6* will present conclusions from previous chapters, give recommendations of best practices, as well as give a preliminary short-term action plan on how to accomplish the Xantrex objective on reducing customer return. The chapter will also suggest how to execute, monitor or update such action plan.

2 XANTREX OVERVIEW

2.1 The Company Profile

2.1.1 The History

Established in 1983, Xantrex Technology Inc. develops and manufactures advanced power electronic products to convert raw electrical power from any central, distributed, or backup power source into high-quality power required by electronic and electrical equipment. Xantrex is headquartered in Burnaby, BC with facilities in Arlington, WA; Livermore, CA; Elkhart, IN and Barcelona, Spain. There are approximately 500 employees working worldwide for the company.

Xantrex is a public company listed on the Toronto Stock Exchange (TSX: XTX).

2.1.2 The Market

Xantrex's diverse product lines can be categorized into three submarkets which could be described as below:

1. **Distributed Power:** Products related to renewable and distributed power including solar, wind, flywheels, micro turbines and fuel cells for customer use.
2. **Programmable Power:** Products used to develop, test and power precision equipment such as semiconductor manufacturing and medical equipment.
3. **Mobile Power:** Products belonging to back up and emergency potable power systems for homes and small business during electric grid disruptions, or

auxiliary electrical power on the mover for boats, recreational vehicles, heavy duty trucks, commercial work vehicles, and automobiles.

Figure 1 Xantrex Products

Clockwise: Converter Assembly, XPower Powerpack, XPower Inverter, and Battery Monitor

Because the objective of the project is to find root causes of Xantrex mobile product return and find best practices to improve relevant processes and approaches, the project for this paper focuses on studies for those mobile products, especially for XPower series products.

2.1.3 The Vision, Mission and Value

The vision of Xantrex is to improve the lives of people around the world.

Xantrex mission statement states: "Our (Xantrex) mission is to combine proven technology with unparalleled market understanding to bring our customers electricity anytime, anywhere".

Xantrex defines itself according to five critical values. They are:

1. Market-based Innovation – It understands the demands of evolving markets, creating products for today while cultivating future opportunities.
2. Passion for Solutions – It believes its success lies in solving problems to enable freedom, productivity, and a healthy environment.
3. Application Flexibility – It builds upon a breadth of technology know-how for an expanding world of power opportunities.
4. Raising the Standard – It believes that continuous dedication to excellence fuels its ability to exceed commitments and lead the market.
5. Shared Success – Its business creates shared opportunities for the mutual benefit of customers, strategic partners, employees, and shareholders.

2.1.4 The Revenue

During the period of 1998 – 2003, Xantrex experienced the most rapid growth for its business in its history. In 1998, Xantrex created a vision for growth and achieved revenue of US$10 million in the first time in that year. Xantrex acquired Statpower in 1999; raised US$ 35 million in equity and achieved revenue of US$ 45 million. In 2000,

Trace and Heart were acquired; US$ 37 million equity value was raised by Xantrex; and it achieved revenue of US$ 95 million in that year. Between 2001 and 2002, Xantrex integrated its operations into a market focused structure and reorganized into functional units. It also achieved revenue of US$ 109 million during that period. In 2003, it focused on improving quality and service, accelerated R & D procedures, and strengthened management. The total operation revenue for Xantrex was US$136 million / CDN$189 million in year 2003.

2.2 The Organizational Structure

Organizational structure is important to every organization. The structure determines the horizontal differentiation, vertical differentiation, mechanisms of coordination and control, formalization, and centralization of power within an organization. Core processes are largely determined or at least influenced by organizational structure. Hence, it is necessary to introduce Xantrex's organizational structure to have a complete picture of the company's business.

2.2.1 The Organizational Structure at Xantrex

Led by the Chief Executive Officer (CEO), nine functional departments which are directed by Vice Presidents for each exist at Xantrex. The nine functional departments are: Marketing, Financial, Sales, Business Development, Engineering, Operations, Product Creation and Support (PC&S), Human Resources (HR), and Quality Assurance and Customer Service. (See appendix 1 as Xantrex Organizational Chart) The company tries to utilize a flat organizational structure to ensure smooth vertical communication. The purpose and job description for each functional department are:

1. Marketing Department: It mainly focuses on marketing communications and brand management. It is also responsible for channel programs, product planning and marketing.
2. Financial Department: It mainly focuses on common financial and accounting issues in the company.
3. Sales Department: It leads sales and sales application engineering teams.
4. Business Development Department: It is responsible for business development activities worldwide for large-scale renewable energy products.
5. Engineering Department: It is responsible for advanced development, new product development, continuation engineering, and engineering service.
6. Operations Department: It is in charge of all aspects of operations, including manufacturing, contract manufacturing, production engineering, purchasing, materials, logistics, order management, customer service, technical service, warranty and inventory.
7. Product Creation and Support Department: Employees from PC&S department are responsible for the program management, prioritization, scheduling and monitoring of the numerous concurrent projects that are underway at Xantrex.
8. Human Resources Department: It ensures overall human resource function, including design and delivery of employee rewards, recruiting and retention, competency development, HR policies and procedures setting, employee relations and communications enhancement.

9. Quality Assurance and Customer Service Department: It is responsible for corporate quality systems, supplier quality and product assurance as well as customer service, technical support, and field service.

2.3 The New Product Creation Procedure and its Program Team

New product creation processes are the core activities at Xantrex for sustaining competitive advantage. A significant portion of resources from almost every functional department are involved in such activities within the company. The new product creation process is well designed and documented. The data and information can be easily accessed and obtained. The process itself is constantly being revised with an eye towards making it more efficient. Understanding the program or process of new product creation at Xantrex is essential to any effort to improve quality assurance, customer service and manufacturing processes.

2.3.1 The Program Team of New Product Creation

The new product program is driven by the partnership between the Business Champion (BC) and Technical Champion (TC). The product life-cycle management relies upon this partnership to maintain the momentum and responsibility for the complete range of product creation activities. Without BC and TC assignments, product quality control would be far less than optimum. Even when major programs are established and overall program control is assigned to a third member of the leadership team, the Program Manager/Project Leader, this shared product ownership exists for the duration of the program. The BC and TC still ultimately own the product after the Launch

Stage is complete. The dependence for the initiating new products and/or product amendments currently rests entirely with the BC/TC duo.

Ownership for individual product programs lies with a designated Market Business Unit (MBU). Generally, the customers served, the markets targeted, the program team resources and the program review resources are all identified with and supplied by a single MBU. However, cross-functional resources from other MBUs will be required from time to time; it is important not to limit the concurrent membership of teams by organization boundaries. As will be discussed later, new product creation programs are controlled by breaking down the process into a sequence of defined stages and phases. These process steps are implemented and reviewed through the interaction between the MBU's program team and the Product Authorization Committee (PAC).

Two teams are pivotal to the successful implementation of New Product Creation Program – the Program Team and the Product Authorization Committee (PAC).

The Program Team is empowered to deliver on its commitments. It provides all the individual planning and implementation skills required throughout the duration of the program and formulates all the program status updates and recommendations presented to the PAC.

The PAC is the collaborative and supportive management body that endorses a process attitude. It provides each Program Team with business, market and technical guidance and assists with resource assignment priorities.

2.3.2 The Program Process of New Product Creation

The New Product Creation Process at Xantrex intends to be "in time" for its customer needs and to execute such process that delivers products "on time". It is based upon the concept of "Product Cycle Time" – the time elapsed from the idea generation to obsolete of a product. The entire process can be described as "Four Stages & Eleven Phases Procedure" (4-11 Procedure) as shown in Table 1. The shorter the cycle time the more responsive it can be to market changes.

Table 1 "4-11 Procedure" for New Product Creation

Stage	Phase	Milestone
Definition	Idea	
		No Milestone
	Study	
		Preliminary Planning Approval
	Planning	
		Formal Implementation Approval
Development	Design	
		Preliminary Design Release
	Prototype	
		Critical Design Release
	Verification	
		Sales Readiness Release
	Pilot	
		Product Release
Launch	Ramp-up	
		Manufacturing Launch Release
	Deploy	
		Program Complete
Post-Launch	Continue	
		Product Withdrawal
	Discontinue	
		Product Obsolete

- **Idea Phase:** No Milestone here

  Normally, new product ideas are generated and collected through a

number of activities such as market research, communication with customers, customer requests, product line planning, internal brainstorming sessions, or employee suggestions. This phase is in an open process. Ideas are submitted and recorded and then evaluated for fit with company's business strategies, markets, technologies, competencies and manufacturing processes. If one idea appears to have reasonable fit, it would be documented in a short Product Concept Document that describes the idea, its fit to the business, and the market potential. The idea is also ranked in a Product Priority Model. The PAC then reviews the Product Concept Document, the Product Priority Model, and available product program resources to make decision if it will proceed to a more formal definition activity in the Study Phase.

- **Study Phase:** Milestone – Planning Approval

  This is the first formal activity in Definition Stage. Persons who are responsible will identify the primary product concept and program objective, and provide the initial Business Plan and draft versions of the Market Requirements, Program Plan and the Functional Specification. A plan for the subsequent planning phase is mandatory and requires approval before proceeding to the next phase.

- **Planning Phase:** Milestone – Implementation Approval

  The new product idea is consolidated and reviewed with customers to determine its market potential and product features. Then, product development approaches, program team membership and the time-line of

the product program are defined. The results of the planning phase are: a set of Market Requirements showing customer needs; a Product Business Plan showing business objectives; a Program Plan showing implementation actions and an overall schedule time line; a Product Functional Specification defining all product functions; and a detailed task list/schedule for the Design Phase.

- **Design Phase:** Milestone – Preliminary Design Release

  In this phase, a top-level design is completed; and all critical elements/units of the design are identified and thoroughly tested (as a "pre-A" Model) for proving general feasibility. Customer concept testing continues and preliminary manufacturing, quality and service plans are written. At least one technical design review of the proposed product will be completed prior to declare Preliminary Design Release. The planned tasks and associated schedule for the Prototype phase are also confirmed.

- **Prototype Phase:** Milestone – Critical Design Release

  The majority of the detailed design is completed in this phase and at least one working "A" prototype is built and tested according to the specification to prove the design and demonstrate the product's feasibility. The test practices as defined in the DVT[2] process should be applied here. Upon completion of this phase, the product definition and detailed specifications are considered final where any subsequent changed are individually reviewed and kept to a minimum. Before the product design

[2] DVT: Design-to-Test

can proceed to the verification phase and before significant manufacturing preparation actions and expenditures are confirmed, the Critical Design Release milestone must be completed. This indicates that at least one technical design review of the product has been completed, product performance and cost are acceptable and product introduction – both manufacturing and market – plans are in place. The planned tasks and associated schedule for the Verification Phase are also confirmed.

- **Verification Phase:** Milestone – Sales Readiness Release

  Typically, about 5 to 10 "B" prototype models are built and tested to prove the final design and develop final product documentation. These models are not for permanent end-customer use but are used as to support early demonstration or test with key customers. Before the product details can be released to initiate sales and deployment preparations, the Sales Readiness Release milestone must be completed which indicates that accurate price, delivery targets and proven product performance have been established. All planed product development and product verification/validation activities should now be closed with the product design declared complete and now ready for manufacturing introduction. All of the necessary sales promotion, field support and sales tools preparation can then begin. The planned tasks and associated schedule for the Pilot Production Phase are also confirmed.

- **Pilot Production Phase:** Milestone – Product Release

  In Xantrex, about 20- 100 units identified as "C" models are produced in

the manufacturing environment for a pilot run to verify the documentation and SCM[3] processes. Production level testing and the QA of production processes are also proven. These models are distributed and typically used as demonstration units and customer test units. Before the product can be sold to end-customers however, the Product Release milestone must be complete which indicates that all of the necessary field support and sales tools have been put into place. Completion of such milestone also signifies manufacturing acceptance of the product into regular production status. The planned tasks and associated schedule for the Launch Stage are also confirmed.

- **Ramp-Up Production Phase:** Milestone – Manufacturing Launch Release

  During the initial months following the Product Release, the product is in a controlled state of release. For the first, low volume production batches of "C" model with its inventory and the previously proven production processes are finalized and replicated to enable increased product volumes. Marketing, QA and Customer Service are starting the full-scale launch / introduction activities; Manufacturing Engineering and Design Engineering will be supporting the production ramp-up and product availability completion. The Manufacturing Launch Release milestone is accomplished when all activities defined in the Manufacturing and Product Introduction plans have been carried out successfully. The product is then ready for controlled volume deployment.

[3] SCM: Supply Chain Management

- **Deployment Phase:** Milestone – Program Complete

  During the final program period following a successful Manufacturing Launch Release milestone, the product is still in a controlled state of release. Marketing, QA, Customer Service, Manufacturing Engineering and Design Engineering will be involved in market introduction and monitoring activities to ensure that the new product, the deployment channels and the support services are all meeting our original expectations of success. The findings of the program team's "Lessons Learned" review are shared during the Program Complete Milestone review. The Program Complete milestone is accomplished when all activities defined in the Program Plan have been carried out successfully. The Product is then available for general sales.

- **Continue Phase:** Milestone – Product Withdraw

  Post-launch management begins at the completion of the above Launch stage. At this time, the product is commercially available in volume production quantities and is considered stable. Post-launch management engages regular review of the Four P's[4] of marketing as the product progresses through its life cycle, and also involves overall and regular measurement of product financial performance in such key areas as revenue, unit sales, unit cost, gross margin, gross margin dollars, market share, return on investment, warranty return rates, etc. Performing analysis of the market, the competition, customer demands, and market acceptance

[4] 4 P's refer to Product, Price, Promotion, and Place (Distribution) in Marketing Theory.

is especially important, and generally completed, in preparing for new offerings. When to withdraw the product from the market – at the end of its life cycle or in conjunction with new/replacement product introductions – is, however, a sometimes forgotten but important product management task. The Product Withdraw Milestone is recommended when the product is at the end of its life cycle, is causing channel conflict or when it is about to be replaced by a new product. Unlike any other phases, the end of the "Continue Phase" will be determined by the decision to start the following phase – Discontinue.

- **Discontinue Phase:** Milestone – Obsolete Product

  A product discontinuation exercise may be initiated for any single aspect or combination of market forces. Both tactical and strategic decisions around product performance, functionality, the competition, customer demand, market acceptance, product financial performance, can drive the need for product discontinuation. A supplier would not purposely "kill" a product – usually the market forces will determine the fate – unless the support required (by the Supplier) is prohibitive. Cost of maintaining a product often drives the need for a replacement. Product discontinuation follows two stages of preliminary and final notices to existing customers. These notices usually drive a program of final batch manufacturing to meet the customer orders and to provision all spares requirements to meet future warranty and product repair needs. Once final builds have been

completed, manufacturing is halted, processes and documentation are archived and the Obsolete Product milestone is declared.

Through the description of the "4-11 Procedure", it is natural to conclude that activities for new product creation program cover the total life-cycle of the product from a new product idea initiated to the final product obsolete in the market and close the production. Other processes or activities such as quality control and improvement, supplier and inventory management, customer relationship and service, marketing and sales enhancement, manufacturing improvement can be set according with this "4-11 Procedure" at Xantrex.

3 QUALITY ASSURANCE CONCEPTS, METHODOLOGIES AND PROCESSES

This chapter will introduce Quality Assurance Department and its function at Xantrex and discuss important quality management concepts and methodologies which reflect best-practice industry trends in quality management and improvement. These trends include Total Quality Management, Six Sigma, Lean Manufacturing System. The chapter will also discuss the possible applications of these TQM methodologies at Xantrex.

3.1 Quality Assurance Process and Practices at Xantrex

The Xantrex Quality Department in Burnaby can be divided into two sub-group teams, which are called Quality Assurance and Reliability Engineering respectively. The department mission statement reads: Xantrex Quality Department will "enable all employees within Xantrex to be world-class quality champions making it possible for Xantrex to become a 400 million dollars global supplier of advance power solutions in 2008 to make a positive difference in the lives of people by providing electricity anytime, anywhere".

The vision of Quality Assurance at Xantrex is to (1) emulate the best industry practices of excellence in every aspect of its business; (2) mentor and nurture the people within the organization by "Challenging the Process" and through the "Continuous Improvement Process"; (3) become the industry standard and benchmark to be recognized and acknowledged as "World Class Leader in Advanced Power Solutions".

The Quality Department takes a "support and control" role in terms of product realization. Its staff is involved in activities such as Design and Reliability, Supplier Management, Manufacturing Support and Customer Experience. Specific jobs are those such as product out-of-box audit and report, stop build/ship registration, tools and electronic testing equipment calibration, first article evaluation, suppliers' QA process visit, RMA evaluation, reliability test, and "Quality Plan" set and follow up with new product creation procedures.

As for continuous improvement, the Quality Department takes a "measuring" role for the company. QA people are constructing quality metrics and KPIs[5]; defining the company's corrective and preventive actions; and executing Quality System Review with management.

The Quality Department also serves the whole company by acting as a role as Process Controller on any other processes creation and management, process review (audit), and records management. Process review can be done by cooperating with internal employees, with company customers or with external third parties such as consulting companies.

3.2 The Concept and Methodologies of TQM

3.2.1 The TQM Concept

Total Quality Management (TQM) is a management approach by which all employees can involved in the continuous improvement of the processes of goods manufacturing and services within an organization. The TQM concept and its practices

[5] KPI: Key Performance Index.

were originated in the 1950's and have become more and more popular since the early 1980's. The term "Total Quality" is a description of a company's culture, attitude and organization to strive to provide products and services that satisfy its customers' needs. The "Total Quality" culture requires quality in all aspects of the company's operations. Under the TQM environment in a company, all processes must be done right the first time and be improved constantly from a quality point-of-view. Defects and waste should be eradicated from operations. TQM is a combination of quality and management tools aimed at increasing business and reducing losses due to wasteful practices.

TQM is also a management philosophy that seeks to integrate all organizational functions such as marketing, finance, design, engineering, production, quality and customer service to focus on meeting customer needs. Such management methodology views an organization as a collection of processes. It maintains that organizations must strive to continuously improve these processes by incorporating the knowledge and experiences of all employees. The simple objective of TQM is "Do the right thing, right the first time, every time". Although originally applied to manufacturing operations, and for a number of years only used in that area, TQM is now becoming recognized as a generic management approach suitable for many different kinds of organizations.

3.2.2 The TQM Activities

According to one TQM expert, TQM is the foundation for a series of activities that lead to quality objectives. Those activities are:

- Commitment by senior management and all employees;
- Meeting customer requirements;

- Reducing development cycle times;
- Just In Time/Lean Manufacturing;
- Improvement teams;
- Reducing product and service costs;
- Systems to facilitate improvement;
- Line Management ownership;
- Employee involvement and empowerment;
- Recognition and celebration;
- Challenging quantified goals and benchmarking;
- Focus on processes / improvement plans;
- Specific incorporation in strategic planning.[6]

Total Quality Management is an approach for a company to achieve world-class quality. The above-mentioned activities are critical to TQM implementation. But the list is far less than exhaustive. Although there is no universal agreement on what are the essential elements of TQM, many companies use the criteria of the Malcolm Baldrige National Quality Award to define their TQM. The award is administered by The American Society for Quality (ASQ) under a contract with The National Institute of Standards and Technology (NIST). It is an annual self-evaluation covers criteria such as leadership, strategic planning, customer and market focus, information and analysis, human resource focus, process management, and business results.

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[6]"Introduction and Implementation of Total Quality Management (TQM)" [http://www.isixsigma.com/library/content/c031008a.asp#references] Accessed October 2004

The TQM is a conceptual and a philosophical context which requires management and human resources commitment to adopt a perpetual improvement philosophy, through succinct management of all processes, practices and systems throughout the organization to achieve effectiveness in the organizational performance and fulfilling or exceeding the customers' expectations.

To summarize, TQM is from the concept that Quality involves everyone and all activities in the company; the goal of quality is to meet customer requirements; and the quality can and must be managed. TQM is a process for managing quality, increasing productivity, decreasing defects and waste. TQM must be a continuous way of life and a philosophy of perpetual improvement in everything the company undertakes.[7]

3.2.3 The TQM Methodologies

How should an organization implement TQM? A commonly recommended way is to do it by implementing the following 10 steps:

1. Pursue new strategic thinking;
2. Know your customers;
3. Set true customer requirements;
4. Concentrate on prevention, not correction;
5. Reduce chronic waste;
6. Pursue a continuous improvement strategy;
7. Use structured methodology for process improvement;

[7] "Total Quality Management"[http://home.att.net/~iso9k1/tqm/tqm.html#Introduction] Accessed October 2004

8. Reduce variation;

9. Use a balanced approach;

10. Apply to all functions.[8]

Table 2 below is another specific way to implement TQM:

Table 2 TQM Process Improvement and Problem Solving Sequence

Step			Reference
PLAN (Plan a Change)	**Define the Problem**	1. Recognize the process that you are doing	
		2. Identify the product being processed.	Process inference
		3. Define some measurable characteristics of value to the product	
		4. Describe the "Process"	Flow Analysis Flow charts List of steps
		5. Identify the "Big" Problem	Brainstorming Checklist Pareto Analysis
	Identify Possible Causes	6. "Brainstorm" what is the root cause	
		7. Determine what past data shows	Frequency distribution Pareto charts Control charts - Sampling
	Evaluate Possible Causes	8. Determine the relationship between cause and effect	Scatter diagrams Regression analysis
		9. Determine what the process is doing	Control charts -

[8] "Ten Steps to Total Quality Management" [http://home.att.net/~iso9k1/tqm/tqm.html#Introduction] Accessed October 2004

Step			Reference
		now	Sampling
DO (Implement the Change)	**Make a Change**	10. Determine what change would help	Knowledge of the process Scatter diagrams Control charts – Sampling Pareto analysis
CHECK (Observe the Effects)	**Test the Change**	11. Determine what change worked (confirmation).	Histograms Control charts – Sampling Scatter diagrams
ACTION (Embed the Fix into the Process for Good)	**Take Permanent Action**	12. Ensure the fix is embedded in the process and that the resulting process is used.	
		13. Ensure the problem is fixed for good.	
		14. Ensure the process is good enough.	Control charts - Sampling
		15. Ensure continuous improvement – Return to step 5.	

3.3 The Six Sigma Methodology

3.3.1 What is Six Sigma?

Six Sigma is a rigorous and disciplined methodology that utilizes data, product specifications, and statistical analysis to measure and improve a company's operational and quality control performance, practices and systems. It aims to identify and eliminate "defects" in manufacturing and service-related processes in order to anticipate and exceed expectations of all stakeholders to accomplish effectiveness.

Six Sigma can be defined and understood at three distinct levels which are: metric, methodology and philosophy.

At metric level, Six Sigma can be defined as 3.4 defects per million opportunities. It allows a quality inspector to take complexity of product/process into account, and to consider at least three opportunities for a physical part/component – one for form, one for fit and one for function, in absence of better considerations. At this level, the inspector only needs to check critical to quality characteristics, not the whole unit/characteristics.

At methodology level, Six Sigma methodology requires staff to utilize DAMIC or DAMDV processes to structure problem solving roadmap and tools. The Six Sigma DMAIC process (define, measure, analyze, improve, control) is an improvement system for existing processes falling below specification and looking for incremental improvement. The Six Sigma DMADV process (define, measure, analyze, design, verify) is an improvement system used to develop new process or products at Six Sigma quality levels. It can also be employed if a current process requires more than just incremental improvement. Both Six Sigma processes are executed by Six Sigma Green Belts and Six Sigma Black Belts, and are overseen by Six Sigma Master Black Belts.

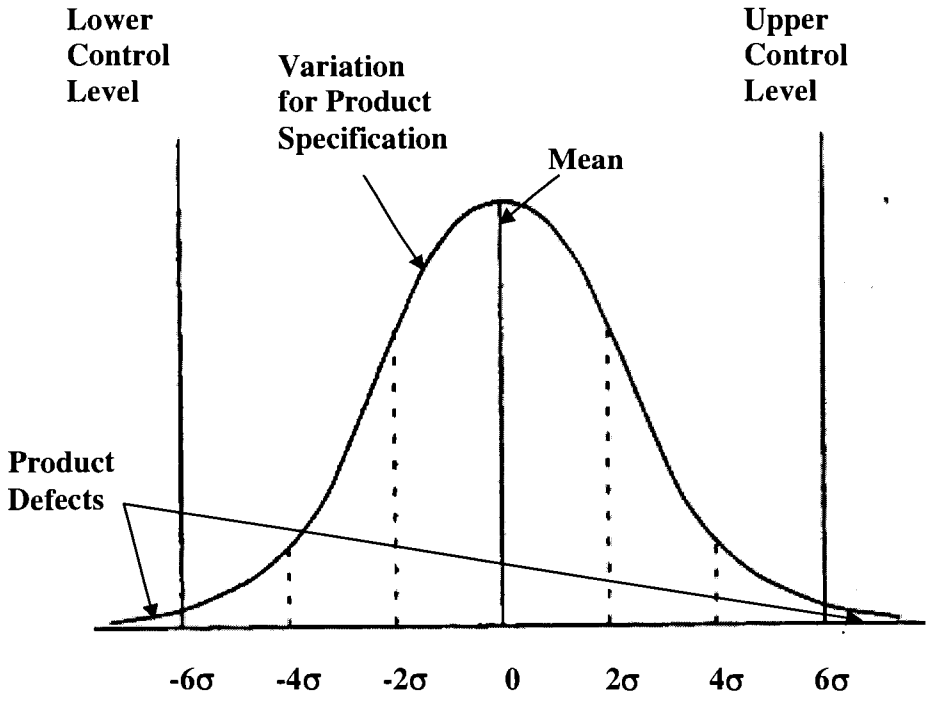
At philosophy level, Six Sigma aims to reduce variation in business and take customer-focused, data driven decisions. This increase in performance and decrease in process variation leads to defect reduction and vast improvement in profit, employee moral and quality of product.

Six Sigma at many organizations simply means a measure of quality that strives for near perfection. In fact, Six Sigma is a disciplined, data-driven approach and methodology for eliminating defects (driving towards six standard deviations between the

mean and the nearest specification limit) in any process – from manufacturing to transactional and from product to service.

The statistical representation of Six Sigma describes quantitatively how a process is performing. To achieve Six Sigma, a process must not produce more than 3.4 defects per million opportunities. A Six Sigma opportunity is then the total quantity of chances for a defect. See Figure 2 as variation chart for one product specification in Six Sigma.

Figure 2 Six Sigma Variation Chart



The fundamental objective of the Six Sigma methodology is the implementation of a measurement-based strategy that focuses on process improvement and variation reduction through the application of Six Sigma improvement projects.

3.3.2 Six Sigma Techniques and Principles

Six Sigma techniques and principles can be listed as below:

- **DMAIC / DMADV**

DMAIC process (define, measure, analyze, improve, control) is an improvement system for existing processes falling below specification and looking for incremental improvement.

DMADV process (define, measure, analyze, design, verify) is an improvement system used to develop new process or products at Six Sigma quality levels. It can also be employed if a current process requires more than just incremental improvement.

- **Yellow, green, black and master black belts**

A Yellow Belt employee typically has a basic knowledge of Six Sigma, but does not lead projects on his/her own. He/she often responsible for the development of process maps to support Six Sigma projects. He/she participates as a core team member or subject matter expert on a project. In addition, Yellow Belts may often be responsible for running smaller process improvement projects using the Plan/Do/Check/Act methodology.

A Green Belt is an employee of an organization who has been trained on the improvement methodology of Six Sigma and will lead a process improvement or quality improvement team as part of his/her full time job. Extensive product knowledge in his/her company is a must in his/her task of process improvement.

A Black Belt is Six Sigma team leader who is responsible for implementing process improvement projects within the business to increase customer satisfaction levels and business productivity. Black Belts are knowledgeable and skilled in the use of the Six

Sigma methodology and tools. They coach Green Belts and receive coaching and support from Master Black Belts.

A Master Black Belt is Six Sigma Quality expert that is responsible for the strategic implementations within an organization. His/her main responsibilities include training and mentoring of Black Belts and Green Belts; helping to prioritize, select and charter high-impact projects; maintaining the integrity of the Six Sigma measurements, improvements and tollgates; and developing, maintaining and revising Six Sigma training materials.

- **Variation reduction**

Variation is the fluctuation is process output. It is quantified by standard deviation, a measure of the average spread of the data around the mean. Variation is sometimes called noise.

Variation reduction is a process improvement to decrease common cause variation caused by unknown factors to increase the process potential; and to remove special cause variation caused by known factors to prevent a shift in output of a process.

- **Project process (one to three months)**

Project process leverages cross functional teams and specifically defined activities. It is characterized as a temporary endeavour undertaken to create a unique product or result which is performed by people, planned, executed and controlled.

- **Statistical process control (Cp, Cpk)**

Statistical process control is the application of statistical methods to identify and control the special cause of variation in a process.

Process Capability Index: Cp = (Upper Control Level – Lower Control Level)/6 σ

Cpk = either (Upper Specification Level – Mean) / 3 σ

or (Mean – Lower Specification Level) / 3 σ

which is the smaller.

Cpk of at least 1.33 is desired for Six Sigma.

- **Measurement system assessment (Gage R&R)**

Gage R&R stands for gage repeatability and reproducibility. Measurement system assessment is a statistical tool that measures the amount of variation in the measurement system arising from the measurement device and the people taking the measurement.

- **Root cause analysis and hypothesis tests**

Root cause analysis is a study of original reason for non-conformance with a process. When the root cause is removed or corrected, the non-conformance will be eliminated.

Hypothesis testing refers to the process of using statistical analysis to determine if the observed differences between two or more samples are due to random chance or to true difference in the samples. It is a process finding statistical evidence that the null hypothesis is false, which allows rejecting the null hypothesis and accepting the alternate hypothesis.

- **Design of Experiments, Taguchi Methods**

A Design of Experiment (DOE) is a structured, organized method for determining the relationship between factors affecting a process and the output of that process.

Taguchi Method is a technique for designing and performing experiments to investigate processes where the output depends on many factors without having tediously and uneconomically run the process using all possible combinations of values of those variables. By systematically choosing certain combinations of variables, it is possible to separate their individual effects.

- **Regression analysis**

Regression analysis is a method of analysis that enables you to quantify the relationship between two or more variables (X) and (Y) by fitting a line or plane through all the points such that they are evenly distributed about the line or plane visually.

- **Analysis of Variance (ANOVA)**

Analysis of Variance is a statistical technique for analyzing data that tests for a difference between two or more means by comparing the variances within groups and variance between groups.

- **Failure Modes and Effects Analysis (FMEA)**

FMEA is a procedure and tool that help to identify every possible failure mode of a process or product, to determine its effect on other sub-items and on the required function of the product or process. The FMEA is also used to rank and prioritize the possible cause of failures as well as develop and implement preventative actions, with responsible persons assigned to carry out these actions.

- **Evolutionary Operation (EVOP)**

The basic idea of EVOP is to replace the static operation of a process by a continuous and systematic scheme of slight perturbations in the control variables. The

effect of these perturbations is evaluated and the process is shifted in the direction of improvement.

- **Process stability**

Ensuring process stability is the ability of the process to perform in a predictable manner over time.

3.4 Lean Manufacturing System

3.4.1 What is Lean and Lean Manufacturing?

Modern manufactures are always searching for efficiency strategies that help reduce costs, improve output, establish competitive position, and increase market share. After World War II, Japanese manufactures created several new, low cost, manufacturing practices, and developed a disciplined, process-focused production system now knows as the "Toyota Production System", or "Lean Production". The objective of this system was to minimize the consumption of resources that added no value to a product.

Lean methodology is used to accelerate the velocity and reduce the cost of a manufacturing/ service process by eliminate any waste for the process. Lean manufacturing can be defined as "a systematic approach to identifying and eliminating waste (non-value-added activities) through continuous improvement by flowing the product at the pull of the customer in pursuit of perfection" [9].

[9]Peterman, Mike. "Lean Manufacturing Techniques Support, The Quest for Quality" P24 QM Jan./Feb. 2001, [www.qualityinmfg.com]

Specifically, the value of a product is defined only by the customer in lean manufacturing. The product must meet the customer's requirements of delivery time, quality and price. The thousands of mundane and sophisticated activities that manufacturers do to deliver a product are generally of little interest to customers. To view value from the eyes of the customer requires most manufacturers to undergo comprehensive analysis of all their business processes. In order to identify the value in lean manufacturing, the manufacturer has to understand all the activities required to make a specific product, and then to optimize the whole process from the view of its customer. This customer's viewpoint is critically important because it helps identify activities that clearly add value, activities that add no value but cannot be avoided, and activities that add no value and can be avoided.

The aim of lean manufacturing is to eliminate waste in every area of production including product design, supplier and inventory management, production and delivery management, and customer service. Its goal is to incorporate less human effort, less inventory, less time to develop products, and less space to become highly responsive to customer demand while producing necessary quality products in the most efficient and economical manner by incremental improvement on production and service processes.

3.4.2 The Waste and its Causes for Lean

Based on knowledge and experience of all kinds of manufacturers, the purpose of Lean Manufacturing is to eliminate the eight types of waste of Lean. A "waste" is anything that the customer is not willing to pay for. Typically, the eight types of waste considered in a lean manufacturing system include:

1. Overproduction: It means making more than is required by the next process, making earlier than is required by the next process, or making faster than is required by the next process.
2. Waiting: The wait time of a machine for its process.
3. Inventory or Work in Process (WIP): It is material between operations due to large lot production or processes with long cycle times.
4. Extra processing: it refers to all unnecessary processing steps during production.
5. Transportation: It does not add any value to the product. Instead of improving the transportation, it should be minimized or eliminated.
6. Motion: Motion of the workers, machines, and transport (e.g. due to the inappropriate location of tools and parts) is waste.
7. Defects: Making defective products is pure waste.
8. Underutilized people: It means not taking advantage of people's abilities.

The probable causes of "waste" can be listed in Table 3 as below:

Table 3: Waste Causes in Lean

Waste Type	Waste Cause
Overproduction	• Just-in-case logic • Misuse of automation • Long process setup • Unlevelled scheduling • Unbalanced work load

Waste Type	Waste Cause
	• Over engineered • Redundant inspections
Waiting	• Unbalanced work load • Unplanned maintenance • Long process set-up times • Misuses of automation • Upstream quality problems • Unlevelled scheduling
Inventory or WIP	• Protecting the company from inefficiencies and unexpected problems • Product complexity • Unlevelled scheduling • Poor market forecast • Unreliable shipments by suppliers • Misunderstood communications • Reward systems
Extra processing	• Product changes without process changes • Just-in-case logic • True customer requirements undefined • Over processing to accommodate downtime • Lack of communications • Redundant approvals • Extra copies/excessive information
Transportation	• Poor plant layout • Poor understanding of the process flow for production • Large batch sizes, long lead time and large storage areas
Motions	• Poor people/machine effectiveness • Inconsistent work methods • Unfavourable facility or cell layout • Poor workplace organization and housekeeping • Extra "busy" movements while waiting

Waste Type	Waste Cause
Defects	• Weak process control • Poor quality • Unbalance inventory level • Deficient planned maintenance • Inadequate education/training/work instructions • Product design • Customer needs not understood
Underutilizing people	• Old guard thinking, politics, the business culture • Poor hiring practices • Low or no investment on training • Low pay, high turnover strategy

As described above, Lean targets "waste" or "non-value-added activities". Some of those activities contribute to poor product quality as well. Why? Because the causes of product quality degradation may include: transportation damage, storage misidentification or loss, rework double handling, setup adjustments producing marginal product, inspection versus process capability, and most important is the loss of communication between operators during the long procession to a finished product. Eliminating the "Waste" is eliminating the causes of quality degradation. Thus, the most direct benefit of lean manufacturing is improved quality. It means not only product quality, but also quality of the manufacturing experience. Operators in close proximity with one another can enable more meaningful communication about the process.

3.4.3 Lean Techniques and Principles

Manufacturers apply the principles of lean by facilitating Kaizen (Japanese word for "continuous improvement") events. Manufacturing teams are formed to identify and attack waste.

Lean techniques and principles are listed as below:

- **Workplace organization**

Workplace organization is the way to organize the elements of a workplace to fit individual needs. It can save time and effort throughout the work day by thinking about the best position for equipment and the most effective use of the space. The motto for workplace organization is "A place for every thing and everything in its place".

- **5S / Visual Management**

A method of creating a clean and orderly workplace that exposes waste and errors. Originally summarized by 5 Japanese words beginning with S, 5S is widely translated as Sort, Shine, Set in Order, Standardize and Sustain.

Visual management provides real-time information and feedback regarding the status of the plant. It is a company-wide "nervous system" that allows all employees to understand how they affect the factory's overall performance.

- **Standardized work**

Standardized work ensures that production operations are performed the same way each time. It consists of 3 important elements: 1) Takt time - the time needed to produce a product at the rate equal to the pace of sales. 2) Standard work sequence – the

order in which a worker performs tasks. 3) Standard in process inventory – the minimum number of parts required to keep a process moving.

- **Waste identification and elimination (eight elements of waste)**
- **Value-stream mapping**

A value stream is the set of all actions (both value added and non value added) that are required to bring a specific product or service from raw material through to the customer. Value stream mapping follows a product or service from beginning to end, and draws a visual representation of every process in the material and information flow.

- **Team-based, multi-skilled workforce**

Individuals who perform the work in an organization should work with a team. The team is built up not only to finish a single piece of work, but to fit different kind jobs, define job responsibilities and requisite, support the continues development of individual's skill, to evaluate individual and team performance.

- **Kaizen events (one week)**

Kaizen is Japanese term means continuous improvement. A Kaizen event refers to any action whose output is intended to be an improvement to an existing process. It is an efficient to quickly improve a process with a low Sigma score. The true intent of a Kaizen event is to hold small events attended by the owners and operators of a process to make improvements to that process which are within the scope of the process participants.

- **Poka-yoke**

It is a Japanese term which means mistake proofing. A Poka-yoke device is one that prevents incorrect parts form being made or assembled, or easily identifies a flaw or error. Poka-yoke is actually the first step in truly error-proofing a system.

- **Jidoka (Error proofing)**

Error proofing is a manufacturing technique of preventing errors by designing the manufacturing process, equipment, and tools so that an operation literally cannot be performed incorrectly.

- **Just-in-time**

JIT manufacturing is a planning system for manufacturing processes that optimizes availability of material inventories at the manufacturing site to only what, when and how much is necessary. It is a pull system where the product is pulled along to its finish, rather than the conventional mass production which is a push system.

- **Cellular manufacturing**

Cellular manufacturing refers to a group of workstations, machines or equipment arranged such that a product can be processed progressively from one workstation to another without having to wait for a batch to be completed or requiring additional handling between operations. It can be dedicated to a process, a sub-component, or an entire product.

- **One piece flow (Takt time)**

One Piece Flow refers to the concept of moving one workpiece at a time between operations within a work cell.

Takt time is "beat time", or "Rate time", or "Heart Beat" Lean Product using as the rate or time that a completed product is finished. It is established by the customers buying rate. Imbalanced Takt time will drive security inventories and buffer space. There is no substitute for continuously improving a balanced Takt Time, thereby eliminating security inventory / buffering.

- **Set-up time reduction (SMED)**

SMED is a "Lean" tool that reduces the changeover time. It has a set of procedures to be followed for a successful implementation. It enables Lean Manufacturing, reduces setup cost, allows small lot production, smoothes flow, and improves Kanban.

- **Pull system (Kanban)**

Pull system means the flow of resources in a production process by replacing only what has been consumed.

Kanban is a Japanese term means "signal". It is one of the primary tools of JIT system. It signals a cycle of replenishment for production and materials. It maintains an orderly and efficient flow of materials throughout the entire manufacturing process. It is usually a printed card that contains specific information such as part name, description, quantity, etc.

- **Inventory Reduction**

It refers that a company should be fast and nimble enough to react quickly to changes in customer demand and do it with little inventory.

- **Total Productive Maintenance (TPM)**

TPM is the systematic execution of maintenance by all employees through small group activities. Its goal is zero breakdown and zero defects. It obviously improves equipment efficiency rates and reduces costs. It also minimises inventory costs associated with spare parts.

3.5 Integrating Six Sigma, Lean into TQM

Because both Six Sigma and Lean manufacturing system are newly-developed, fashionable methodologies to improve existing processes, proponents of Six Sigma and Lean manufacturing have frequently clashed over the alleged superiority of one methodology above the other. However, in recent years, practitioners have begun to integrate elements of the two into one strategy along with the concept of Total Quality Management.

Bringing the two concepts together delivers results by establishing baseline performance levels and focusing the use of statistical tools where they will have the most impact. Most companies using both methodologies began by applying basic lean manufacturing techniques such as 5Ss, standardized work and the elimination of waste. Once Lean techniques eliminate much of the noise from a process, Six Sigma offers a sequential problem-solving procedure: the DMAIC cycle and statistical tools so that potential causes are not overlooked; and viable solutions to chronic problems can be discovered. Six Sigma is an enhancer for Lean.

Similarly, without Lean methodologies, a Six Sigma organization will not maximize the potential of TQM; and will complicate the organization's system and waste

significant resources, which is in violation to Lean methodology. Lean is an enabler for Six Sigma.[10]

TQM is philosophy for an organization. Six Sigma and Lean methodologies provide structured approaches to the philosophy of Total Quality Management. Integrating Six Sigma and Lean methodologies into TQM will be an evolution for Process Improvement and Quality Management in years to come.

3.6 The TQM Practices at Xantrex

Through the study of quality activities at Xantrex, specific methodologies and activities which reflect TQM at certain level can be observed in the company.

3.6.1 Corrective Action Request (CAR) System at Xantrex

There is a Corrective and Preventive Action Request Procedure at Xantrex. The purpose of this procedure is to define the activities involved in capturing existing or potential non-conformities relating to the products, processes, and services of the company; and to consequently take an action to resolve the issue and to prevent occurrence or re-occurrence of the existing or potential non-performance in the future.

Existing or potential nonconformities may be identified within various sub-processes which are:

- Inspection and test records;
- Non-conformance reports;
- Observations during process monitoring;

[10] Drickhamer, David. "Best Practices – Where Lean Meets Six Sigma" IndustryWeek, May 1st, 2001, [http://www.industryweek.com/CurrentArticles/asp/articles.asp?ArticleId=1247]

- Internal Process Review audit findings or observations;
- Field service, or customer complaints;
- Regulatory authority or customer observations;
- Observations and reports by personnel;
- Sub-contract problems with vendor;
- Management review results;
- Inherent process variability.

The identifier of the nonconformity will generate a CAR by completing a CAR form (see Appendix 2 as Xantrex CAR form template). Then he/she will send the form and any other supporting documentation to CAR administrator in the QA Department. The Administrator receives the CAR form, reviews it for completeness and accuracy, assigns a CAR number, and enters the CAR detail into the CAR Log.

The CAR Review Board has a meeting weekly for routinely review all CARs. The board includes at least one representative from Sales, Operations, Human Resources, Marketing, Engineering and Quality Assurance and Customer Service Department. They review the status of CARs, assign new CARs, and review corrective action taken on closed CARs. The board representative is responsible for coordinating and managing the resolution of all CARs assigned within their respective departments.

The CAR system can be treated as part of Total Quality Management at Xantrex. However, it is a specific routine for products, processes and service activities improvement. It is focused on detailed issues resolution and improvement; a way of cross-functional communications. But it may lack the total concept, culture, and

momentum of TQM. As this analysis develops, we will see that there is considerable room for Xantrex to implement more structure on quality improvement.

3.6.2 ISO 9001 at Xantrex

ISO 9001 is a series of documents that define requirements for the Quality Management System Standard. It contains the actual requirements an organization must be in compliance with to become ISO 9001 registered. In 1998, the 3 Xantrex facilities in Burnaby, BC; Arlington, WA; and Livermore, CA have hold the certificate of ISO 9001:2000 for the scope of design and manufacture of advanced power electronics equipment.

Although ISO certification creates guidelines for quality compliance, it is likely not a robust-enough set of processes to help Xantrex achieve its ultimate goal of reducing product returns. ISO in and of itself does not require any of the TQM processes discussed previously and is more than anything else a documentation-control and reporting process.

4 SURVEY AND ANALYSIS ON CUSTOMER RETURN

The driving objective of this project is the analysis of the phenomenon that the mobile products from Xantrex have about 4 – 6 per cent return rates, but over 70 per cent of those returned products are non-fault found. The real "pain" is that Xantrex not only receives no revenue from these products but also has to add a large amount of cost on those products for transportation, storage, and scraping.

4.1 Census, Sample Survey, or Administrative Data?

Customer return relates to customer behaviours, which in turn depends on how the customers perceive the products. In order to dig out the root causes behind the customer return issue on Xantrex mobile products, data on customer perceptions must be collected.

In order to be successful, a business must know who its customers are and what the expectations of those customers are for the product or service the business sells. The process of collecting such customer information is known as identifying the voice of the customer (VOC). The key to having success in this process is gathering customer data and converting it into measurable critical-to-satisfaction elements.[11] This chapter will explore customer satisfaction issues related to Xantrex products.

Customer data may readily available to a business from sources such as customer complaints, warranty claims, customer returns, refunds, etc. All these sources can become

[11] Thomas, Debra. "Turing Customer Data into Critical-to-Satisfaction Data" [http://www.isixsigma.com/library/content/c040913a.asp] Accessed November 2004

part of a business' ongoing knowledge base that can be transferred into administrative data. Additional customer data may be obtained from censuses, focus group interviews, and feedback cards.

A census refers to data collection about every unit in a group or population. Thus, there is no sampling variance. But the cost, time and response burden on such a census can be very high. Few if any businesses ever employ census-style data collection.

In a sample survey or focus group interview, only part of the total population is approached for data collecting. The sampling variance is non-zero, and the sample may not be large enough to produce convincing information from small population, sub-groups or small geographical areas. But its cost, time and response burden are relatively low. The smaller scale of this operation also allows for better monitoring and quality control.

Administrative data is collected through some administrative files as a result of an organization's day-to-day operations. These administrative files can be used later as a substitute for a sample survey or a census. For this administrative data, sampling variance is zero. Data is collected on an ongoing basis, allowing for trend analysis. This data eliminates the need to design census or survey and the associated work. Since the data are already collected, there is no additional burden on the respondents. However, data items may be limited to essential administrative information or be limited to the population on whom the administrative records are kept. Data quality may differ from one organization to another.

Feedback cards are a common method of measuring customer satisfaction and are used by many manufacturers, retailers and service suppliers to rate elements such as quality, performance, and service.

The main business method for Xantrex is selling its mobile products through several retailers. Unfortunately, those retailers have cut off information flow between Xantrex and its customers. There was no readily-available and systematic administrative data for this project. In order to understand customer insights, taking a sample survey from customers who have returned products would be an ideal data collection method. However, because this project is the first step to understand customer insights for Xantrex through finding root causes of customer returns, the ability to conduct a rigorous data collection is limited. Additionally, the company does not currently track or record customer feedback information in any systematic way. Therefore, a combination of limited surveying plus focus group interviews have been used to collect rudimentary data related to customer perceptions.

4.2 Focus Group Interview

Before starting the focus group interviews, the objective of such interviews should be clarified and kept in mind. The objective is to find the primary reasons why some customers return Xantrex mobile products. Moreover, several points should be defined before interviewing: what kinds of people/groups will be interviewed; what kinds of questions will be asked; and what kinds of responses will be expected. This project should also define how the information collected through this interview will be analyzed and utilized for the project objective.

4.2.1 Brainstorming for a Survey Questionnaire

Approximately 20 people from Xantrex and one Simon Fraser University MBA class contributed to a brainstorming campaign to generate all possible scenarios of electronic appliances returned from end users. The purpose of this brainstorming process was to generate a comprehensive list of possible reasons for returning Xantrex products. In essence, this process generated multiple possible hypothesis explanations for product return.

After all possible scenarios were collected, analyzed and reorganized, a questionnaire for customer survey was developed as shown in Appendix 3.

4.2.2 The Survey / Interview Plan

By utilizing the customer survey as a template, two sample groups were interviewed in semi-structured face-to-face way to verify actual customer return reasons.

Group #1, "Internal Group" includes 10 people from Marketing, Sales, Engineering, and Quality Assurance and Customer Service Departments of Xantrex. Most of the participants were senior managers who have extensive experience on quality, sales and customer service issues of the mobile products.

The basic questions during the Internal Group interviews were:

1. Rank the items in the questionnaire according to their work experience and their observation/sense on customers;
2. Suggest any other reasons they think possible for customer return;
3. Give their common sense about return rates for electronics appliances such as personal computer, television set or any other power supply unit;

4. Provide comments or recommendations on quality assurance, quality control and quality improvement processes or practices at Xantrex;
5. Provide comments or recommendations on product return, RMA and customer service procedures;

Group #2, the "External Group" includes people who are in charge of or know something about customer return/service in retail industry such as Canadian Tire, Rona and Costco; or customers who ever used Xantrex mobile products or some other similar electronic appliances and have the experience on purchased electronic appliances return.

The general questions during interview with External Group are:

1. What are the return rates of household electronics products in a common store? Is that related to quality, price, service or some other factors of the products?
2. How about Xantrex product performance compared to other electronic appliances?
3. What kind of phenomenon they could see on customer behaviour during product returning: Is package opened or not, how long they returned from purchasing. Is the product used, tried to be used or seems to be never used?
4. Do they think customer knowledge is enough to use of those electronic appliances properly?
5. What are the common real reasons for customers to return electronic appliances they bought?
6. What was the stated reason, if any, for return goods?

4.3 Information, Data, Analysis and Reasoning from the Interview

Gathering customer information is the first step in creating useful data for the project. Customer data is analyzed to uncover customer perceptions and satisfaction trends over time. There are multiple tools available to analyze this data and determine whether customer satisfaction is trending positive or negative, or whether customer is more likely to return the products.[12] The most appropriate tool for analyzing the data presented by the group interviews is a Pareto analysis. Pareto analysis is used to represent the ratio of a number of "causes" to the total number of issues or problems. In this analysis, a Pareto chart can help establish top reasons for customer dissatisfaction. Pareto charts can also show whether defect/reject categories are being driven down over time..

4.3.1 Analysis of Internal Group Interview

Each person from Internal Group ranked the reasons of those mobile products return differently according to his/her own experience and perspective on customers. However, some reasons were more often to be mentioned than others were. Those reasons may the real reasons that cause customers to return the mobile products they bought. Thus, each of the possible reasons suggested by those people is weighted according to those people's ranking. One reason which ranked 1 by one person was given a score 5; ranked 2 was given core 4; ranked 3 was given score 3 and so forth. Based on this procedure, eight most-frequently-mentioned reasons which have highest scores with the cumulative percentage are shown in table 4.

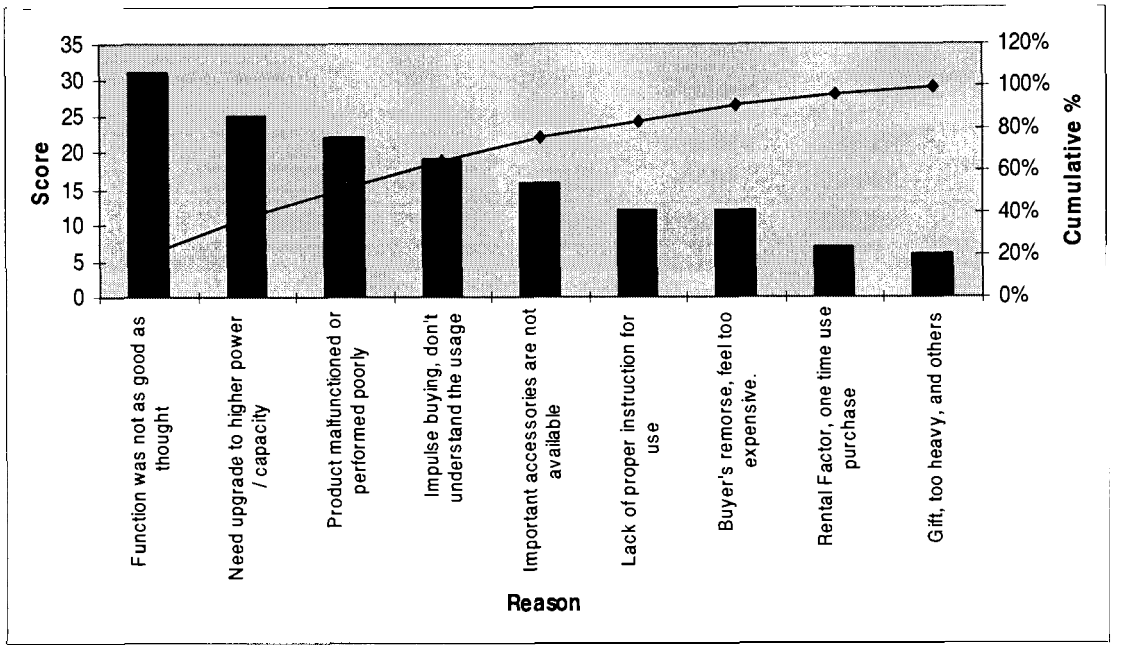
[12] Thomas, Debra. "Turing Customer Data into Critical-to-Satisfaction Data" [http://www.isixsigma.com/library/content/c040913a.asp] Accessed November 2004

Table 4: Customer Return Reasoning Item and Their weighted Score

Reason	Possibility Ranking					Total Score	Cumulative Percent
	Rank 1	Rank 2	Rank 3	Rank 4	Rank 5		
Function was not as good as thought	2	3	3			31	21%
Need upgrade to higher power / capacity	3	1		2	2	25	37%
Product malfunctioned or performed poorly	2		1	4	1	22	52%
Impulse buying, don't understand the usage	1	2	1		3	19	65%
Important accessories are not available	1		3	1		16	75%
Lack of proper instruction for use		2		1	2	12	83%
Buyer's remorse, feel too expensive.	1	1	1			12	91%
Rental Factor, one time use purchase		1	1			7	96%
Gift, too heavy, and others				2	2	6	100%

To study such a case, a Pareto Chart is normally used to graphically summarize and display the relative importance of the differences between groups of data according to the total score and the cumulative percentage of those eight reasons in Table 4. The Pareto Chart by which could show the most important reasons more clearly for customer return was made in Figure 3:

Figure 3: Pareto Chart from Internal Group Interview



By viewing this Pareto Chart, the Pareto Principle or the "80/20 Rule" is demonstrated. Pareto's famous rule holds that about 80 per cent of effects or shown problems are caused by only about 20 per cent of total number of root reasons. In this case, about 75 per cent of possibilities that cause customers to return their mobile products are from the only 5 reasons (about 20 per cent of total reasons mentioned). These 5 reasons are:

1. **Function was not as good as expected.** It may because of quality problems. But in most cases, the customers who had bought the product found that the product's real performance was different to their original expectation on it. There is a "gap" between customer insights on the product and the real situation of the product.
2. **Need to upgrade to higher power or higher capability**. The customers didn't calculate how much the capability of the inverter power they need before they buy. Or customers misunderstood the power the product has. For instance, XPower 400 means its surge power is 400 watts for up to 5 minutes, not as 400 watts for continuous power. Manufacturer does not use the same language as normal customers do.
3. **Product malfunctioned or performed poorly.** In some cases, it is because quality issues such as manufacturing defect, components aren't installed properly. But in some other cases, according to some persons from Customer Service Department at Xantrex, it is because customers abuse the product.

4. **Impulse buying, don't understand the usage.** Customers are encouraged to buy the product by advertisement, in-store promotion, flyers, and shop clerks' introduction. According to a marketing finding, 70 per cent of purchase decisions are made directly at the point of purchase (P.O.P.).[13] They didn't real know that they need the product and how to use such product properly; and finally returned what they bought to the stores.

5. **Important accessories were not available.** Especially for those high capacity inverters, customers have to buy one specific cable which is costly for the customer. So they would rather give up using the products and return them.

4.3.2 Analysis of External Group Interview

In order to verify findings from the Internal Group's interviews, External Interviews were done as well. The people who responded for the External Group interviews are store managers from Canadian Tire, Costco, and persons who are in charge of customer services in stores such as Wal-Mart, Rona, and etc. The group also includes individuals who have Xantrex mobile products or other electronics appliances purchasing and have the experiences of returning such goods.

About two dozens external people were interviewed regarding customer return issues. The most-frequently-mentioned items are listed in Table 5 as below:

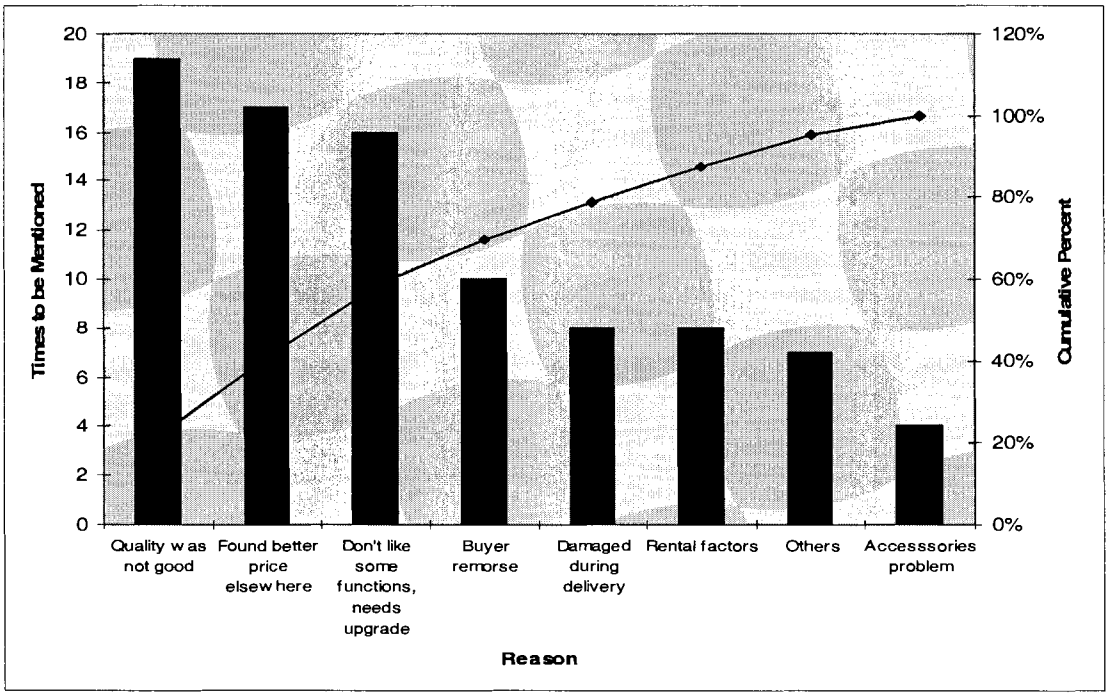
[13] LNOPPEN. "POP Marketing Benefited from Shopper Insights – Winning the Last Three Feet at Retail" China Business July 2004

Table 5: Main Customer Return Reasoning from External Group Interview

Reason	Times to be mentioned	Cumulative Percent
Quality was not good	19	21%
Found better price elsewhere	17	40%
Don't like some functions, needs upgrade	16	58%
Buyer remorse	10	70%
Damaged during delivery	8	79%
Rental factors	8	88%
Others	7	96%
Accessories problem	4	100%

The Pareto Chart can be shown in Figure 4:

Figure 4: Pareto Chart from External Group Interview



Most responses about customer return issues during the interviews refer not only to Xantrex mobile products, but to normal electronic appliances as a whole – thus,

construct validity for this group is not perfect. Those electronic appliances include personal computer, TV set, audio/video appliance, and home and garden power tools.

Through the Pareto Chart in Figure 4, the top five items for common electronic appliance return are described briefly as below:

1. **Quality was not good.** Quality is the most often mentioned item by those respondents.

2. **Found better price elsewhere.** The second most important issue is price comparison. Customers returned the good because they either found a better price on competitive product; or found a better price on the same product in other stores; or just be informed a new price deduction from same store after purchasing. As for Xantrex mobile products, for instance, retailers like Canadian Tire may send flyers to promote "Motomaster"[14] with a discounted price. It may seduce some customers who have bought "Motomaster" before promotion to return the old one and buy a new one with lower price.

3. **Don't like some functions, needs upgrade.** Customers prefer the function of one specific model, or need to upgrade the model they purchased. These cases may cause them to return the original ones. Such cases often happen for electronic appliances, especially under the environment in which new technologies are developing more rapidly. As mentioned in Internal Group Interview analysis, this related to customer

[14] Motomaster is Xantrex mobile product under Canadian Tire brand.

knowledge on those goods, and how manufacturers describe the functions in one model.

4. **Buyer's remorse.** A customer sometimes feels that a product was too expensive for what they bought, or feel guilty of spending money. In this case, they might return products as well. Common "Customer Return Policies" of most retailers in North America are liberal enough for customers to return what they bought without sound reasons. Such policies can increase the sales volume. But it can also increase product return rates.

5. **Damaged during delivery.** The fifth most-common response is a packaging problem; or product damaged during delivery. For Xantrex, according to responses from Internal Group, it may not the case for its mobile products.

Besides the five main issues often mentioned during interviews, some other issues may contribute to increasing return rates as well. These include: rental factor – customers only use what they bought one time and return the products after their projects completed; retailers overstocking the products and returning them to manufacturers through customer return procedures. Customers found additional accessories were too expensive and gave up using the original products and return them.

4.3.3 Critical-to-Quality Analysis

Having identified key customer return issues, the question remains as to how Xantrex can resolve those problems? The information should be translated into critical-

to-quality (CTQ) requirements for the company. Some common aspects can be elicited from those main reasons via detailed analysis.

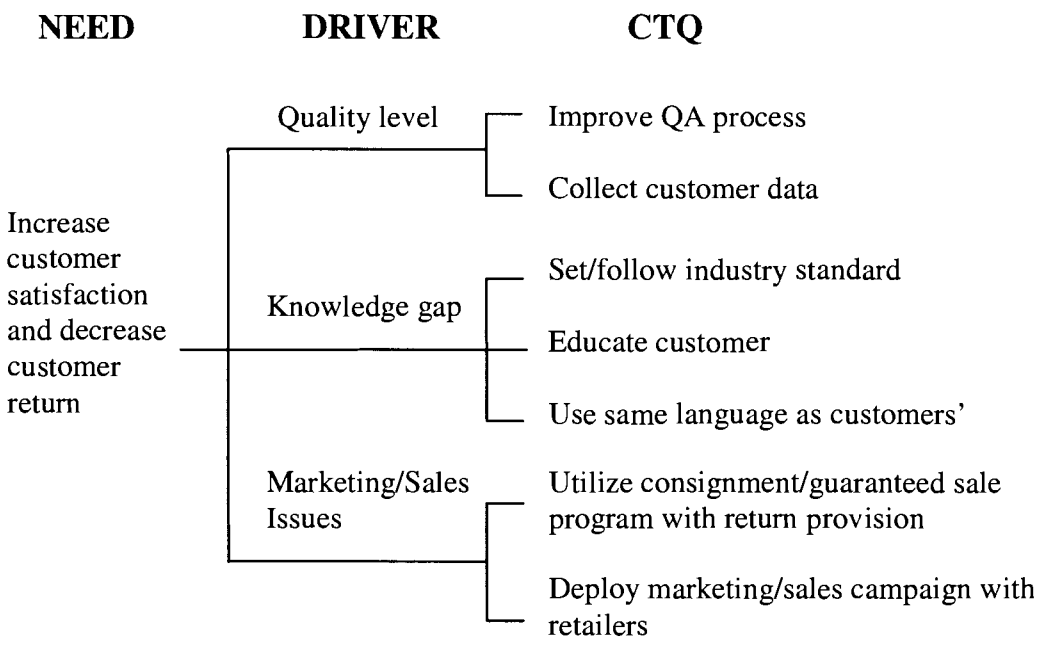
First of all, product quality is always related to customer return. The quality level of mobile product can be improved through quality improvement to core Xantrex production processes. This can decrease product malfunctions and relevant quality issues both mentioned by Internal and External groups. On the other hand, quality level should be defined according to real customer requirements. Thus, systematically and continuously collecting customer information and saving it as customer data is critical to Xantrex as well. Perhaps the most significant issue is that Xantrex does not have robust-enough data on customer returns to know where the primary issues lie.

Secondly, a "knowledge gap" exists that causes customers' expectations on products to be different from product actual performance. Customers may not make enough pre-purchase study to understand the product functions and usages. Xantrex may not clearly express the functions or capacities of its products to potential customers. All these scenarios can cause customers to use the products improperly or to abuse the products, or to look elsewhere to meet their needs.

Thirdly, the company's sales and marketing procedures or promotion campaigns may not be perfectly balanced, especially for those working directly with retailers. Properly set, those procedures should increase the enthusiasm of retailers to sell Xantrex products, give better service to end users, and to decrease cases such as buyer's remorse, "rental factors", impulse buying, etc.

The creation of a Critical-to-Quality tree can help understand the nature of the quality gaps. The CTQ tree can be seen as below in Figure 5:

Figure 5: CTQ Tree for Customer Return



Here it should be noted that some of the activities are short-term which can be executed through a short-term project team. Some, however, are long-term activities which should align with company's business strategy and long-term processes.

Product quality issue can be resolved from two aspects. First, the company can increase its quality level by setting and following an efficient, complete and understandable quality assurance/control processes; and then continuously improving such processes. It is a long-term activity. Second, the quality specifications should be always defined by the customers. So the company should set a proper way to collect and translate customer information to its product quality specification.

Additionally, customers need to be educated. The ways include in-store demonstration, graphic pamphlets, or even video to help the customer understand the products and how to properly use them. The company also needs to ensure that the

introduction and technical information it uses on product packages, and in product installation and operation manuals is understandable by common customers and is consistent with customer knowledge and insights on the products.

Because the company sells its product through retailers, it has to work closely with its key retailers on balanced sales/marketing promotions. Unbalanced campaigns may increase customer return as well.

Details on those specific suggestions as to changes in practice will be recommended with a specific short-term action plan in the last chapter of this project. The next chapter focuses on benchmarking for best practises in product quality management.

5 BENCHMARKING FOR BEST PRACTICES ON PRODUCT RETURN

Having analyzed the reasons for customer returns, the next step should be to set a series of approaches to eliminate or decrease those causes of customer return. For this project, as mentioned in last chapter, three aspects can be reviewed in parallel. One is to improve the quality level of those mobile products through improved product-creation quality management. There is likely room for Xantrex to continue to improve their process – as they themselves recognize. Another aspect is to fill the gap of the product knowledge between manufacturers and customers. The final aspect is to take balanced marketing/sales activities with its retailers and modify its customer return procedures to decrease the return rates.

But how can the company correctly implement solution strategies for those three aspects? One method is to implement a benchmarking strategy against other manufacturers to learn "best practices" in the same industry or outside the industry. As presented in last chapter, some causes of customer return are irresolvable or inevitable at the moment, or need a long-term strategy to improve. But some causes can be resolved partly through "best practices" learned from benchmarking. The art of benchmarking is comparing how you do things and how well you do things against acknowledged "best practices" companies. Upon discovering gaps, a company can adopt systems and practices proven in other companies for their own purposes.

5.1 The Benchmarking Process for the Project

5.1.1 What is Benchmarking?

Benchmarking is a tool to help a company improve its business processes. Any business process can be benchmarked. Benchmarking itself is also a process of identifying, understanding, and adapting outstanding practices from organizations anywhere in the world to help the organization improve its performance.[15] As a highly respected practice in the business world today, benchmarking looks outward to find best practice and high performance and then measures actual business operations against goals of the organization. For this project at Xantrex, benchmarking will assess quality management, manufacturing operation, inventory management, customer/retailer relationship and service, and so on in select other organizations, as well as their own processes at Xantrex. The aim is to help the company in the effort to learn how to match and even surpass those best-in-class organizations.

It should be noted in advance that benchmarking is not simply a competitive analysis, number or data crunching, or site briefings and industrial tourism. An organization can not easily copy what its competitors or other firms are doing. It is not a quick and easy way to improve a company's system and processes. Benchmarking is a formal undertaking of process-to-process comparison.

There are four types of benchmarking:

- Internal Benchmarking – Comparison with other functional departments or Market Business Units in the same organization.

[15] "The Benchmarking Exchange" [http://www.benchnet.com/wib.htm] Accessed September 2004

- Competitive Benchmarking – Analysis of strategies, process and practices with competitors and companies in the same industry.
- Process Benchmarking – Analysis of best practice processes and functions regardless of industry
- Strategic Benchmarking – Proactive analysis of emerging trends options in markets, processes, technology and distribution that could affect strategic direction and deployment.[16]

In order to implement benchmarking to find best practices on customer return issues, it is important to understand Xantrex's own processes or approaches. This project of benchmarking will, at first, compares processes, practices and results within the organization. These practices are then compared to its competitors, world-class organizations in electronics industry, or organizations outside this industry. After that, Xantrex can plan to take actions to match or even exceed the best accordingly.

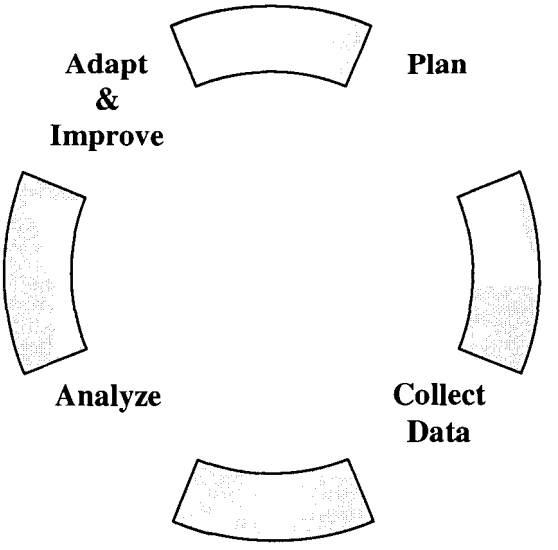
5.1.2 The Benchmarking Process

This project will implement benchmarking by utilizing "4-Phase Model" which is generated by American Productivity and Quality Center (APQC) [17]. This model includes Plan Phase, Collect Data Phase, Analyze Phase, and Adapt & Improve Phase respectively.

[16] "Benchmarking: An Executive Overview, Education & Training Division", American Productivity & Quality Center

[17] APQC: American Productivity and Quality Centre. It is a recognized benchmarking authority for helping companies' processes and performances improvement worldwide.

Figure 6 APQC's "4 – Phase Benchmarking Model"



In the Plan Phase, the benchmarking team has to prepare the benchmarking study plan, establish the scope of the study, do research on best practices in several industries, select proper competitors/organizations, and analyze its existing process. It will also document the process, establish family of measures, introduce how to determine the process of performance, and identify potential partners for secondary research.

Next, in the Collect Data Phase, the benchmarking team will prepare and administer questions, capture the results, follow-up with its partners. The team will present how to develop a database to tabulate responses, and how to determine primary partner relationships and conduct site visits if needed. Methods of survey, results and data collected will be shown as well.

In the Analyze Phase, performance gaps and the real reasons of the problems, best practices, methods, and enablers in each of study areas will be examined. This will show

analysis based on survey results and data collected and try to identify relative best practices for resolutions.

The last phase of benchmarking is the Adapt and Improve Phase. The team will publish findings, create an improvement plan, and execute the plan for change. During the Adapt and Improve Phase in benchmarking approach, the project team must make sure to gain the support from company's management. Then long and short term improvement goals are established. The team can formulate and obtain approval for the action plan they made and then track progress of action team.

Since benchmarking is a continuous process for a company, the project team should also adapt changes, update measurement process, then, as appropriate, recycle the benchmarking.

5.2 The Methodologies for Benchmarking

Benchmarking takes many forms from reverse engineering of competitors products and plant visits to gathering data from industry associations and on-line toolkits. It is relatively easy to take an internal benchmark with one process and best practices in another functional department in the same organization. Competitive benchmarking can bring obvious benefits to the company since best practices are easy to copy. However, standard internal and competitive benchmarking is not enough for an organization to obtain competitive advantages in a fast-changing and extensive competitive environment. As one manager whose plant won the Best Plants Award from "IndustryWeek" magazine noted, "If you want to run with the big dogs, you have to get up off the porch." The corollary is that if you want to find out what the "big dogs" are doing, you have to get out

of your factory and start taking notes. Only then will you understand how you are doing in comparison to the top performers. Process and strategic benchmarking will provide some ways to let an organization to compare with those "big dogs".

Through benchmarking, at least three things can be understood about a company. First, the position of the company in the industry: What are competitors doing? Which of them are better and which are worse than the company? What can be learned from them so that the company can keep the pace of development in the industry or even surpass its competitors? These all could be answered through competitive benchmarking. Secondly, the best practices can be utilized. Those best practices in similar or relative processes regardless of industry can be modified and utilized which will benefit the company's plant. This is reflected in process benchmarking. Thirdly, the future trends in years to come: The company has to know what the new-emerging technologies are and what new methodologies will affect the organization. These new things can be found through strategic benchmarking.

The biggest challenge to successful external benchmarking is that the information is not often easy to obtain, especially for the important metrics that a company wishes to use for comparison. People are aware that critical information must be kept in secret. Frequently, a benchmarking organization must resort to other indirect media such as mutual customers, industry associations, published articles, and so on to obtain this information. Some organizations even set up a specific unit called Information and Strategy Department to collect such information. The cost and time for such tasks are considerable.

For this project, besides on-line and library information search, one on-line benchmarking toolkit was used named "IW Path to Excellence" from IndustryWeek magazine. This toolkit allows a company to dig into dozens of best practices and performance indicators from IndustryWeek's Best Plants winners and finalists – many of the top manufacturing facilities in North America. It is very helpful for process and strategic benchmarking.

5.3 Internal Benchmarking QA Process with New Product Creation Procedures at Xantrex

Internal benchmarking can improve the quality of Xantrex products by keeping its quality assurance processes in line with new product creation procedures.

5.3.1 Benchmarking QA Processes with New Product Creation Procedures at Xantrex

Customer-defined product quality is one of the critical factors directly related to customer returns. For Xantrex, benchmarking QA processes and practices can help to achieve its customer returns objectives. Internal benchmarking can be done at first with the new product creation "4-11 procedure" previously explained in Section 2.3.2.

One contribution by the Quality Assurance Department on new product creation is to help achieve product realization. This is a critical commitment of the QA Department. In this regard, the concept of TQM seems be well understood by Xantrex management and QA managers. However, some intended practices from TQM seem to be partly implemented. As previously described, the New Product Creation "4-11 procedure" includes activities ranging from the new idea generation phase to the product

discontinuation phase – the whole life-cycle of a specific product. This procedure should embrace Total Quality Management concepts and practices.

Quality assurance practices that should be in line with the "4-11 procedure" can be summarized in Table 6.

During the Definition Stage of the "4-11 Procedure", new ideas normally originate from the Engineering, Marketing and Sales departments. In fact, the TQM requires that all employees understand customer needs, generate new product ideas to fit these needs, and consider those ideas from a quality point-of-view. The QA Department could enhance its contribution to new product ideas by having more involvement from employees, and educating them regarding TQM concepts. The "4-11 Procedure" requires QA involvement in reviewing Market Requirements and the Product Priority Model during the Study Phase. However, these procedures do not seem to be mandatory within the organization. Currently, QA has little participation in this phase. TQM philosophy requires that not only QA staff, but all of the employees understand customer needs. Hence, increased execution of the TQM will increase understanding of market and customer needs, and then, will increase the viability of more new, realistic product ideas. As the TQM concept describes: "Do the right thing, right the first time, every time". QA should also give some input toward the Program Plan in the Planning Phase. At the top management level in the company, the VP of Quality Assurance and Customer Service Department is a member of the PAC, so there should be some contribution from the Quality Assurance department. But as observed, relatively few thoughts regarding quality and TQM concepts are considered during Planning Phase.

Table 6: QA Activities Along with New Product Creation Procedure at Xantrex

Stage	Phase	Quality Assurance	Engineering Design	Marketing Product Mgmt	Manufacturing Supply Chain Mgmt	Customer Service
DEFINITION	**Ideas Phase**	Input ideas	Product concept	Product concept	Input ideas	Input ideas
	Study Phase	Review MR and PP	Feasibility study Draft FS Draft PP	Market study Draft BP Draft MR	Producibility Quality Tooling Objective	Review FS and PP
	Planning Phase	Input to PP	Final FS Final PP	Final MR Final BP	Input to PP	Input to FS & PP
DEVELOPMENT	**Design Phase**	Draft Quality Plan	System Design Pre-A model Product cost	Test concept with customers	Draft Mfg Plan	Test concept with customers
	Prototype Phase	Final Quality Plan	Unit build/test A model verification Alpha tests	Preliminary intro plan Customer review	Final Mfg plan Product cost	Draft service plan
	Verification Phase	Program & product evaluation Check SRR	Finalize design B model verification Beta tests	Final intro plan Alpha validation tests	Product cost Develop Mfg processes B model build/test	Final service plan B model evaluation Check SRR
	Pilot Product Phase	Process monitoring Product audit	Support for production & validation tests	Introduction / preparation beta validation tests	Prove C model production Set FBS Ramp up preparation	Technical training Product audit
LAUNCH	**Ramp Up Production**	Process monitoring Check SRR	Production support	introduce product	Final product cost Update MPS	Technical training Product audit
	Deploy Phase	Customer follow up	Customer follow up Close PP	Customer follow up Close PP	Meet COGS and delivery targets	Customer service
POST LAUNCH	**Continue Phase**	Customer follow up Customer data	TC support Continue Engineering Sustain Engineering	Business Champion support	Maintain FBS / MPS	Customer Service Maintain WR data
	Discontinue Phase	Maintain customer satisfaction data	TC support Continue Engineering Sustain Engineering	Discontinue product	Support ramp-down/ inventory reduction	Close WR program

In the new product Development Stage, QA people are deeply involved in all phases, with people from other departments, to create Program Teams. A QA person submits both draft and final quality plans in the Design Phase and Prototype Phase respectively. Program and

product evaluation are conducted in the Verification Phase. Reliability Engineers test the prototypes through HALT (Highly Accelerated Life Tests) and HASS (Highly Accelerated Stress Screens) for product reliability. A QA person has the authority to check the Sales Readiness Release as well. During the Pilot Production Phase, a QA person also takes the process and product audits. In this stage, the only needs may be a more powerful tool and a realistic practice routine to improve the effectiveness and efficiency of the work.

When a new product is in its Launch Stage, the "4-11 Procedure" requires QA staff to continue process monitoring and improving in accordance with TQM. During this stage, the CAR system is implemented. What Xantrex needs is a more systematic and continuous process from the TQM point-of-view in the Ramp-Up Phase. In the later Deploy Phase, the "4-11 Procedure" requires QA staff to execute the Customer Follow-Up process. However, no evidence shows that QA staff have gone to customers already.

In the Post-Launch Stage, a QA person is required to be responsible for customer follow-up and to collect relevant customer data during the Continue Phase. Even when the product is obsolete, and enters to the Discontinue Phase, a QA person must maintain the customer satisfaction data. So far, Xantrex has no sufficient data/information collecting process and does not maintain a database in a proper location to help the company improve its relevant processes and management ability in the future. It seems urgent and necessary to set up appropriate customer data collection processes at Xantrex.

As previously described, the new product creation "4-11 Procedure" covers the entire life-cycle of the product. It has applicable activities, milestones and responsibilities for each phase. However, Quality Assurance currently focuses its main efforts on the

Development Stage. According to TQM, Six Sigma and Lean manufacturing concepts, the Quality Assurance Department should be in charge of educating all employees who are involved in new product creation activities, to have the Total Quality Management concept. Furthermore, the company should define all quality specifications according to customer requirements; and do every thing with quality in mind. By just doing this, the quality of the new product can be improved in the right direction. Moreover, quality can be improved during the Launch Stage by continually checking and improving quality control and manufacturing processes with the Six Sigma and Lean Manufacturing methodologies. During the Post Launch Stage, customer follow-up and customer data are so important in that they are not only for existing product development but also for future product development.

5.4 Competitive Benchmarking and Relevant Information

Competitive benchmarking can be done in several ways: hiring key staff from your competitors; extracting information from industry associations, published articles, news media, and the internet. In some cases, information about competitors can be difficult to obtain. General methods for this project relate to searching on-line, reviewing published articles from libraries, and conducting interviews.

5.4.1 The Competitors of Xantrex

Currently, Xantrex does not have very strong head-to-head competitors in the market. But interviews of Sales and Marketing staff at Xantrex combined with on-line searching, has revealed the extent of existing competition. The possible or potential competitors and corresponding benchmark information are:

1. **Vector:**

   Vector Manufacturing, Ltd., based in Fort Lauderdale, Florida is a manufacturer of portable power products including battery chargers, power inverters, portable jump-starters, hand-held rechargeable spotlights, thermoelectric coolers, mini-fridges and rechargeable table lamps. Products are sold by most major retail, automotive, do-it-yourself homecenter, hardware and sporting goods stores, in addition to major catalogue retailers, wholesalers and truckstops. Currently, Vector's main retailers are Costco, Home Depot, Wal-Mart, and West Marine. Reportedly, its product quality is as good as Xantrex in the market.

2. **Coleman:**

   The Coleman Company's original factory is in Wichita, Kansas. It is developing portable products in order to enter the mobile market. Reportedly, its products are of poor quality at this time.

3. **Tripp Lite:**

   Tripp Lite is located in Chicago, Illinois. Its inverters and inverter/chargers convert DC (battery) power into 120V AC (household) power for use in cars, SUVs, trucks, RVs, boats and more. However, these products are reported to be of lower quality compared to existing Xantrex products.

4. **Victron Inc.:**

   Victron Inc. was founded in 1983 and is headquartered in Fremont, California. Victron is a privately held minority certified corporation.

Victron provides leading edge Electronic Manufacturing and Supply Chain Management services to a variety of leading Original Equipment Manufacturers (OEMs) in the communications, networking, medical, automotive, consumer and wireless industries. It is currently developing mobile power supplies for cars, SUVs, boats, RVs and other applications through its NPI (New Product Introduction) facilities. Its goal is to provide Total Customer Satisfaction through timely delivery of quality products and services at a highly competitive cost. Through the implementation of Victron's Total Quality Management System, it achieves this objective by encouraging continuous improvement of performance across all areas of the company.

Victron's NPI Center utilizes state-of-the-art manufacturing equipment that is designed to handle small volume prototype runs with extremely quick turnaround times. Most importantly, Victron's NPI center has dedicated New Product Introduction Engineers that oversee all functions including equipment programming, process creation and quality verification. Combining their extensive experience and technological expertise, Victron's NPI Engineers also utilize the Valor software system (Trilogy 5000) to provide complete DFM[18] and DFT[19] analysis for all products.

According to what Victron states, it understands that the new products introduction process is extremely critical to its customers and frequent

[18] DFM: Design for Manufacturing
[19] DFT: Design for Test

design changes are a way of life during this stage of product development. Therefore, Victron's NPI Center focuses intently on customer requirements and swift response to meeting any changes or requests.

5. **Targus:**

   Targus is the leading global supplier of mobile computing cases and accessories. Its goal is to enhance customer lifestyle by offering innovative and quality products, as well as continuing to listen to and respond to its customers. Targus is currently developing power inverters for computers.

Further detail and additional information for the above companies are not available. Sensitive data such as customer return rate, the cost of warrant authorization, or decrease return rate during last 3 years is currently unavailable – the research of which is outside the scope of this project.

5.4.2 Competitive Benchmarking in the Same and Similar Industries

With the exception of the potential competitors listed in previous section, additional benchmarking information for manufacturers and retailers in similar industries can be found. Product data from these manufactures and retailers that produce or sell similar products and common electronic appliances is available. Similar products and electronic appliances include auto electromechanical parts, personal computers, and some household electronic appliances.

When comparing customer return rates of consumable products, it should be kept in mind that return rates for different products vary over a wide percentage range. They

could range from almost zero per cent to more than 30 per cent. For instance, one broadband wireless product that helps improve the performance of plug-and-play Wi-Fi equipment has a product return rate that can be as high as 30 per cent.[20]

5.4.2.1 A Manufacturer for Automotive Electrical Products

Here is an example of a power system supplier, HEHR Power System (HPS). HPS is a manufacturer of a wide range of electrical products for the automotive, RV, marine, transit, and emergency service industries. Its products include heavy duty alternators, marine regulators, vehicle-mount D.C. welders and multi-battery isolators. HPS works closely with OEM's and has one strong distributor network for widespread product availability throughout the U.S., Canada and other countries. HPS is located in Fort Worth, Texas, and is a certified ISO9001 manufacturer.

Similar to that of Xantrex, HPS has a Quality Policy, which states "The company quality policy has been established identifying quality system objectives. This policy has been communicated to all employees and is actively sustained by all associates as the highest priority within the company, so that each employee clearly understands his and her role". This company focuses on internal communication and sets everybody's goal in accordance with the company goal.[21]

HPS is very aware of Total Customer Satisfaction. It uses a communication network which offers the customer base and user base immediate access to technical support and personal answers to their product questions without the distraction of voice mail. It guarantees same day response to customer inquiries and 100 per cent on time

[20]Mackie, Kurt. "Hawking to Use Motia's Smart Antenna Product" [http://www.shorecliffcommunications.com/magazine/news.asp?news=3298] Accessed October 2004
[21] [http://www.hehrpowersystems.com/hps.htm] Accessed October 2004

delivery of products. It also promises that it will take no more than three business-days to respond to a customer order.

Below is the fundamental quality system comparison table between HPS and Xantrex:

Table 7: Quality System Comparison Table

	HPS	Xantrex
Customer Satisfaction	▪ Personal answer to customer requirement ▪ Same business day response to customer inquires	▪ Strong customer service / technical support ▪ Personal answer to customer requirement
Product Delivery	▪ 100% on time ▪ No more than 3 business day response to customer order	▪ 82.7% on time
Product Quality	▪ 100% defect free product ▪ Process capability: Cpk $\geq$ 1.33	▪ 95% of first-pass yield for finished products ▪ Process capability should be much less than 1.33
Customer return rate	▪ Less than 4% of gross sale.	▪ From 4% to 6%
Process Improvement	▪ Prevention of manufacturing problems	▪ CAR system
Quality Control	▪ Real time SPC program	▪ Suppliers' processes monitoring and product testing

Through such benchmarking, it is easy to see a quality advantage of HPS over Xantrex. HPS seems to have deployed some TQM and Six Sigma Methodologies that give it a much higher level of quality on its products. Its products can reach defect-free rates of almost 100 per cent before they get into the hands of customers. The Cpk level is more than 1.33. HPS uses a real time SPC program and preventive activity during manufacturing in securing its quality level.

Based on the information and benchmarking described above, the HPS product return rate of gross sales is less than 4 per cent. This suggests that Xantrex could decrease its return rates by about 1 per cent through product quality improvement. Further reduction could be achieved through improvements of other processes such as Return Merchandise Authority, Sales and Marketing, and Customer/Retailer Relationship.

5.4.2.2 An On-Line Computer Shop

The return rate information for one U.S. on-line personal computer and PC accessories shop, Directron.com, is presented below:

"On average, the total RMA orders constitute 4.4 per cent of all its orders regardless of the reason for return. In other words, a customer who places an order with Directron.com currently has a 4.4 per cent chance of making a return request for various reasons. Since the average quantity of items ordered is 3 per order, the overall return rate on an item-by-item basis is 1.5 per cent. It means that a customer who bought any one single item from Directron.com has an average of 1.5 per cent chance of returning it."[22]

[22] [http://www.directron.com/rates.html] Accessed October 2004

Directron.com also reported that return rates vary among categories of products. Here is a list of product categories in order of descending return rates:

- Motherboards, about 35% of all returns;
- Power supplies and cases, about 20% of all returns; mostly due to power supplies;
- CD-ROM and DVD-ROM drives, about 5% of all returns;
- Hard drives, about 5% of all returns;
- Processors, about 4% of all returns;
- Memory, about 3% of all returns; most due to compatibilities issues;
- All others, about 28% of all returns.

According to the information above, among all computer accessories, power supplies, as well as motherboards can be categorized as products with very high return rates. Computer power supplies are analogous to Xantrex mobile products. Thus, it may not be a surprise that mobile products have higher return rates than have some other electronics.

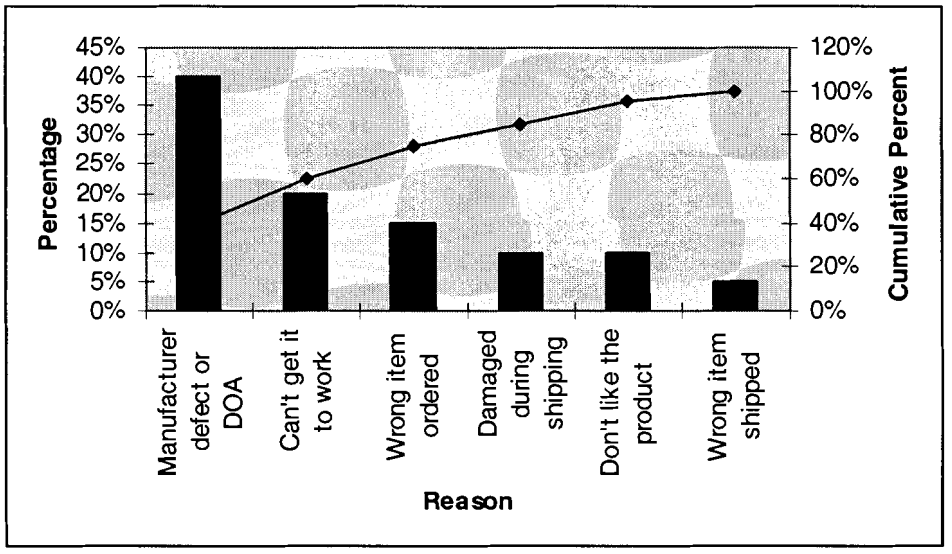
From the report at Directron.com, a list of return reasons, in descending order of occurrence as a percentage of total RMA requests, is shown as below:

- Manufacturer defect or DOA (Dead On Arrival), about 40% of all returns
- Can't get it to work, about 20% of all returns
- Wrong item ordered, about 15% of all returns
- Damaged during shipping, about 10% of all returns

- Don't like the product, about 10% of all returns
- Wrong item shipped, about 5% of all returns

Such phenomenon can be translated into the following Pareto Chart to identify the main reasons for the return:

Figure 7: Pareto Chart for On-line Computer Purchase Return Reasoning



According to the information above, it is easy to see the 3 main causes that affect customer returns. First of all, the quality problem is always the most frequent reason for return. It refers to product defects, DOA and some "can't get it to work" cases which add up to 60 per cent of total reasons. Secondly, packaging and delivery problems comprise some of the returns as well. Reasons such as damaged during shipment or wrong item shipped cases occupy 15 per cent of the total. Thirdly, inexperienced or unknowledgable customers and those with incorrect expectations cause some returns as well. This would

refers to reasons such as wrong item ordered and don't like the product. Such cases comprise the other 25 per cent of the total.

This phenomenon is applicable to Xantrex product return as well. Here it should be noted that, typically, on-line shoppers have more experience and knowledge of what they want to buy than those that buy through traditional means. However, there are still some percentages that relate to a gap between customer expectation and the reality of the product.

5.5 Processing and Strategic Benchmarking for Xantrex

As most people know them, quality processes are the most important facilities for a company to maintain its desired quality levels. Regardless of what kind of products or services a company provides to its customers, its quality assurance processes will determine the quality level of the products. Quality level can make an impact on product return. It will also make a big impact on its future business potential. Quality process improvement is an ever-lasting effort, which needs to be strived for by all manufacturers. As such, processing benchmarking can help to achieve quality level objectives.

Processing benchmarking poses some difficulties during implementation such as deciding what kind of measurements to use, how to collect data and how to translate it for the company who is doing the benchmarking. Traditionally, such benchmarking is performed by visiting plant, studying published articles and industry association research, etc. However, with recent advents in Information Technology, benchmarking can be done via on-line benchmarking toolkits. These On-line benchmarking toolkits are now available from a large amount of different internet websites, by different providers. For

this project, the "IW Path to Excellence" on-line benchmarking toolkit was chosen through careful planning, research, and comparison. The advantages and benefits of the "Path to Excellence" benchmarking toolkit are shown in next section.

5.5.1 IW Path to Excellence Benchmarking

IndustryWeek is the only magazine exclusively dedicated to covering the complexities of managing a manufacturing company in today's New Economy for senior-level management. It is a monthly published magazine with a circulation of 200,000, mostly in the U.S., and partially in Mexico and Canada. It brings together senior manufacturing executives to explore business issues, strategies, trends and technologies that can help them succeed in today's "better, faster, cheaper" global economy.

On-line benchmarking is the easiest, most affordable way to benchmark the plant's performance and identify strategies for improvement. For instance, the on-line benchmarking toolkit from IndustryWeek named "IW Path to Excellence" allows a company to compare its plant with IndustryWeek Best Plants winners and finalists from 1998 to 2002. There are 110 discrete plants in the database; many of them are in the top manufacturing facilities in North America. A company that uses "IW Path to Excellence" can find data on elite companies such as Dell, Boeing, BorgWarner, Kodak, and Medtronic within the database. Although these companies do not produce similar products to those of Xantrex and its competitors, and these companies size, history and culture are very different to Xantrex, the toolkit is ideal for a plant as Processes and Strategic Benchmarking to learn some "best practices". Such "best practices" may become industry trends in the years ahead.

The "IW Path to Excellence" toolkit gives an interactive 80-point benchmarking checklist for a plant. Once it inputs its information, the company can use this checklist to compare its facility's performance with those of top manufacturers in seven key areas: quality, employment practices, customer & supplier relations, manufacturing operations, inventory management, environment & safety performance, and productivity & cost management.

In examining the practices and performance metrics presented, bear in mind that performance levels achievable in one industry may not be realistic goals for another. What is important isn't so much the raw numbers themselves, but how they are used to track and show the results of process improvements over time.

5.5.2 Quality Processing Benchmarking for Xantrex

Manufacturing operations which are striving for world-class results typically channel a great deal of their employees' time and energy into quality improvement initiatives. Quality performance heavily impacts customer satisfaction; in addition, successful quality initiatives can enhance competitive advantage by reducing internal costs associated with poor quality – including scrap, rework and warranty costs.

Table 8 compares the benchmarking results of Xantrex to the IW Best Plant winners and finalists.

Table 8: Quality Benchmarking Metrics Table

Metrics	Xantrex	IndustryWeek Best Plants Finalists (1998-2002)				
		Bottom 25%	Average	Median	Top 25%	Top 10%
ISO 9000: 2000	Yes	9%				
Six Sigma	No	37%				
Quality function deployment	No	35%				
Poka-yoke	No	77%				
Failure mode effect analysis (FEMA)	No	67%				
Design of Experiments	No	60%				
TQM	No	77%				
5S	Yes	68%				
Employee Problem-Solving Team	Yes	97%				
Advanced Product Quality Planning (APQP)	No	50%				
Plan/Do/Check/Verify	No	79%				
Manual SPC	No	59%				
Computerized SPC	No	63%				
First-pass yield	95%	93.7%	95.3%	97.5%	99.0%	99.9%
In-Plant Defect Rate	10,000 ppm	16,000 ppm	21,605 ppm	4,421 ppm	500 ppm	71 ppm
Customer Return Rate	50,000 ppm	2,000 ppm	2,810 ppm	292 ppm	24 ppm	3 ppm
Scrap/Rework Costs of Gross Sales	3%	1.8%	1.2%	0.4%	0.2%	0.1%
Warranty Costs of Gross Sales	3%	0.7%	0.6%	0.1%	0.0%	0.0%

To a large extent, quality has high visibility in manufacturing organizations. It is measurable and an assortment of metrics can be tracked and statistically analyzed to pinpoint opportunities and priorities for improvement.

Through benchmarking some quality metrics with IndustryWeek's Best Plants winners and finalists, a number of items can be identified for product quality improvement at Xantrex.

In terms of Quality Certification, Xantrex does well in comparison with IW Best Plants winners and finalists. Actually, 79 per cent of these firms obtained ISO 9000:1994. Because ISO 9000:2000 was released in the late of 1990's, only 5 plants got it by 2001, whereas 12 plants were certified by 2002. It has become the trend that plants treat ISO 9000 as a quality standard and obtain this certification to become world-class manufacturers.

In terms of quality practices, Xantrex executes some of the requirements for employee problem solving team and 5S. However, an increasing number of Best Plants adopt Six Sigma, Poka-yoke and Design of Experiments, TQM, and Computerized SPC. As discussed in Chapter 3, the most fashionable quality management trend today is to integrate some applicable methodologies from Six Sigma and Lean Manufacturing into the TQM concept. It may also become Xantrex's quality management strategy while overview its quality assurance processes for improvement.

In terms of quality metrics, the average first-pass yields for all finished products among those Best Plants is 95.3 per cent. Some in the Top 10 per cent Best Plants can reach yields up to 99.9 per cent. Comparing this to Xantrex, which is at about 95 per cent, there still have space for further improvement.

By looking at the customer reject rate on shipped products, which is the most interesting data for this project, Xantrex can understand that most normal products have much lower return rates compared with its mobile products. The average return rate among the Best Plants is only 0.28 per cent. However, as reported, the reject rate for all winners and finalists ranges from almost 0 to 28,561 ppm. Reject rate levels are likely to be higher for delicate products susceptible to damage in transit. Xantrex mobile products, since they have passed reliability test before launch, should not be susceptible to this phenomenon. This suggests that Xantrex could learn some "best practices" from those Best Plants to significantly decrease its return rates.

The scrap/rework cost for Xantrex is about 3 per cent compared to the average of 1.2 per cent for the Best Plants. Some of these firms have reached levels as low as 0.1 per cent. There should be some "best practices" on returned product scrap/rework that Xantrex can learn as well.

Another important metric is warranty costs of gross sales. At Xantrex, these costs are about 3 per cent. However, for the Best Plants, the average is only 0.6 per cent. A good one can practically reach zero per cent of its gross sales.

Having analyzed the metric differences revealed through this benchmarking, areas for improvement become clearer. Some "Best Practices" to be adopted will be presented in the recommendation section in next chapter.

5.6 Strategic Benchmarking for Xantrex

Strategic Benchmarking is the proactive analysis of emerging trend options in markets, processes, technology and distribution that could affect strategic direction and deployment.

The "IW Path to Excellence" benchmarking toolkit can also be used for strategic benchmarking for Xantrex as well. Through metrics comparison, "best practices" cases analysis, several strategic trends that Xantrex could follow in quality aspect in the future can be listed as below:

First of all, the Total Quality Management (TQM) movement that began to flourish in the mid-1980s will likely continue and be enhanced by increasing number of effective methodologies such as Six Sigma and Lean System. Other considerations, such as the establishment of the Malcolm Baldrige National Quality Award and the push to secure ISO 9000 or QS 9000 quality certification have all elevated quality issues to higher levels of management attention in the company.

Secondly, companies are evolving more toward process control vs. product control. Techniques such as 5S, Poka-yoke and Cpk process-variability measurement will be widely utilized. In order to approach zero ppm, "prevention" takes on a more dynamic meaning than "correction".

Thirdly, a disciplined approach and common understanding of quality process improvement will become a key for most companies in years to come. All employees within the organization should use the same terminology and same methodology to resolve issues and process problems.

6 CONCLUSION, RECOMMENDATION AND ACTION PLAN

Having determined root causes for customer return in Chapter 4 and benchmarked metrics, approaches, processes of quality improvement and other relevant activities to decrease customer returns in Chapter 5, several conclusions from the work of this project are summarized in the first section of this chapter. Based on these conclusions, the second section gives seven recommendations regarding quality process improvement and methodologies to decrease product return at Xantrex. In the third section, an applicable short-term action plan is discussed to achieve the goal of the Returns Steering Committee (RSC) mentioned at the beginning of this paper. The final section of this chapter describes how to execute, monitor and update this action plan.

6.1 The Conclusions of the Project

One conclusion of this project is that the customer behaviours may be uncontrollable to a certain extent under the real situation of retail industry in North America. Attempts to minimize negative reaction should be implemented through a long-term strategy of the company. However, according to the findings of this project, some "best practices" can be adopted to improve processes at Xantrex relating to quality, marketing and sales, customer and retailer relationship and operations. These "best practices" should aim to decrease mobile product return rates and to save business costs and sustain the company's competitive advantage.

Three considerations can contribute to decreasing customer return rates. First, Xantrex has to continuously improve its product quality levels, by using the most effective methodologies which are applicable to the company. Second, Xantrex needs to introduce "best practices" to increase customer satisfaction by better understanding of customer needs, insights and expectations. Furthermore, customers should be more informed regarding the application and use of the mobile products' technologies. Third, Xantrex needs to generate innovative and effective procedures for RMA, marketing and sales promotion, and operations to decrease return rates and reduce business costs.

For quality improvement, Xantrex still has room to progress further. As analyzed in Chapter 4, Xantrex has tried to bring its quality assurance processes in line with world-class QA processes, standards, and trends. Some activities of quality assurance partially reflect TQM concepts and methodologies. However, such activities are deployed discretely on a case-by-case basis. Overall, processes or procedures to ensure quality levels are somewhat weak and can not be followed up properly.

Xantrex could place further emphasis on customer information, customer satisfaction, and customer knowledge of its products. According to findings of this project, Xantrex has weak relationships with the end users of its mobile products. The dual-direction information flow is now intersected by the retailers. To add further complexity to this situation, information flow between Xantrex and its customers is also directed through retailers.

To further decrease return rates or save costs on product returns, deployment of cross-functional department cooperation or setting up a project team is necessary. Customer returns can be decreased not only by improvement of quality levels, but also by

implementation of balanced marketing/sales campaigns and customer service procedures - especially when working with retailers. Effective overall operation can save costs in dealing with those returned products.

6.2 Recommendations

6.2.1 Implement TQM with Six Sigma and Lean Manufacturing Methodologies

Total Quality Management is a management approach that requires all managers and employees in a company to be involved in continuous improvement of the processes of manufacturing and services. The basic TQM concept is understood by Xantrex management and, hence, some related practices are being executed within the company. The practices are those such as 5S on the work floor, ISO 9000 for standardized work, some just-in-time practices, waste identification and elimination for production, project process implementation for new product creation, suppliers' process and product audits, etc. However, these activities are not sufficient for a world-class electronics company. As mentioned in the conclusion section, lacking applicable methodology to consistently apply TQM is the critical problem that the management cannot see the complete implementation of TQM across the entire organization. Another problem is that although some quality and other processes have been set in accordance with TQM, there is no focus on process improvement which makes some processes either hard to deploy smoothly or to be obsolete over time.

Based on these issues, some "best practices" from TQM, Six Sigma, and Lean Manufacturing methodologies are recommended to Xantrex.

1. The company should consider standardizing quality assurance processes within its manufacturing and new product creation processes. To facilitate this, it is important that QA personnel collaborate with people from other departments to build cross-functional project teams. In accordance with TQM concepts, initiation of any process needs employee involvement and empowerment. Lean System implementation also requires a team-based, multi-functional workforce. The project team should clearly understand its specific function, product or service it will work with, and communicate this effectively among the team members and the organization. By working together, the team can take the evaluate-stream mapping, create an effective workplace organization, adopt cellular manufacturing according to 5S, identify and eliminate the "waste" in the process, and finally, implement a quality assurance process which is applicable and effective for the company to increase the product to a new quality level.

2. The company should keep an eye on continuous process improvement all the time. A given process should not be treated as static as it is initiated and followed by the company. Besides the project team members, all employees who work with this process should be involved in continual evaluating, modifying or changing to make it more effectively. This would be necessary to keep up with fast-changing customer requirements, and competitive market environments.
   Specific methods which can be used here are: Kaizen events, Takt time setting, SMED, Balanced workflow, EVOP and process stability, etc.

3. The company should utilize Statistical Process Control (SPC) to define its quality analysis and control. This is a very specific and applicable method to pinpoint the

quality situation, quality problem and the specification level. Data obtained by SPC can speak to the result of quality level. Doing so, with additional methods such as Root Cause Analysis (as performed in this project), Hypothesis Tests, and Variation reduction can help to realistically improve product quality levels.

6.2.2 Utilize Benchmarking Frequently

While it is necessary for the company to be aware of its quality levels, this condition is not sufficient to obtain competitive advantage in the market. The company also needs to know its competitors' quality levels and their practices to deal with quality issues; to know its current position within the industry; and most importantly, to be aware of the quality process trends inside and outside the industry. The company's quality strategy should be consistent with identified trends. Here, this information seems very critical for the company. Benchmarking is the common way to obtain such information.

Through proper use, benchmarking can accelerate the rate of change within the company. Subsequently, the company can identify breakthrough processes and improve customer satisfaction and competitive advantages. The company can also create a fact-based climate for generating consensus.

In the IndustryWeek Best Plants Award campaign, each candidate was asked how many benchmarking studies it had conducted during the past year. In 2002, the median response was four studies. As previously mentioned, the competitive advantage does not arise from beating competitors across the area or even across the country, but around the world. 85 per cent of Best Plants applicants in recent years report that they have benchmarked against companies outside of their own particular industry.

6.2.3 Set a Process and Database to Integrate Customer Information

The wholesaler, the jobber, and the retailer have now stepped in, and in effect have set up a barrier between the manufacturer and the end consumers. But sampling and statistical analysis, a new science, steps in and pierces that barrier.

Manufacturers used to think of manufacturing in three steps, which are

1. Design the product;
2. Make it and test it in the production line and in the laboratory;
3. Put it on the market.

These three steps were independent. Success depended on guess-work – guessing what type and design of product would sell, and how much of it to make.

In more recent methodology, management introduces, usually with aid of consumer research, a fourth step:

4. Test it in service; find out what the user thinks of it, and why the nonuser has not bought it.

Repetition of the fours steps leads to a helix of continual improvement of consumer satisfaction at a lower and lower cost.[23]

The TQM concept is also based on customer requirements. Quality and other specifications should be defined by the customer, so the company should know the customer, understand customer requirements and expectations, and translate them to its quality management and relevant processes for production and service.

[23] Deming, W Edward. "Out of the Crisis" P. 179

However, for many kinds of products and services, the consumer's judgement may require a year or even several years for formation. For example, a purchaser of a new automobile can give you a more useful evaluation of the quality of the automobile in a year from the date of purchase than he could when it was new.[24] Furthermore, the business environment is constantly shifting, the competitor's ability is changing, and the customers themselves and their requirement are changing as well. As a result, customer and competitive information should be collected continuously in a process and invert to administrative data in order for the company to remain informed of any changes.

Current Information Technology readily allows for database storage of such data in a server. In addition, a variety of software tools are available for data storage and data analysis. Customer databases can easily be utilized for marketing, customer service or other applications. Appropriate use of IT technology can easily help the company continually and systematically collect customer satisfaction, relationship and behaviour data and administrate the database for various uses by the company.

The information for the customer database can be collected in a number of ways including customer satisfaction surveys, post-purchase customer visits, customer feedback cards for warranty service, and more detailed customer return forms.

6.2.4 Conduct Regular Customer Satisfaction Survey and Consumer Research Studies

Most Xantrex's mobile products get to end users through retailers. But those retailers break the relationship between Xantrex and their end users. Even though most retailers act as intermediaries within the Xantrex customer relationship, it is the end users

[24] Deming, W Edward. "Out of the Crisis" P. 168

that determine the business of the products. Therefore, the company should understand the expectations and requirements of the end users. Activities such as improving product and service quality, determining customer service levels, or even creating new products should all agree with the end users information. In addition to extracting information from the databases as stated in the previous recommendation, a specific way to know customer information is to conduct customer satisfaction surveys by the company on its own or by cooperating with its retailers.

An effective customer satisfaction survey program should focus on measuring customer perceptions of how well the company delivers on the critical success factors and other dimensions of the business. These factors and dimensions usually include service promptness, courtesy of staff, responsiveness, understanding of the customer's problem, etc. The need for constant customer feedback has become a requirement in today's marketplace. To best serve its customers in a competitive environment, a company should act as the best fit to its customers' expectations.

Asking customers to rate the company's performance has proven to be a great customer relationship strategy. In a research study conducted over the course of a year by two professors from Rice University, one group of customers were sent out a satisfaction and opinion survey and the other was not surveyed. After a year, twice the number of people continued and renewed their loyalty towards the company in the group that took the survey.[25]

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[25] Bhaskaran, Vivek. "Sending Out A Survey To Customers Can Double Sales" [http://www.questionpro.com/akira/showArticle.do?articleID=customersatisfaction02] Accessed October 2004

The research study offered some interesting rationales based on consumer psychology on customer satisfaction surveys. They can be summarized as below:

1. Satisfaction surveys reinforce the customer's desire to be cared for and reinforce positive feelings. It is human nature to "appreciate" a product or service that is already liked. The survey is a tool to those customers to "interact" with the company to express this appreciation. Moreover, human nature is such that is not easy to give up on something to which a commitment has already been given.

2. Surveys can be considered to be a vehicle of communication for the customers, although some people consider surveys as a data collection exercise. When conducting consumer surveys, they can also serve as a medium for disseminating information. Thus, some of the information a company wants its customers to know can be delivered through the customer satisfaction survey.

3. The very process of asking people their opinion can induce them to form an opinion on something they otherwise would not have considered. This can be treated as one of the ways to educate customers and enhance customers' knowledge on the company's products.

Surveys should be considered as a critical tool in the customer relationship dialog. The best thing about a survey is its ability to convey "bi-directional" information. The survey not only acquires information for the company that is critical for its business, but also enhances and builds upon the established relationship the company has with its customers.

6.2.5 Induce Customer Behaviour, Enhance Customer Knowledge, and Use the Same Language as the Customer

The customer is not necessarily in a good position to prescribe products or services that will help him in the future. The producer is in a far better position than the consumer to invent new products and new services.[26] To some extent, mobile products are not so commonly used by end users. There is no dominant mobile product in the marketplace. This presents the opportunity for Xantrex to lead the market and set the standard in the industry via its business strategy.

However, the knowledge and interpretation of customers on such products is different from what the company has expected. In turn, this leads to customer behaviour that can differ from what the company anticipates. Therefore, the customer perception may vary from what was intended to be conveyed through the product installation guide, operation manual, product label, and packaging. Such factors, as analyzed in Chapter 4, can cause the high customer return rates.

Ways to narrow the knowledge gap between the company and its customers can be accomplished from two sides. From one side, the company should study its customer preferences. The purpose of studies in consumer preferences is to adjust the product to the public, rather than to adjust the public to the product, as is the case with advertising.[27] The company needs to review its product installation and operation manuals to communicate to customers clearly and effectively. This would be especially applicable to customers lacking in-depth product knowledge. Xantrex should set its quality, function, and customer service levels according to customer expectations. From the other side, the

[26] Deming, W Edward. "Out of the Crisis" P167
[27] Bross, Irwing. "Design for Decision" Macmillan, 1953, P. 95

company should deploy campaigns to change customers' behaviour and expectations. Customer satisfaction surveys, as previously recommended, are one way to do so. Other campaigns include TV advertisements, in-store demonstrations, operation and technology introduction pamphlets, post-purchasing onsite visits and services, etc. These activities can educate customers and induce their behaviour, and therefore have the potential to reduce customer return rates.

6.2.6 Work with Key Retailers to Establish an Innovative Customer Return Policy

Given that retailers communicate directly with the end users, they should not be viewed as customers, but more so as strategic partners. However, retailers may have different purposes and different strategies for selling the company's products. Many retailers have established their return policies with the belief that the "customer is king". As such, many customer services of retailers seem to be equal to accepting unconditional returns or to at least maintaining extremely liberal return policies. On the other hand, the retailers shift the cost associated with returned items to Xantrex. If the company rejects the return from the retailers, it will significantly impair future goodwill and the existing relationship. It is almost impossible to be done by Xantrex at the moment. Hence, it is extremely important to closely collaborate with those retailers to create an innovative customer return procedure that motivates better retail customer services but lower customer return rates.

An increasing number of retailers are demanding consignment terms and/or guarantees that the company's product will sell. In order for consignment to work, the company must receive timely and accurate sales data from the retailer. However, when the company requests a current update of consigned merchandise, the retailer may not be

able to account for 100 per cent of the inventory. Experience indicates that retailers are more careful with merchandise they own than with merchandise hold on consignment. This case provides Xantrex with a challenge as well as an opportunity to properly set the consignment terms. This paper strongly recommends working with those key retailers to develop new consignment terms including return provisions that benefit both parties regarding customer returns. New customer return provisions could be established through a project team working with marketing, sales and key retailers. Feedback from interviews with retailers suggests that some of their customer service personnel have extensive experience with customer returns. They are able to judge the real situations and the true behaviour of the customers, and adopt particular approaches to deal with those returns. Having more employees who are enthusiastic and knowledgeable about customer service can significantly decrease the customer returns for Xantrex mobile products.

Another way to reduce customer returns is to sell mobile products OEMs[28] of automobiles, marine vehicles, and other larger products, etc. Most industrial OEM customers can easily understand the company's product and its technology, or can easily be educated. The OEMs have few customer behaviour problems as previously discussed. Selling to OEMs should be part of Xantrex long-term business strategy.

6.2.7 Deal with Returned Products in an Appropriate Manner

Managing large amounts of returned products by end users has become a major challenge for manufacturers that must accept and process the products back for purposes of refurbishing, remanufacturing, recycling or liquidating them. Since this additional overhead effectively reduces the profit margin for returned products, the manufacturer's

[28] OEM: Original Equipment Manufacturer.

ability to efficiently manage the reverse flow of these goods is a critical aspect of its business.[29]

As mentioned before, many Xantrex retailers have established their return policies based on the belief that the "customer is king". Customer service seems to be equivalent to accepting unconditional returns or maintaining extremely liberal return policies. However, it seems that those retailers are unwilling to take the financial burden or lose money on those returned goods. The returned merchandise is transferred to Xantrex as "stagnant" inventory under today's situation.

Xantrex has several options regarding the handling of those returned goods:

First, Xantrex can sometimes reject the return, or return merchandise to retailers. However, it should do so very carefully. Otherwise, it could seriously harm the relationship with those retailers. It is unfeasible to implement this option with current business model of Xantrex.

Second, Xantrex can negotiate return policies with key retailers. It is actually the best choice for Xantrex and has been explained in previous recommendations.

Third, Xantrex can reprocess the returned merchandise by refurbishing and placing it back in inventory. Each item must be carefully analyzed to determine the viability for its "second life." A major decision during this stage is determining whether the re-processing and reselling costs exceed the value of the product.

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[29] Sherrard, William; Rosenbaum, Mark; Raafat, Fred. "Manufacturer's Dilemma: Managing A Growing Volume of Returned Merchandise" [http://www.manufacturingnews.com/news/editorials/sherrard.html] Accessed November 2004

Fourth, Xantrex can refurbish the returned merchandise and send it to the company's own retail outlet. Currently, the Xantrex e-store can resell returned merchandise to knowledgeable on-line customers or staff members with a large discount.

Fifth, Xantrex can recycle parts of returned goods for other products or recycle them into reusable raw materials. But it also needs to be determined whether recycling costs exceed the value of processing the returned goods. Sometimes such recycling process can reduce inventory turnover and impair the performance of the company.

Sixth, Xantrex can outsource the processing of the returned merchandise to a third party. For instance, the currently leading company specializing in this field is Genco Distribution Systems, located in Pittsburgh, Pennsylvania. Genco operates return centers nationwide that serve 10,000 customers and process $3 billion in returned merchandise each year. One of Genco's primary reverse-logistics tactics is to centralize all of a manufacturer/retailer's returned items to a central distribution center. Genco personnel process the returns and dispose of the items in a manner that maximizes potential profits.

Seventh, another method for reducing losses of returned merchandise that would otherwise be destroyed is to donate them to charity. Some nonprofit groups assist manufacturers and retailers in the donation of goods to various needy organizations. Those groups produce all the necessary tax documentation for the donor and are active in public relations activities. The benefits of donating returned merchandise to charity are not only saving the cost of scraping the items and tax saving, but also the enhancement of the company's social marketing position and brand reputation in the communities.

Eighth, Xantrex could process to scrap the returned merchandise. While scraping can add cost to the returned merchandise, it may save more on inventory cost as a permanent liquidation method.

In the first three options, Xantrex has the potential of making a profit on the transaction. The next two options (4 and 5) give the manufacturer little potential for profit and will likely result at best in the recovery of material costs. The last three options (6 through 8) result in returns below material costs.

6.3 Suggestion for the Short-Term Action Plan

It should be noted that the long-term practices recommended above can be built into Xantrex's business strategies and its long-term processes. These practices include implementing Total Quality Management within the organization by combining it with some applicable methodologies from Six Sigma and Lean Manufacturing; Becoming the industrial standard and benchmark to be recognized and acknowledged as world-class leader; and continuously improving the company's processes.

However, short-term practices could be implemented immediately by a cross-functional project team with an action plan. It does not mean that the objective of the RSC, which was presented at very beginning of this paper, can be immediately achieved after this project. But short-term practices can be applicable to verify the conclusion and recommendations of this paper. Short-term practices can assist in verifying the conclusion and recommendation of this paper. This would subsequently help in determining the most effective ways to achieve the objective of the RSC. Furthermore,

short-term practices would help determine the right direction for the company's long-term improvement strategies.

An action planning process involves transforming goals, methods and procedures into measurable implementation items. The action plan should specify responsibility and time frames that are agreed upon. It should also be easy to follow by the executioners or the team. With a keen focus, the results that need to be delivered become clear and attainable.

The scope of this action plan is to set a 3-month period for the duration of a project. The project team will be built up by members from different functional departments and outside sources such as key retailers and third parties. In order to resolve the customer return issues caused by three aspects which are quality, knowledge gap and unbalanced sales/marketing campaigns, this action plan also includes five specific items. First, establish a customer return policy for consignment/guaranteed contracts with key retailers. Second, set up a customer information database in a server for the company. Third, create customer feedback cards with product warranty service. Fourth, review product installation and operation manuals. Fifth, establish an appropriate returned goods liquidation procedure.

It is better to create a cross-functional project team led by one nominated project manager. The project manager can own the overall responsibility for this project. The project team may work more efficiently by following this proposed action plan for the three month short-term period. This project must be sponsored, directed and supported by the company's top management and the RSC.

Table 9: Short Term Action Plan for Customer Return Issue

Task Name	Duration	Responsibility
Build up project team	**6 days**	
Nominate a Project Manager	1 day	Top Management, QA Director
Nominate project team members	5 days	Project Manager, Department VPs
Project Kick-off Meeting	**0 days**	Project Team, Top Management
Set customer return procedure with retailers	**75 days**	
Review RMA procedure and consignment provisions	10 days	Project Team, Sales Dpt.
Benchmarking, new ideas initiation	10 days	Sales Dpt., Project Team, Key retailers
New CR procedure draft	3 days	Project Team, Sales Dpt.
Negotiate with retailers	5 days	Project Team, Sales Dpt., Key retailers
Finalize new CR procedure	5 days	Project Team, Sales Dpt.
Sign procedure agreement with retailers	1 day	Sales Dpt., Key retailers
New customer return procedure kick-off	0 days	
New CR procedure executing, monitoring, modifying	40 days	Project Team, Sales Dpt., Key retailers
Set up customer database	**75 days**	
Initiate customer survey questionnaire	1 day	Project Team, Mkting Dpt., Sales Dpt.
Review database server and software	5 days	Project Team, IT Dpt.
Install database sever and software	5 days	Project Team, IT Dpt.
Implement customer survey	15 days	Project Team, Mkting Dpt., Key retailers
Input customer survey result	15 days	Project Team, Mkting Dpt., IT Dpt.
Input customer return database	40 days	Project Team, Sales Dpt, IT Dpt.
Set up a feedback card with product warrant service	**75 days**	
Initiate feedback card and its procedure	5 days	Project Team, Sales Dpt, Key retailers, Engineering Dpt.
Finalize feedback card and attach it with product	30 days	Project Team, Operation Dpt, Sales Dpt.
Utilize feedback card for customer information	40 days	Project Team, Sales Dpt, Key retailers, IT Dpt.
Review product packages and manuals	**50 days**	
Review product packages and manuals	20 days	Project Team, Engineering Dpt.

Modify packages and manuals	30 days	Project Team, Operation Dpt, Engineering Dpt.
Set up returned goods scrap procedure	**40 days**	
Review returned goods	2 days	Project Team, QA Dpt., Operation Dpt.
Decide scrap plan	3 days	Project Team, QA Dpt.
Execute Scraping	30 days	Project Team, QA Dpt., Operation Dpt.
Review Scraping cost	5 days	Project Team, Operation Dpt.
Project review, report and close	**5 days**	Project Team
Project close	**0 days**	

The recommended short-term action plan is shown in table 10. The table presents the specific task items, their durations and assigned responsibilities. Appendix 4 illustrates the detailed action plan via Microsoft Project software toolkit.

Through implementation of this project, the company should at least obtain an integrated customer database that would be very useful for developing long-term practices based upon customer return issues, quality improvements, and management ability increasing. It would also be useful to help determine critical activities to meet the objective of RSC, and to train the project members or other employees regarding Total Quality Management concepts and cross-functional team-building skills.

6.4 Action Plan Executing, Monitoring and Updating

In order to successfully implement the action plan, some critical notes are worth emphasizing here:

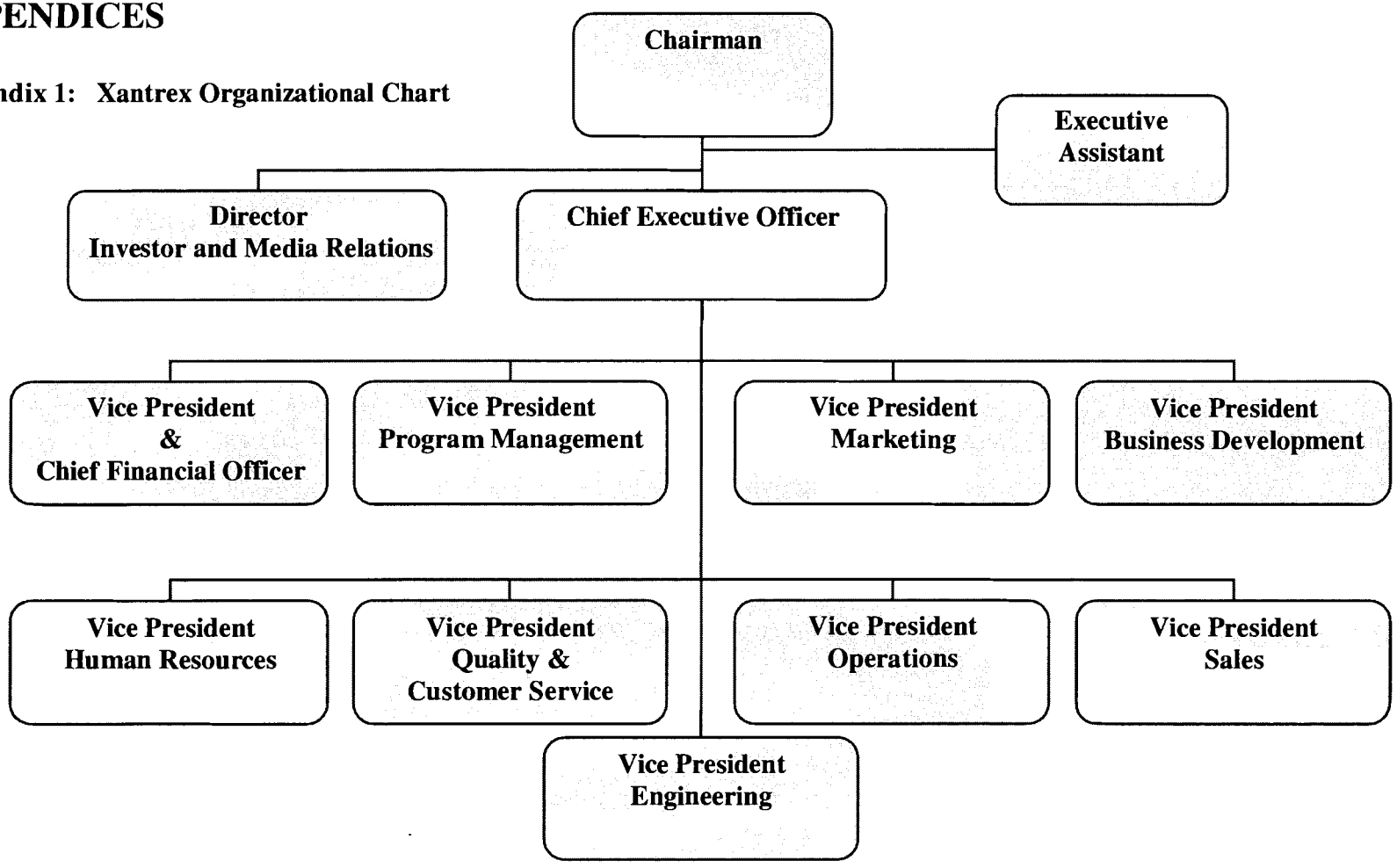
The most important thing is that the action plan should be executed in a team-based work environment. Time frames and responsibilities should be known and agreed upon by all team members.

During execution, the plan should be constantly monitored. Periodic checks should be performed to ensure that previously agreed upon actions are being undertaken, and certain activities have taken place or have been completed. The team has to make sure that the action plan becomes a living and dynamic process rather than a stable and stagnant document.

It is important to frequently seek if the solutions have the desired outcomes and effects. Use the data to check the plan. Review this data to anticipate any foreseeable problem, and make appropriate modifications to finalize the implementation details. Ensure the implementation would be realistic and separated into manageable parts with interim targets and milestones.

APPENDICES

Appendix 1: Xantrex Organizational Chart



Appendix 2: Corrective Action Request Form

(To be filled in by CAR Administrator) **CAR #:**		
(Please check one) **Corrective Action** ☐	**Preventive Action** ☐	
1. PROBLEM DESCRIPTION		
Initiated by:	Date:	
Description of Problem:		
Product or Process affected:	Product number:	
Notification to Customer Required: ☐ Yes ☐ No	Stop Ship Required: ☐ Yes ☐ No	
Recommended Priority : ☐ 1 – Critical (1-10 DAYS) ☐ 2 - Major (10-20 DAYS) ☐ 3 - Minor(20-30 DAYS) ☐ 4 -Observation (30-60 DAYS)		

Forward to CAR Administrator upon completion of shaded area of form.

Change Board Representative:	**Assignee: (Manager or Process Owner):**	**Acknowledgement Received:** ☐ Yes ☐ No **Date Due:**
Priority: ☐ **1 – Critical (1-10 DAYS)** ☐ **2 - Major (10-20 DAYS)** ☐ **3 – Minor (20-30 DAYS)** ☐ **4 -Observation (30-60**		
2. CONTAINMENT (if applicable) *Isolate the effect or concern from*	**Date Due:**	**Date Complete:**
Assigned to:		
3. ROOT CAUSE *Identify all potential causes, isolate and verify*	**Date Due:**	**Date Complete:**
Assigned to:		
4. CORRECTIVE ACTION PLAN *Define and implement corrective*	**Date Due:**	**Date Complete:**
Corrective Action Implementation		
Assigned to: Complete:	Date Due:	Date
5. PREVENTATIVE ACTION PLAN *Modify mgmt.& operating*	**Date Due:**	**Date Complete:**
Preventive Action Implementation		
Assigned to: Complete:	Date Due:	Date
6. VERIFICATION OF CA/PA EFFECTIVENESS *Confirm that the selected actions did resolve the problem*		
Assigned to: Date Assigned:	Date Due:	Date Complete:
7. COMMUNICATE SOLUTION *CAR Administrator to inform original requestor of results.*		
CAR Admin. Notes:		Date Closed:

Appendix 3: Customer Return Survey Template

Dear Customer:

As the Customer Service Manager of Xantrex, I want to thank you for the opportunity you ever purchased and tried our product. Please help us serve you better next time by taking a couple of minutes to tell us the real reasons that you returned the product you bought. We appreciate your business and want to improve and make sure that our product, along with its service will meet your expectations in the future.

Attached, you will find a coupon good for completing this questionnaire. We hope that you will accept this as a token of our good will.

Sincerely,

Customer Service Manager

Xantrex Technology Inc.

Please Check One or More Reasons That You Returned the Product:

Quality:

The product malfunctioned or performed poorly.

The overall quality of the product, its accessories, and buttons was lower than you anticipated.

Price:

Found a better price or better functions on similar product elsewhere.

Buyer's remorse, feeling too expensive for what he bought, or guilty of spending money.

Function and Operating:

Product performance was poor. You didn't like some functions of the product, or the function was not as good as thought.

Impulse buying, don't understand the real usage of the product.

Post purchase recognition of the need for higher power / higher capacity product.

Don't have all necessary accessories to install or proper use. (installation cable or other important accessories are not available)

Lacked proper simplified instruction, especially for those non-knowledgeable end users.

Appearance and Style:

Don't like the appearance and style of this mobile product. Or the product does not fit your vehicle, boat or other machinery.

The product was too heavy for hand-carrying.

Service:

Customer support was unsatisfactory.

Network and Commercial Reference:

Post purchase recommendation from friend, family member or someone you trust. (end user's network)

Post purchase promotion from internet (on-line chat, topic on electronic appliances) or advertisement (TV, Radio, Magazine, Newspaper) for a more attractive competition offer.

Others:

Return from lower stream small reseller, because can't sell it.

Gift from your family members or friends. But you were not happy with it.

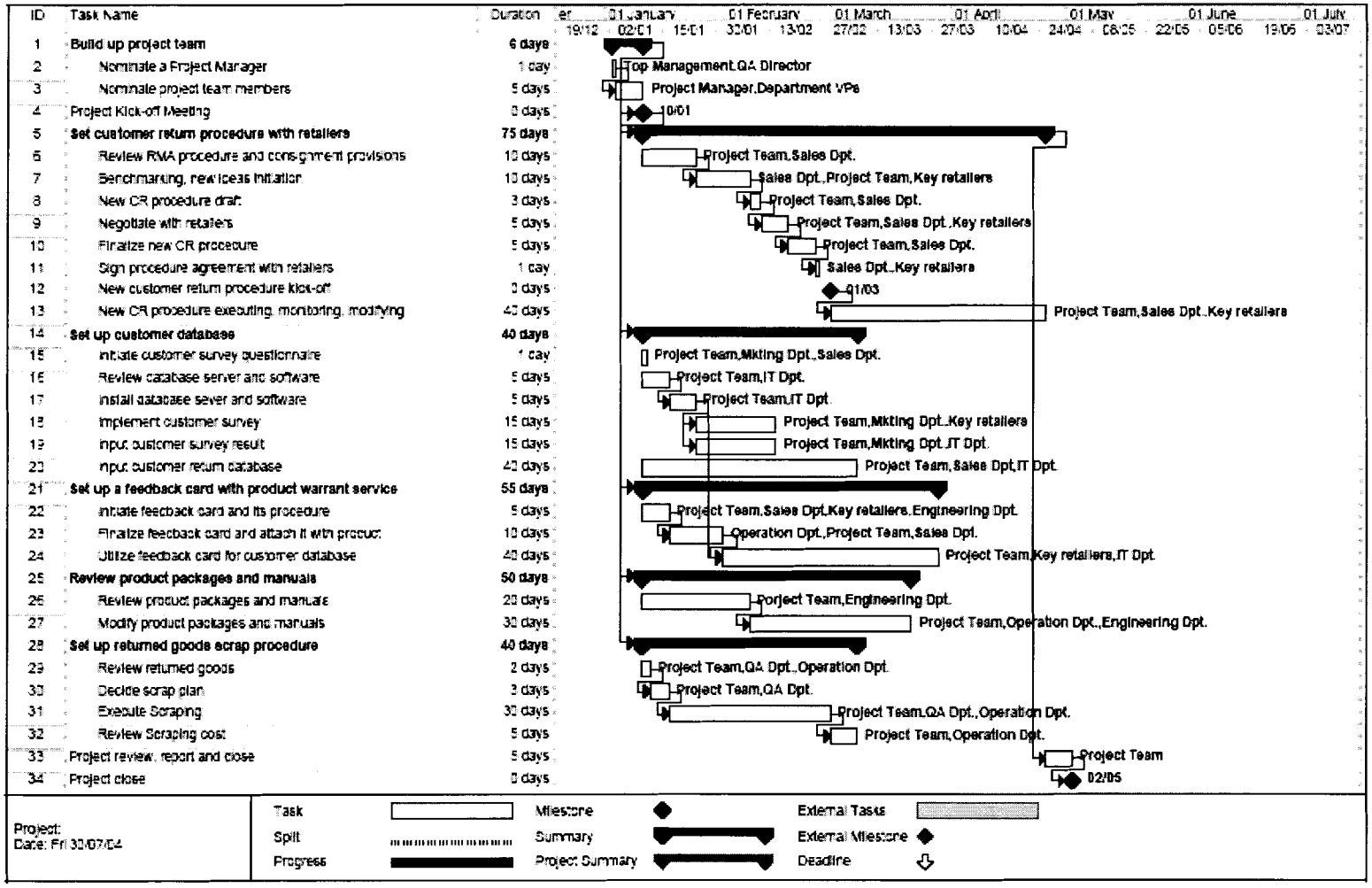
One time use purchase. Returned after project completed.

Other reasons, please specify: _____

_____

_____

Appendix 4: Short-Term Action Plan:



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