Title: Improving a Present Manufacturing Process by Implementing TQM and ISO 9001

Course:
Year: 1994
Author(s): G. Hansen, A. R. Razif, Mohamed , S. Badelon, N. Renaud and E. Armoush

Report No: P94002

Abstract: The team are taking an existing manufacturing process which products battery packs. It is changing details of the handling each step of the process in order to comply with ISO 9001 standard of quality. The current process is suffering from an excessive quality costs. The team is utilizing Statistical Process Control in order to identify the causes behind the failures in the process and suggest suitable solutions. Statistical Process Control includes Pareto Diagram, cause and effect analysis, ideas finding , solutions finding , and suggestions for implementation.

Improving a Present Manufacturing Process by Implementing TQM and ISO 9001

G. Hansen, M.R. Abdul Razak, S. Badelon
N. Renaud, E. Armoush

EMP-P9402

Improving a Present Manufacturing Process by Implementing TQM and ISO 9001.

Total Quality Management I

EMGT 510

Team Project

Submitted To : Professor Dick Deckro

Team Members :

Graydon Hansen

Abdul Razak, Mohamed Razif

Ségolène Badelon

Nicolas Renaud

Emad Armoush

Portland State University

March, 1994

1.0 Scope

We are taking an existing manufacturing process which produces battery packs. We are changing details of the handling each step of the process in order to comply with ISO 9001 standard of quality. The current process is suffering from an excessive quality costs. We are utilizing Statistical Process Control in order to identify the causes behind the failures in the process and suggest suitable solutions. Statistical Process Control includes Pareto diagram, cause and effect analysis, ideas finding, solutions finding, and suggestions for implementation. We will also apply the TQM principles to the organization.

2.0 Introduction

The company produce battery packs according to customers' specifications and designs. These battery packs are use, for example in cellular phone, shavers and toys. The customers provide the design drawings, plastic casing, and a list of specification. The company manufactures battery packs to the specifications using battery cells and performing the complete welding and the packaging required.

3.0 Product Description

The product used for this project is a portable power pack of a cellular telephone. It is made of four battery cells which are electrically connected using a resistance welding process. This battery assembly is glued together and then installed into a two-piece plastic case. Once

Battery pack

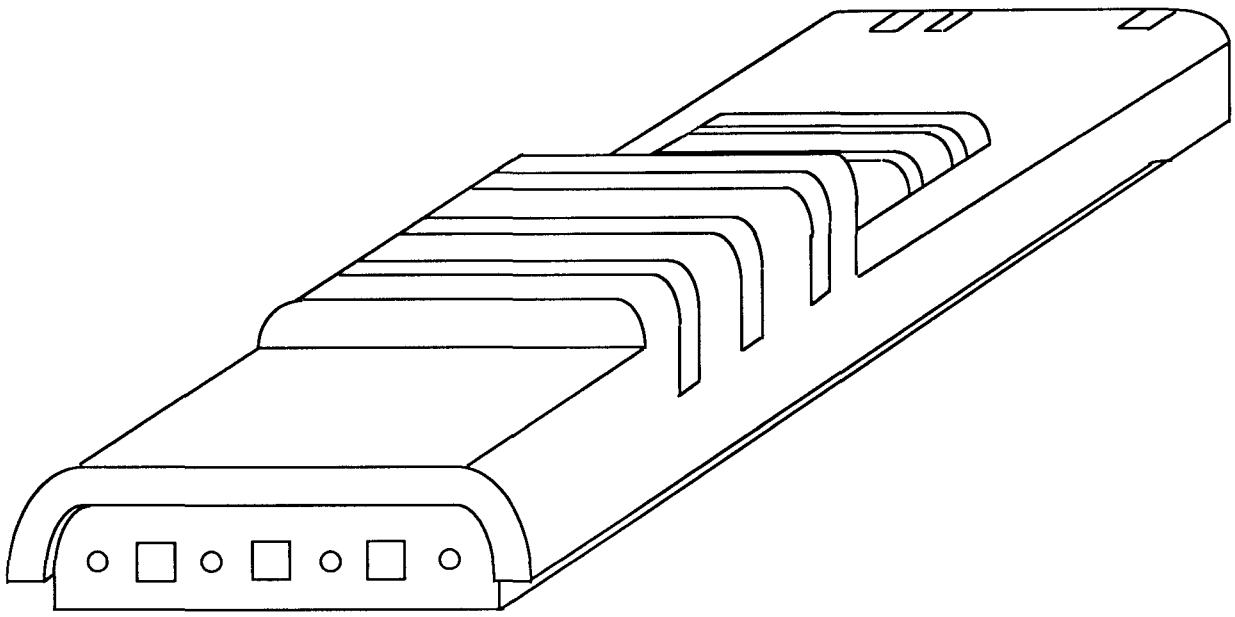

FIGURE 1.

enclosed in the plastic case, the pack is welded together using an ultrasonic welding process. Refer to figure 1 for schematic diagram of battery pack.

4.0 Problems and Costs

Presently, we have a process which is suffering on the average of 15% quality costs. The data was collected from the factory. By utilizing SPC, we are able to investigate the causes behind the high quality cost and suggest solutions and methods of implementation. For the long term solution, we will recommend to the management of the company how to adopt the TQM principles in managing their organization.

At the same time, the company is also interested to deal with clients in Europe. therefore, it must obtain ISO 9001 certification in order to enter the market over there. In order to comply with the ISO 9001 standard, we will change the way each step of the process is presently handled according to the ISO 9001 requirements. By following the ISO 9001 requirements, the company will also be able to reduce the quality costs and decrease failures through out the process.

By decreasing the quality costs, the company will be able to:

1. Eliminate all waste throughout the process.
2. Ensure producing better quality product to customer.
3. Reduce the production cost of the products
4. Be able to price products more competitively in the market.
5. Ensure that customers will receive conforming products.

The company has been successfully in producing products that complies with the customer's quality characteristics which are:

1. Good quality electrical wielding.
2. Compliance with the required electrical tests.
3. Meet the minimum shock resistant requirement.
4. Correct labeling and packaging.
5. Responsive after sales services, which includes replacement of defectives packs.

4.1 Process Outline

The process of manufacturing battery packs is represented by the attached flowchart. Please refer to figure 2 on the following page.
Throughout the process, there are many failures and high number of scrapped occurs which contribute to high quality costs. The details of quality cost for each step of the process are listed below :

4.2 Data collected: Specific Failures and Costs

We were able to obtain the real data the company. The data consist of the quality costs and percentage of failures at each step of process. Data was collected during processing a whole order.

Cost Analysis based on:

$.54 purchase cost per cell

$.97 purchase cost per case

$15.00/hour fully burdened labor cost

PROCESS FLOWCHART FOR BATTERY PACK

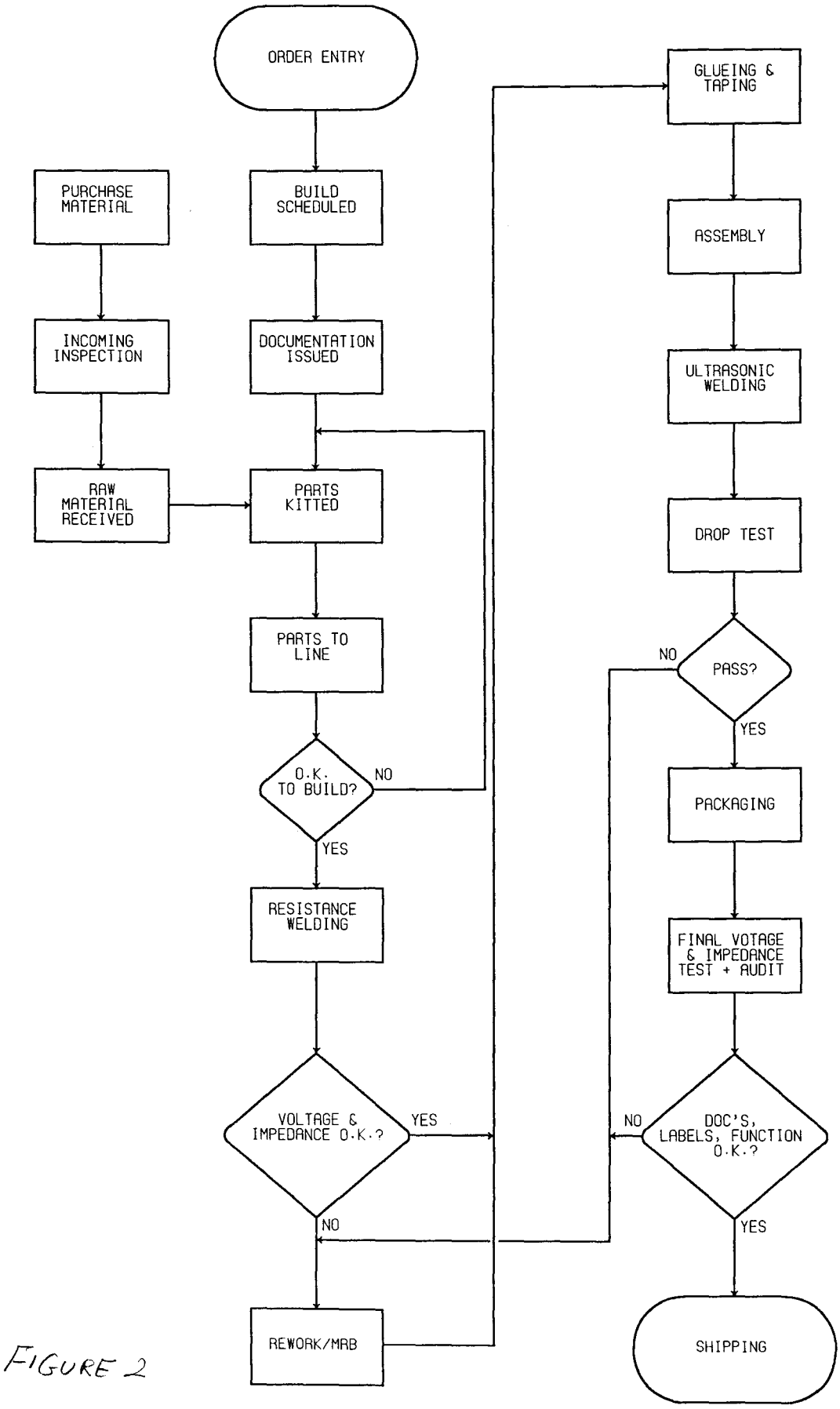

FIGURE 2

Terminology:

Cell: A single battery cell, 4 cells to a pack.

Pack: A set of 4 cells in a plastic case.

Case: A plastic enclosure used to make a pack.

Whole order = 42 lots.

1 lot = 2400 battery cells / 600 battery packs.

1 lot requires 600 cases.

Whole order = 25,200 battery packs.

Data collected for each step of the process :

Incoming Inspection:

Raw cells: 14 lots received/ 1 lot rejected. { cells are always received when the cells are ordered }

Cases: 12 lots received/ 0 lot rejected.

$.0094/cell: Appraisal

$.013/cell: Internal Failure

$.0376/case: Appraisal

Order Entry:

No records of errors.

Estimate: 15% of orders incorrect.

42 lots: $150 Internal Failure

Build Scheduled:

No records.

Estimate: 30% of orders rescheduled due to parts shortages.

42 lots: $300 Internal Failure

Documentation Issued:

Roughly 50% of all documentation is incorrect.

This product: 3 errors on document.

Changes to document are not incorporated until work order issued, causing a "hurry up" change process.

Cost: $22.50/lot, 42 lots: $945 Internal Failure

Parts Kitted:

Records indicate that 2% of issued materials are returned as incorrect.

Cost: $.00074/cell: Internal Failure

$.0002/case: Internal Failure

Parts to Line:

No records.

Estimate: 5% canceled or changed due to various causes.

Cost: $75/error, 2 failures: $150: Internal Failure

Resistance Welding:

No records.

Estimate: 7-8% rework.

Cost: $.043/cell: Internal Failure

Voltage & Impedance O.K.?:

Cost: $.0047/cell: Appraisal

Gluing & Taping:

In-process Inspection records indicate zero-defects.

Estimate: 5% scrap.

Cost: $.0051/cell:Appraisal

$.029/cell: Internal Failure

Assembly:

No records at In-process Inspection.

Estimate: 2-3% scrap.

Cost: $.017/cell: Internal Failure

Ultrasonic Welding:

No records.

Estimate: 10% scrap.

Cost: $.108/case: Internal Failure

Drop Test (Pass/Fail?):

No records.

Estimate: 2% scrap.

Cost: $.022/case: Internal Failure

Packaging:

Final Audit records indicate zero-defects.

Estimate: 2% rework.

Cost: (Rework) @ $1.25/pack: $.025/pack: Internal Failure

Final Voltage & Impedance Test & Audit:

Final Audit records indicate zero-defects.
Estimate: 100% documentation failures require change/question process on every shipment.

Cost: $.0425/pack: Internal Failure
$.0425/pack: Appraisal

Shipping:
No records.
Estimate: 100% of shipments received by customer undamaged.

Returns:
2% of net sales returned defective. Inadequate corrective action system in place with no financial tracking of failures.

Cost: @$6.83/pack

Total Prevention Costs: .67% (Company-wide)

Total Appraisal Costs: $.157/pack = 1.6%

Total Internal Failure Costs: $.655/pack = 6.7%

Total External Failure Costs: $.196/pack = 2.0%

Total quality costs is estimated at 15% of the total production cost of a battery pack. Total quality costs consist of the sum of appraisal cost, internal failures and external failures.

Since the company doesn't keep accurate records of all the occurring failures, Some of the data obtained was estimated by the employees who are responsible for performing the specific step of the process.

Data Analysis

From the data collected, we calculate the quality costs for a whole order.

The quality cost for each step is plotted on the pareto charts to identify which steps of process contribute significantly to the total quality costs. By graphically presenting the major contributors, we can select which steps of the process needs an immediate attention and improvements. From the pareto diagram, we observe that three steps of the process contribute almost 60% of the total quality costs. Please refer to figure 3. These three steps are, incoming inspection, documentation issued, and gluing and taping. Packaging, voltage & impedance test contribute another 20% of the total quality costs. We decided to focus on the first six major contributors that are mentioned above.

Steps Of Operation	*Quality Cost $*	Cumulative	Percentage
Incoming inspection	$1,989	32.29%	32.29
Documentation issued	$945	47.64%	15.34
Gluing and taping	$660	58.35%	10.72
Packaging	$630	68.58%	10.23
Voltage & impedance test	$474	76.28%	7.70
Resistance welding	$347	81.91%	5.63
Build Schedule	$300	86.78%	4.87
Ultrasonic welding	$272	91.20%	4.42
Order Entry	$150	93.64%	2.44
Parts to line	$150	96.07%	2.44
Returns	$99	97.68%	1.61
Parts kitted	$80	98.98%	1.30
Assembly	$52	99.82%	0.84
Drop test	$11	100.00%	0.18
Total	$6,159		

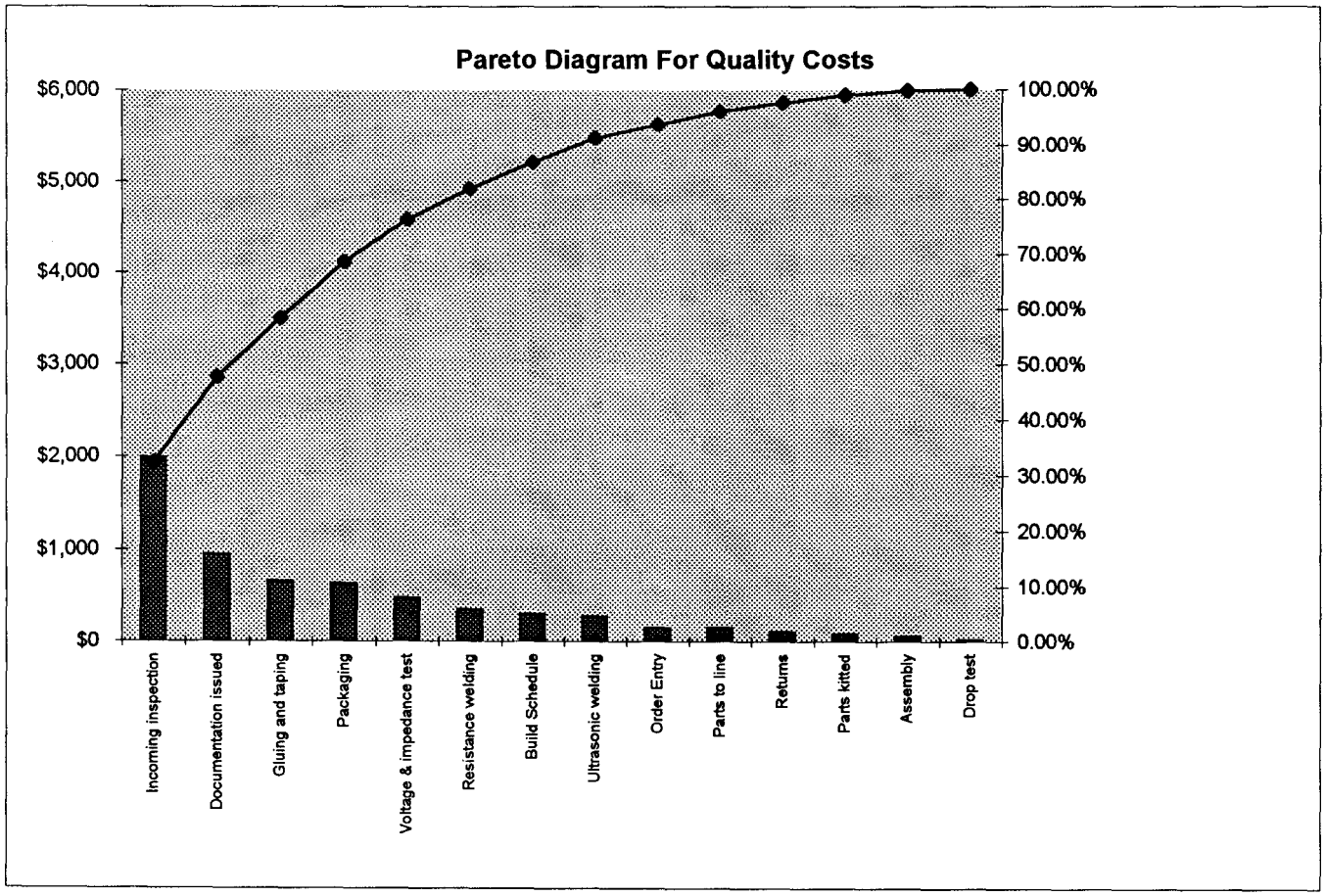

FIGURE 3.

To find the major causes and the contributors to the causes of the problems, we will utilize the cause and effect analysis. Figure 4 represents a comprehensive cause and effect diagram for all the operation. Figure 5 presents all possible causes that might be contributing to the failures of the selected steps of the process.

FISHBONE DIAGRAM

FISH BONE DIAGRAM

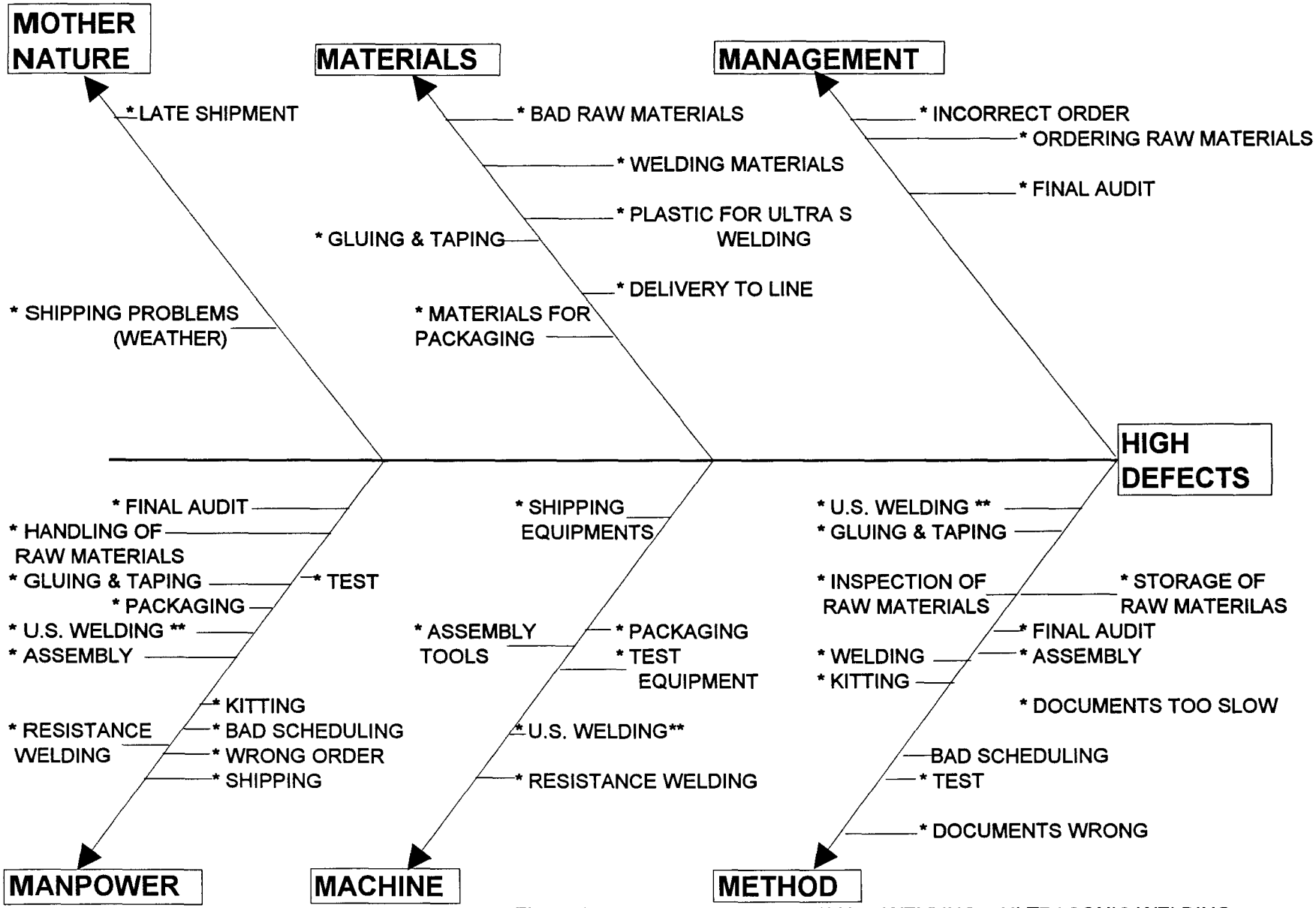

Figure 4

** U.S. WELDING = ULTRASONIC WELDING

CAUSE AND EFFECT DIAGRAM FOR
" INCOMING INSPECTION "

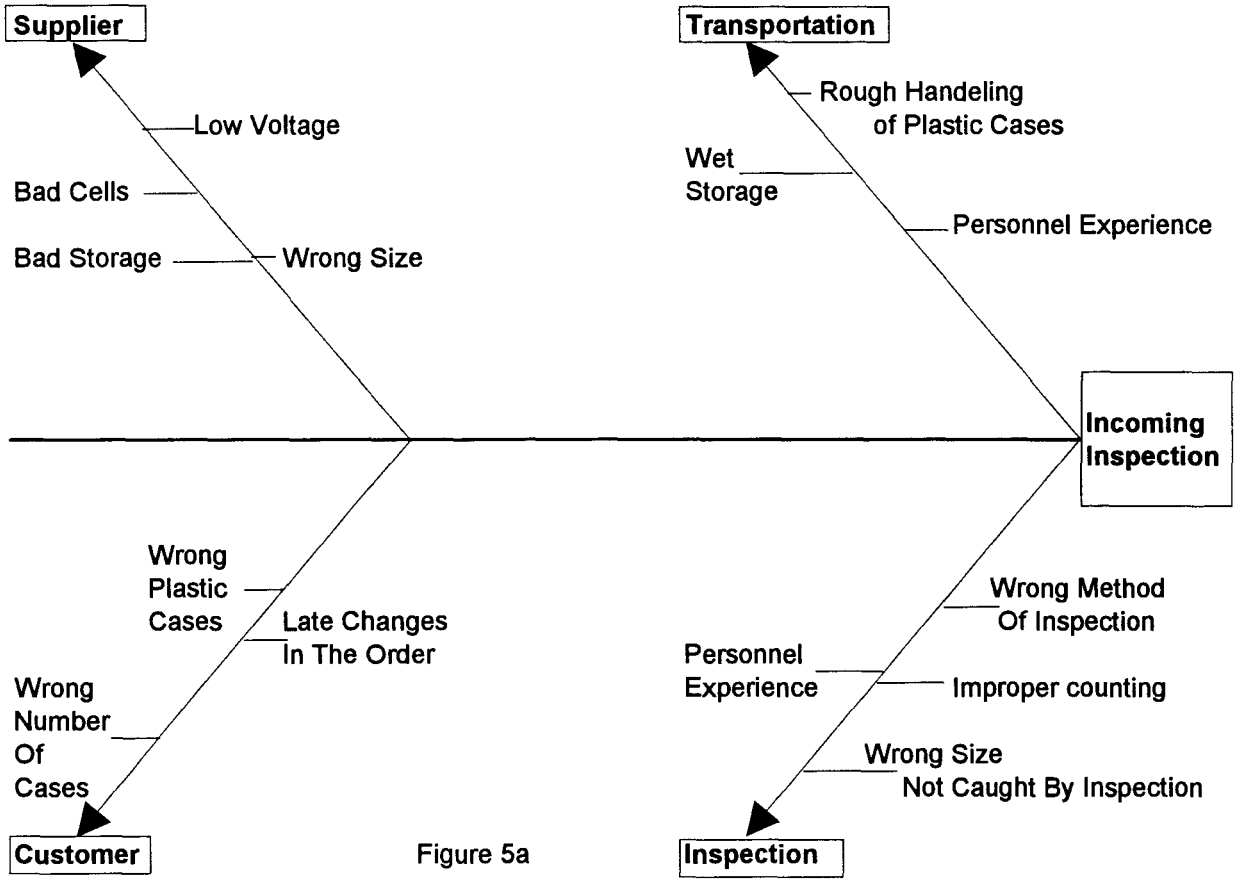

Figure 5a

CAUSE AND EFFECT DIAGRAM
FOR " DOCUMENTATION ISSUED "

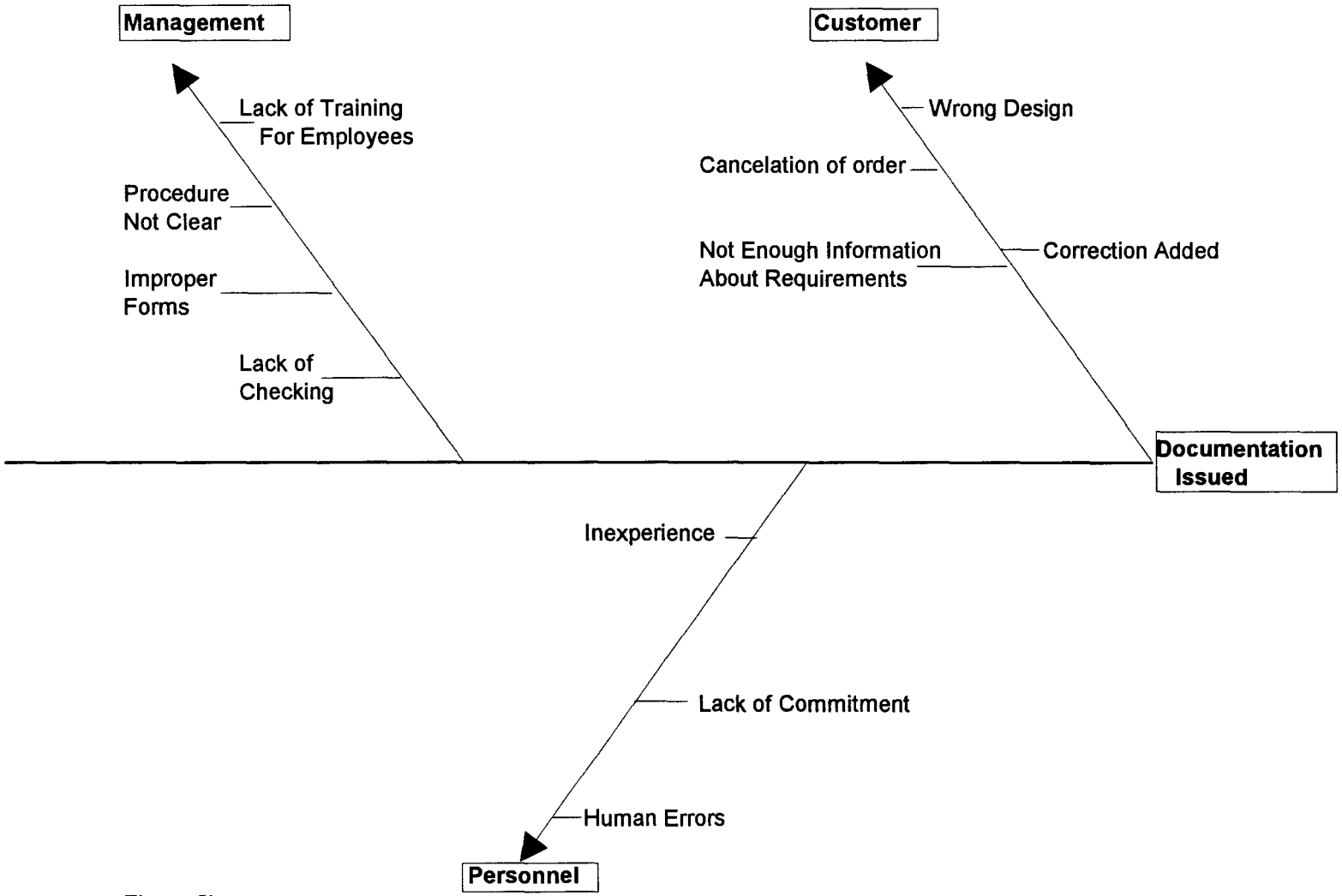

Figure 5b

CAUSE AND EFFECT DIAGRAM
FOR " GLUING AND TAPING "

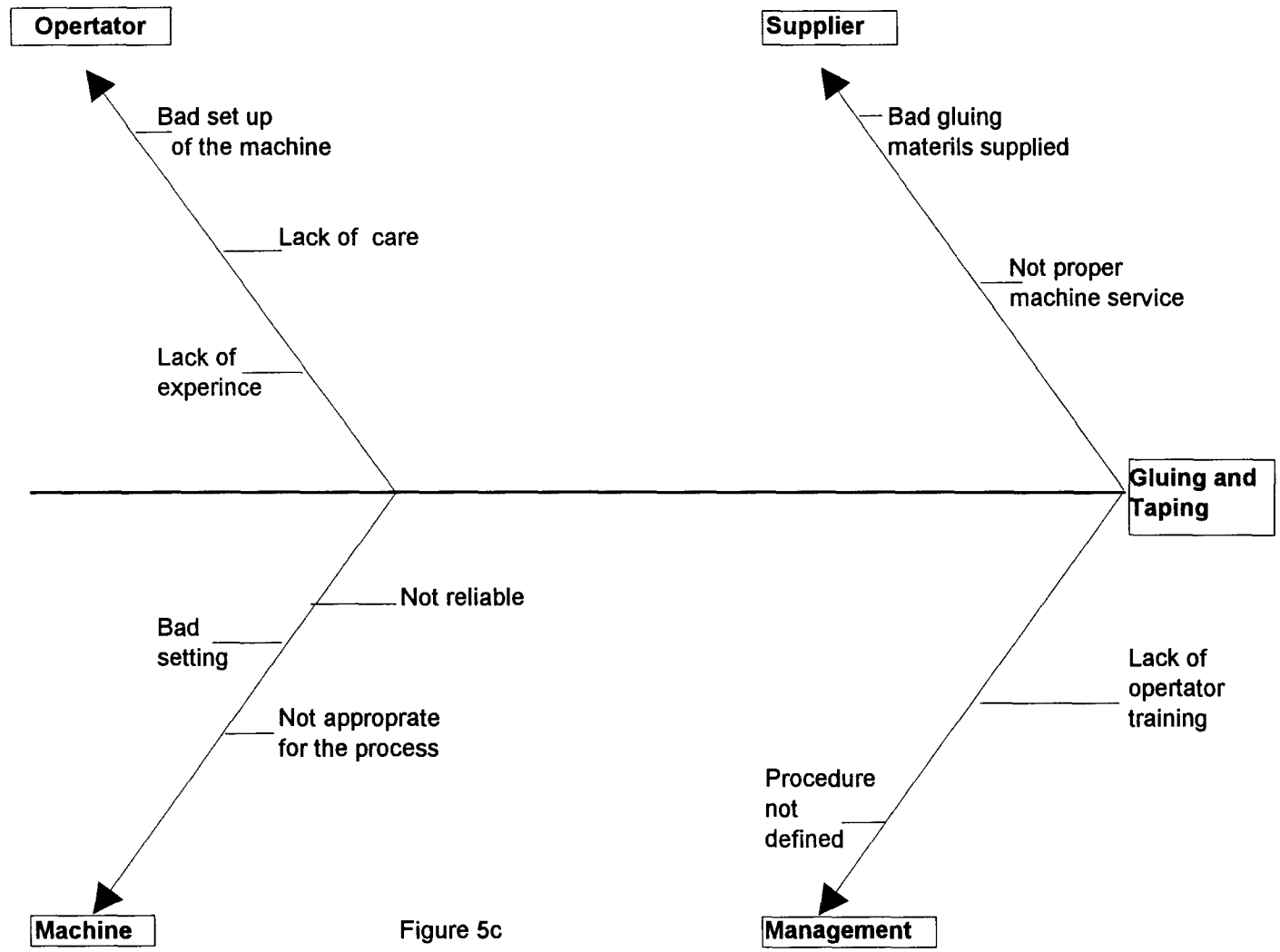

Figure 5c

CAUSE AND EFFECT DIAGRAM FOR " PACKAGING "

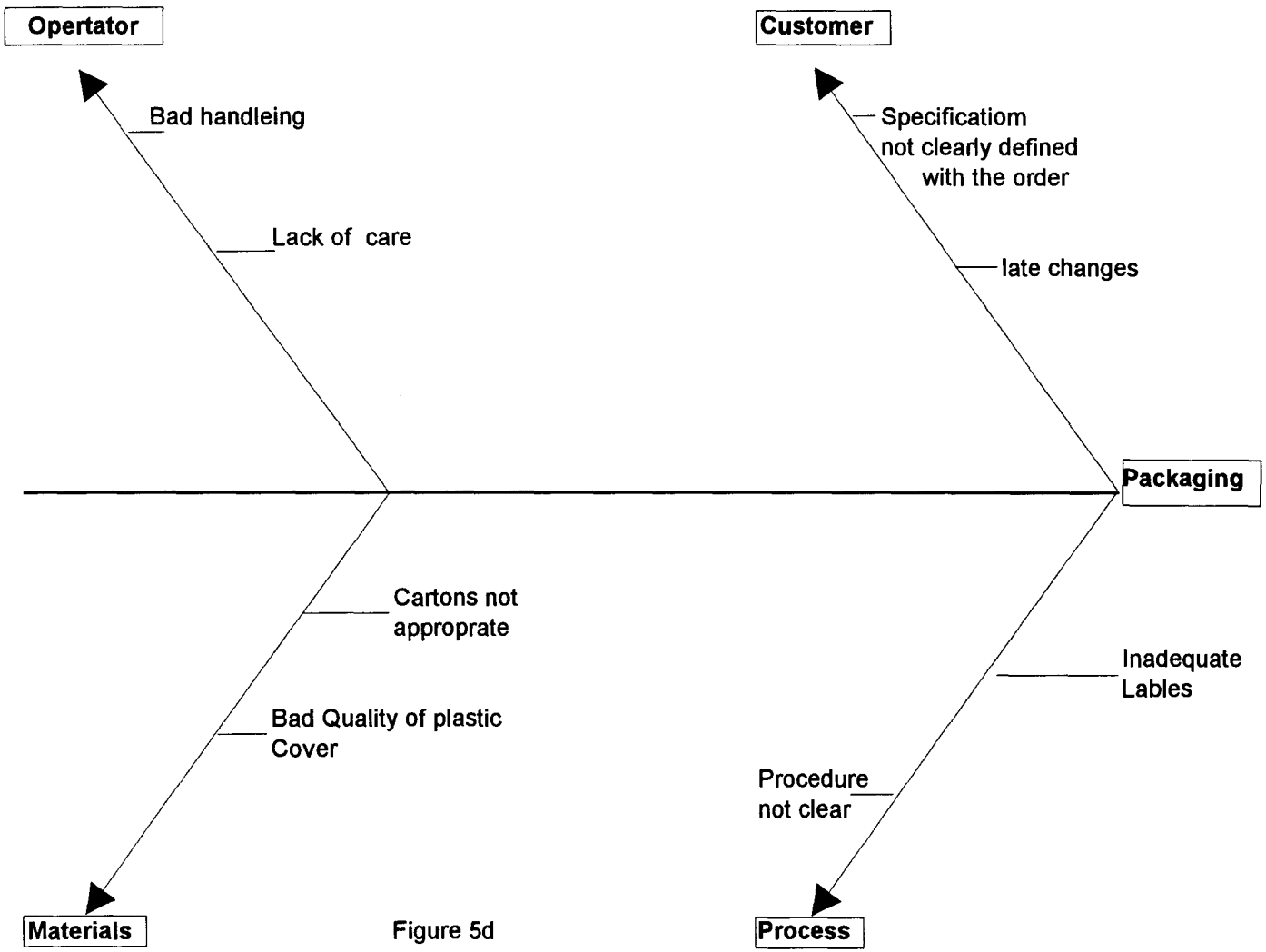

Figure 5d

CAUSE AND EFFECT DIAGRAM
FOR " VOLTAGE AND IMPEDANCE TESTS "

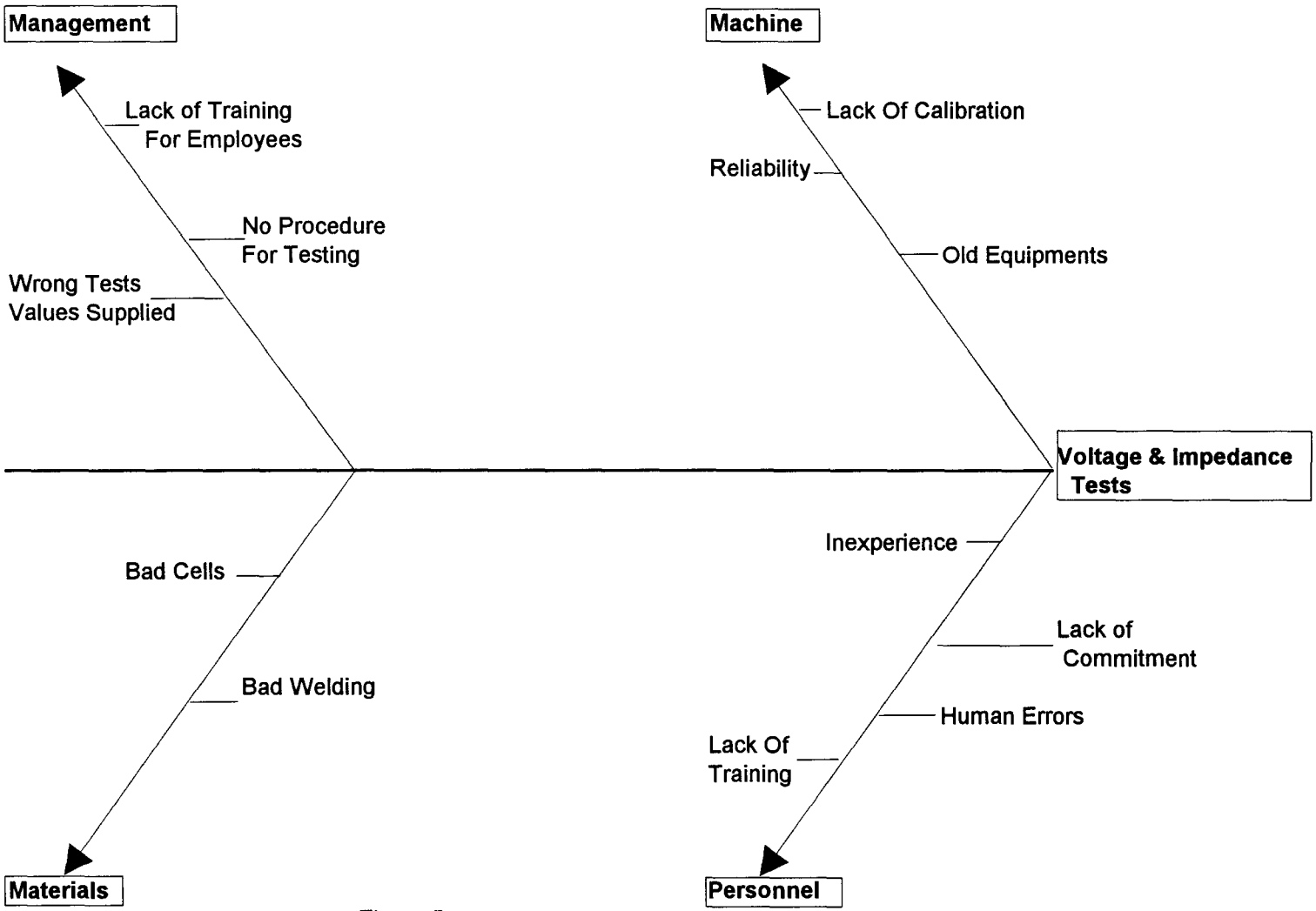

Figure 5e

CAUSE AND EFFECT DIAGRAM
FOR " RESISTANCE WELDING "

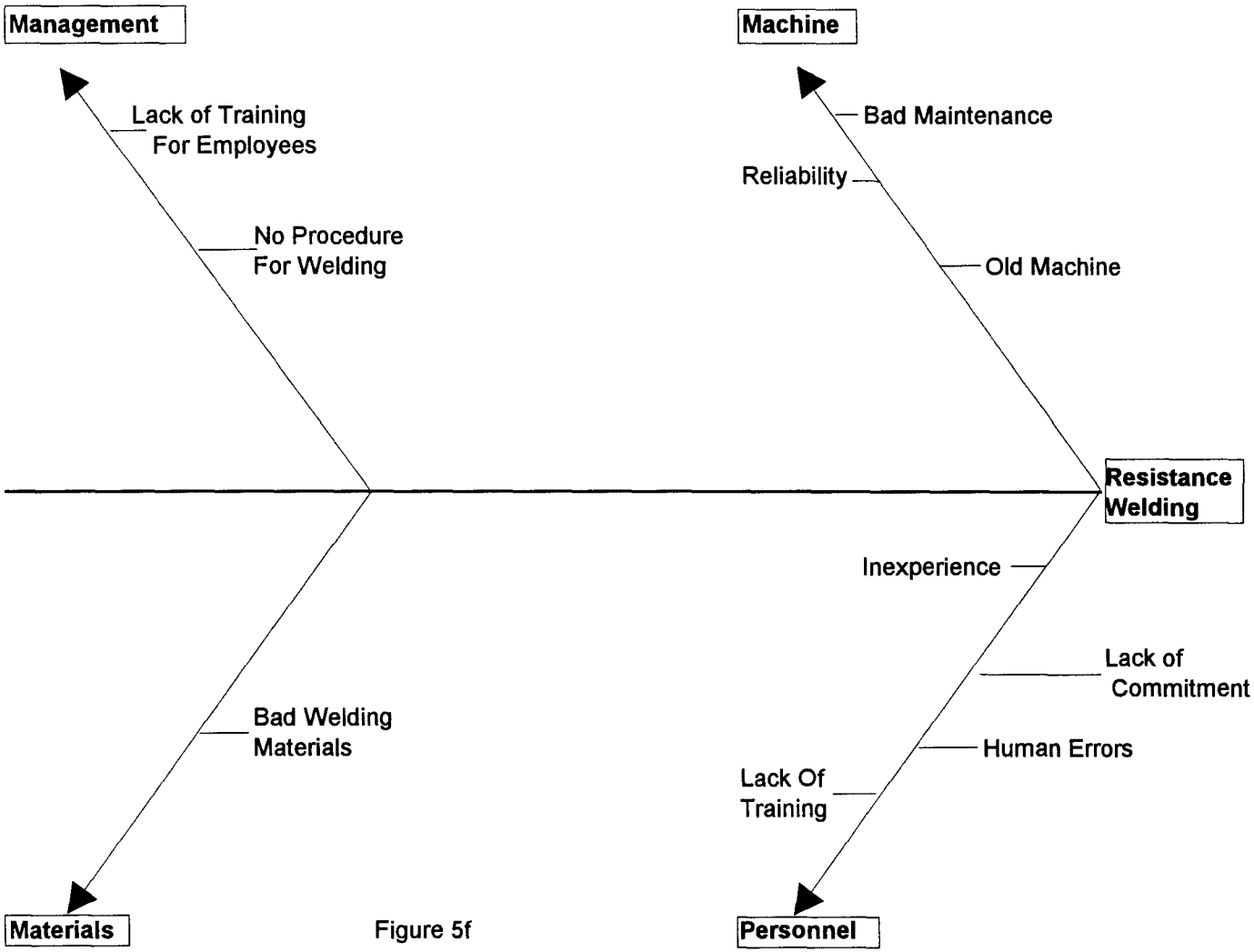

Figure 5f

SOLUTION FINDING

Incoming inspection.

Problem: The major problem which affect this step is getting low voltage battery from suppliers.

Solution: A possible solution can be by ranking suppliers according to the past experience and to select who is proven to be the more reliable. However, the company must work for a quality insurance from any supplier it wishes to work with. The insurance should consist of verification of the time period which battery has been in storage before packaging.

Documentation issued:

Problem1: On the management, there is a problem of not identifying the exact procedure of issuing the documentation. Presently, documentation are made by several people in the plant, then collected and issued without being checked by experienced personnel.

Solution1: There should be a designated team that issues the document and verifies it before being issued to the assembly line, so the company could standardize this step of the process.

Problem2: Another problem in this step is caused by the customer. Very often, corrections are being added after material has been set to the line, this causes a lot of problems.

Solution2: The management must establish a communication channel with the customer before issuing the final documentation of the order. Verification must also be obtained from the customer.

Gluing and taping:

Problem:Bad set-up of the machine.

Solution: The management should provide a documentation which describe step by step the set-up procedure, and the changes in the set-up required from one product to another. The operator should be trained for this.

Packaging:

Problem: There are not enough information regarding the labels and the king of packaging that is required. This causes delay in the process.

Solution: Management should verify that document received form customers contain all the needed information regarding labeling and packaging. This would also avoid the late changes in the order.

Voltage and impedance test :

Problem: There is a lack of calibration of the equipment. The measure are not accurate and they fluctuates.

Solution: Periodical calibration must be established to ensure accurate measurements.

Resistance welding :

Problem: No specific procedures that describe the welding process and the quality required. Now, management rely on the personnel's workmanship to accomplish this task.

Solution: Management should issue documentation which identify clearly the steps of the welding, so that that task will be performed more efficiently with care of the quality level required.

ISO 9001 REQUIREMENTS.

To meet the ISO 9001 standard of quality, the company must change the way which it is handling each step of the process to comply with the specification. The comparison of how each step of the process being handle presently, and how it should be according to ISO 9001 is stated on the following sheets:

Order Entry

Present	*ISO 9000*
The records indicate no errors. But the estimation are 15% of orders incorrect.	Section 4.3: Contract Review The supplier shall establish and maintain procedures for contract review and for the coordination of these activities. Each contract shall be reviewed by the supplier to ensure that: a) the requirements are adequately defined and documented b)any requirements differing from those in the tender are resolved c) the supplier has the capability to meet contractual requirements. Records of such contract reviews shall be maintained. Comments: The contracts must be clarified with the supplier. Quality standards should be discussed.

Build Scheduled

Present	*ISO 9000*
No records are kept. There is an estimation of 30% of orders rescheduled due to parts shortages. Comments: These mistakes can come either from the company, or from the supplier. If they come from the company, the purchasing department should work closer to the production in order to coordinate the reception of the materials with the line to be produced. If the mistakes come from the supplier, the company can eliminate them by working closer to suppliers. The company should work towards a Just-In Time approach.	There is no ISO 9000 requirements for this step.

Documentation Issued

PRESENT	*ISO 9000*
Changes to document are not incorporated until work order is issued, causing a "hurry process Roughly 50% of all document is incorrect For the order in hand, 3 errors are found in the document	Clause 4.5 Approval by authorize personnel prior to issuing Document must be available to -- purchasing office of raw materials. -- each step of operation. After one product is fully processed through the line, all documents related to this specific product must be removed before a new product is send on the line Any changes to the documents should be reviewed and approved by the authorized personnel responsible for issuing the documents. Before document are issued, the relevant information for the causes of changes in the document must be available to the designated personnel for review and approval. Documents shall be reissued after appropriate changes are made to the original copy of the documents. **Comments** By checking the document according to ISO 9001, we note that any mistake in the documentation will be discovered and and correction can be made in the initial stage before wrong document can affect all steps of the process.

PARTS KITTED

PRESENT	*ISO 9000*
Due to the wrong documents which included the number and type of part to be included in the process, the record shows 2% of the issued materials are returned as 'incorrect. There are no check that parts kitted before being sent to the assembly line.	Since ISO 9001 assured the right document is issued, error in collecting parts related to mistakes from the document will be eliminated. ISO 9001 also requires the company to provide a method of handling the part which will eliminate errors due to handling Special arrangement of raw material created in order to avoid miscounting or picking the wrong parts

Purchasing Materials

Present	*ISO 9000*
No records are kept. Their vendors don't have any certification.	Section 4.6: "Assessment of Sub-Contractors" The supplier shall select sub-contractors on the basis of their ability to meet subcontract requirements, including quality requirements. The supplier shall establish and maintain records of acceptable sub-contractors. The supplier shall ensure that quality system controls are effective. Comments: A system of vendor evaluation and certification would have to be put in place

Incoming Inspection

Present	*ISO 9000*
The company inspects all the raw materials received (cells, and plastic case). On the total 14 lots of raw cells, one lot was rejected. On the total 12 lots of cases , none was rejected..	Section 4.10: Inspection and Testing: The supplier shall ensure that incoming product is not used or processed until it has been inspected or otherwise verified as conforming to specified requirements. Verification shall be in accordance with the quality plan or documented procedures. Comments: A system of proper receiving inspection would have to be put in place, in addition to properly calibrated equipment to be used for the inspections.

Raw Material Received

Present	*ISO 9000*
All material received are put into a manual inventory. Comments: The inventory should be made on a computer instead of manually on sheets. This will save time. The most important benefit is the accuracy of the documents. All the inventories issued will come from the same source, and people will know where to find it when they will need it.	Section 4.15.1: The supplier shall establish, document, and maintain procedures for handling, storage, packaging, and delivery of product. Section 4.15.2: Handling The supplier shall provide methods and means of handling that prevent damage and deterioration. Section 4.15.3 : Storage The supplier shall provide secure storage areas or stock rooms to prevent damage or deterioration of product, pending use, or delivery. Appropriate methods for authorizing receipt and the dispatch to and from such areas shall be stipulated. In order to detect deterioration, the condition of product in stock shall be assessed at appropriate intervals. Comments: The plastic cases don't seem to be demanding precise conditions of storage. However, the cells may be damage by being stored in a room with inadequate temperature, or moisture. The company should make a study to determine if the cells were damaged within the company, during their transportation, or in the supplier's company.

Resistance Welding

PRESENT	*ISO 9000*
No record of failures really exist. An estimate of failure is 7-8% Types of failures is : bad welding and bad connection of battery cells. The quality of the process is based on the operator experience and " feel".	Clause NO. 4.9 : ISO 9001states that a process must be controlled by having document work instruction defining the method of welding, the quality. of the materials used in welding, the suitability of the machine doing the process, and the environment in which the welding is done. The quality of the final process must also be defined. The company must monitor and control the welding process. The quality of workmanship of welding should be defined in written standard or by a sample. Clause NO. 4.20 : ISO 9001 specifies the necessity of applying statistical technique to collect data about the process capability and the product characteristic, such as the number of failures per hour / per shift, and investigate the causes of the failures.

Voltage & Impedance tests

PRESENT	*ISO 9000*
Data collected : V1 = 6.23 v (average) Z1 = ? (not used) V2 = 6.16 v (average) Z2 = ? (not used) V3 = 6.12 (average) Z3 = 192m ohms V4 = 6.13 v(average) Z4 = 200 m ohms V5 = 6.10 v (average) Z5 = 192 m ohms The specified value of the voltage and impedance do not exit. Thus, measurement taken to insure consistency and not conformance with a specified required value. The impedances of some samples are not measured. There are no records which show that measurements taken are accurate, and the meters used are calibrate periodically.	Clause 4.11 : 1. identify the value of the voltage and the impedance which measurmets are made against, and the level of accurecy. 2. periodically calibrate equipments. 3.establish and document the calibration procedure. 4. ensure the accuracy of equipments. 5. maintainence a record of the calibration values of the voltage and the impedance meters. 6. compare with the previous results of the calibration. 7. ensure that the environmental conditions are suitable for calibration. 8. safeguard inspection. Clause 4.10.4 : Records of voltages and impedance measurement must be maintained to provide evidence that the products are per the specifications Clause 4.13 : Documentation of non-conformity must be maintained. The non-conforming products must be segregated immediately to prevent an advertence use. Statistical records must be obtained of the non-conforming product and the causes of the non-conformity.

Rework

PRESENT	*ISO 9000*
If any defects, final auditor determines disposition such as, vender, scrap, and rework. Few records are kept. No statistical analysis is done. All items which go to rework are handled separately in a mini- assembly line.	Clause 4.13 : ISO 9001 specifies that a record of all the rework battery pack must be established. Items which need rework must be segregated from the process in order to prevent the inadvertent use of the non-conforming products. Clause 4.13.1 : A company must define the responsibilities and authorized people to disposition the non-conforming products, and document the procedure. Non-conforming products may be : Reworked to meet specified requirements, or accepted with or without concession, or re-graded for alternative applications, or rejected or scraped. Clause 4.14 : Investigation of the causes of the non-conformity must be initiated and the corrective actions must be applied in order to prevent the reoccurrence. Analyze all steps of the operation to detect and eliminate potential causes. Initiate actions to deal with the problems depending on their risks. Apply controls to ensure that corrective actions are taking place and are effective. Implement and record changes in the process as a result of the corrective actions.

Gluing and taping.

Present	ISO 9000
In process inspection. Use jig. Done from memory. * Quality level: Zero defect, no SPC, Jig not always controlled, no documentation, scrap: 5%.	ISO 9001(4.9) The supplier shall identify and plan the production. The process should be carried out under controlled conditions: * The work instruction should be well documented. They are used to define a suitable production and installation equipment. * Control of suitable process, product characteristics. * Approval of appropriate processes and equipments. * Workmanship stipulated A statistical process control is required.

Assembly

Present	*ISO 9000*
Put two halves together. No written criteria. * Quality level: 2-3% scrap, no record at in process inspection.	ISO 9001(4.9) The records should be maintained for qualified processes. The process should be carried out under controlled conditions: * The work instruction should be well documented. They are used to define a suitable production and installation equipment. * Control of suitable process, product characteristics. * Approval of appropriate processes and equipments. * Workmanship stipulated Decrease scrap, SPC required.

Ultrasonic welding

Present	*ISO 9000*
Present Set up and run by feel No documented process. * Quality level: 10% scrap, no records, No SPC	ISO 9000(4.9) The process should be carried out under controlled conditions: * The work instruction should be well documented. They are used to define a suitable production and installation equipment. * Control of suitable process, product characteristics. * Approval of appropriate processes and equipments. * Workmanship stipulated Continuous monitoring and compliance with documented procedures is required to ensure that the specified requirements are met.

Drop test

Present	*ISO 9000*
Dropped from 1 meter to carpet floor on 3 axes. Use of dummy battery. * Quality level: Pass/Fail test, customer required, 2% scrap, no record.	ISO 9001(4.10.2) Test product as required by the quality plan. Establish product conformance to specified requirements by use of process monitoring and control methods. Hold product until test is completed or necessary reports have been received and verified. Identify non conforming product. Specific instruction and documentation on the drop test. Use real battery pack to verify if the drop test has an effect the resistance welding.

Packaging

Present	*ISO 9000*
This operation is done manually. The final audit indicates zero-defects. The operators estimate that there is 2% rework. This shows that the measurement is not accurate.	Section 4.15.4. The supplier shall control packing, preservation, and marking processes (including material used) to the extent necessary to ensure conformance to specified requirements and identify, preserve, and segregate all product from the time of receipt until the supplier's responsibility. Comments: The tests, as far as checking all the documents and labels should be made by the operator while he's packaging. This will save time and money.

FINAL VOLTAGE & IMPEDANCE TEST
& AUDIT

Present	*ISO 9000*
The final audit records zero-defects. In fact, we estimate that there is a 100% documentation failures which require change/question process in order to make the right test. 2% of the net sales are returned defective. Comments: 1-In order to test the battery packs, the cartons must be re-opened. This requires time and efforts. Moreover, this supplemental handling can damage the product. 2- The specifications for the tests are not clear enough or are not with the lot to be tested. 3-The tests should be extended in the lot to avoid returns from customers. A study should be conducted in order to identify the problems.	The quality plan or documented procedures for final inspection and testing shall require that all specified inspection and tests, including those specified either on receipt of product or in-process, have been carried out and that the data meets specified requirements. Comments: 1-The voltage and impedance tests seems to be redundant. A study needs to be done to know if the different operations between the two tests can alter the voltage and impedance. 2-Specification and variance should be defined with the customer. These documents must be carried with the product during the whole process. 3-SPC must be used to test the voltage and impedance of the packs. 4-The packaging should be done after this test. This will save time and will diminish the risks of damaging the battery packs.

SHIPPING

Present	*ISO 9000*
No records are kept. The estimates show a 100% of shipments received undamaged by customer. Comments: The 2% of the net sales returned may come from a bad packaging or shipment. This will be identified by a study.	Section 4.15.5 Delivery The supplier shall arrange for the protection of the quality of product after final inspection and test. Where contractually specified, this protection shall be extended to include delivery to destination. Comments: In order to verify the accuracy of the 100% of reception undamaged, the company should make a survey.

5.0 TQM Philosophy

The TQM philosophy chosen for this analysis is "Deming's 14 Points".

Deming's 14 Points are reprinted below for reference:

1. Create constancy of purpose for improvements of product and service.
2. Adopt the new philosophy.
3. Cease dependence on mass inspection.
4. End the practice of awarding business on price tag alone.
5. Constantly and forever improve the system of production and service.
6. Institute modern methods of training on the job.
7. Institute modern methods of leadership. (Empowerment)
8. Drive out fear.
9. Break down barriers between departments; teamwork.
10. Eliminate slogans, posters and exhortations for the work force.
11. Eliminate work standards and numerical quotas.
12. Remove barriers that hinder the hourly workers.
13. Institute a vigorous program of education and training.
14. Create a structure in top management that will push every day on the above 13 points.

After studying Deming's 14 points, we suggest that the company follow this plan of actions: