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COST REDUCTION THROUGH CLOSER CONTROL OF QUALITY

by

Walter R. Kuzmin

A Thesis

Submitted to the Faculty of
The Department of Management Engineering
of
Newark College of Engineering

In partial fulfillment of the
Requirements for the degree of
Master of Science
with a major in Management Engineering
in the
Graduate Division
at
Newark, New Jersey

1952
Approval of Thesis

for

Department of Management Engineering

by

Faculty Advisor

4/2/52
The economy of our nation differs today from that of World War II or pre-World War II days by the fact that a war-production program is being carried on without adversely affecting the production of civilian goods. At the same time management is confronted with rising costs due to the inflationary spiral of wages and materials. To make a profit on products and remain in competition, management is forced to apply the latest cost reduction methods. Because of the dual economy, companies are quoting on civilian goods and war products. Contracts released by the government specify that adequate inspection and quality control procedures should be available in plants or that a procedure should be available if a contract is desired.

During World War II statistical quality control was initiated in a considerable number of plants. Programs of training were sponsored by the War Production Board. The Department of Defense has a Military Standard (MIL-STD-105A) stressing procedures for statistical inspection, and the American War Standards Association has issued requirements for quality control. Today's literature is abundant with featured articles in the leading trade journals stressing quality control and its cost reduction aspects. Thus, quality control methods have become a prominent part of management today and...
are assuming equal importance with such cost reduction methods as time and motion study, methods and plant layout.

This thesis deals with the practical aspects of Inspection and Quality Control as a means of cost reduction. In establishing the present need for cost reduction by inspection and quality control the discussion is centered on cost of rejects in a small plant hereinafter referred to as "the company" or "the plant". A small company employing approximately 200 employees has been selected. The company is a job shop and manufactures sheet metal products.

Large and small companies have successfully employed statistical methods with reductions in costs. Therefore, it is the purpose of this thesis to present a sound basis for a quality control program in a small company so that a foundation may exist for the application of statistical quality control.

General quality control programs and their relationship to inspection will be discussed. Present cost-reduction methods in the company are presented to determine whether cost reduction has been attempted by investigation of quality control methods. Cost of rejects in the present system are analyzed to determine if cost reduction can be effected by closer control of quality.
The success of any program depends on the people who carry it out; hence a discussion of organization and personnel is included so that the program may be "sold" to the employees. Included are brief discussions of successful quality control programs of other companies so that the value of such programs may be demonstrated.

The main conclusion is drawn by analyzing the company's present quality control program through the application of the fundamentals of scientific management.

The author is grateful to Professor Oliver J. Sizelove, Executive Associate of the Department of Management and Personnel in the Newark College of Engineering for his assistance and guidance in the preparation of this paper, and to Frederick M. Burt who read and criticized the manuscript.

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W. R. KUZMIN

Rutherford, N. J.
January, 1952
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CHAPTER I

DISCUSSION OF INSPECTION AND QUALITY CONTROL
SECTION A

INSPECTION

Inspection Defined

In early factory practice inspection of dimensions merely involved looking at the work or making superficial measurements. Through the gradual development of more accurate measuring instruments and better machinery, the art of inspection today has become precise enough to measure readily in thousandths and ten-thousandths of an inch. With this high degree of precision, modern inspection has become recognized as an instrument for quality measurement and an important factor in quality control. It also has been recognized that inspection should be a function independent of any manufacturing process.¹

Generally accepted definitions of inspection are as follows:

"Inspection is the art of comparing materials, products, or performance with established standards."¹

"Inspection is the art of employing tests, preferably by the aid of measuring appliances, to observe whether a given item of product is within the specified limits of variability."¹

¹. Production Handbook -- L. P. Alford, J. R. Bangs, p. 623
Inspection Function and Characteristics

The function of inspection is to detect variations from specifications and report those differences to management. An Inspection Department does not set quality standards; management does that through engineering. The real objectives of an Inspection Department are as follows:

1) Control of quality standards during the manufacturing process.
2) Aid in the location of causes of defective work.
3) Sorting acceptable from rejectable materials.
4) Providing management, through reports, with a picture of the quality of products produced.

It is a well-known fact that preventive inspection pays the highest dividends. Segregating the defective work keeps a company's good name. If quality cannot be described adequately on paper it should be illustrated by samples. The following is a list of types of inspection used to attain the aforementioned:

1) Preventive -- The purpose of Preventive Inspection is to detect the flaw before it occurs thus protecting the name of the manufacturer; also to catch defects that have been produced.

2) Centralized -- This type of inspection involves transporting a product to a central location for inspection. The inspection place is not necessarily at one fixed location. Advantages of Centralized Inspection are as follows:
   a) It is easier to supervise inspectors.
   b) Better working surroundings may be had.
   c) Less interference with workers' production.
   d) Impartial inspection; that is to say, the inspector is not under the strain of rejecting work which is being performed by an operator along side of him.
   e) It facilitates the use of specialized equipment.
   f) Records are kept in one place.
3) Functional -- Functional Inspection involves placing the part in a skeletonized assembly to see if it works.
4) Visual -- Visual Inspection concerns the examination of a product for such flaws as off-color or other factors that may be ascertained easily by the eye.
If a plant desires to have good inspection, it must analyze the present procedures for waste. There are five essential characteristics to investigate when inspection costs are to be decreased:

1) Eliminate non-essential operations. Products should be classified according to defects such as:
   a) Critical
   b) Major
   c) Minor

2) Improve working conditions. Good working conditions emphasize good inspection. If inspection instruments are poor, the inspected product is likewise poor. When management places the Inspection Department in an unsuitable office, it is a reflection of their thoughts as to the quality they desire in their products; hence the human factor becomes involved, and a person placed in poor surroundings immediately assumes that the worth of his particular service is not valued by management and therefore he does not pay attention as he should to the work being inspected.

3. p. 16 - "New Ways to Trim Inspection Waste" -- Modern Industry, Jan. '48
3) Fit the worker to the position. A complete description of each inspection job including gages and other equipment in which dimensions are to be observed, and so forth, should be written in the form of a specification; hence, if an inspector leaves the plant another can take up the job quickly as the specifications are plainly marked as to what is required.

4) Use inspection reports. All key production personnel should be notified of causes of rejects. The use of these reports serves as an analytical tool for management to correct machines that are causing rejected products.

5) Everyone must help on inspection problems. No one is excused for turning out poor quality work. Everyone in the plant is more or less in the category of an inspector.

The following questions must be asked of any management if the most is to be gotten out of inspection:

1) Are there adequate tools and good working conditions?

2) Is there good lighting and ventilation?

3) Is wasted motion eliminated?

4) Do floor inspectors have comparable travel routes?
5) What are the sampling techniques? Are they basic and sound? Is too much or too little sampling being done?

6) Do the Production Manager, Foreman and Engineering Department Head receive copies of inspection reports?

7) Is the human relations aspect of an Inspection Department considered?

8) When should inspection be made? Is inspection always made on the final product?

Organization of Inspection

The relation between the Engineers and the Inspectors in many plants is often complex. However, it must be born in mind that inspection provides service to the Engineers. The Engineering Department must provide the Inspection Department with proper tolerances on drawings and specifications on products. Many times the inspector is confronted with three problems:

1) Parts so far off dimensions that they are scrap. In this case the inspector should have the authority to scrap the material. 2) Parts that can be re-worked and brought within tolerances: a decision of reworking should be made by the Engineering Department. 3) Products

2. p. 265

4. "Relationship Between Engineering & Inspection", Instruments - C. B. Johnston
that have questionable salvage value: The Engineering Department should be consulted as to whether a part is salv-
vageable if such salvage means a product of lower quality.

Organization of an Inspection Department depends much on the size and layout of a plant, the type of product, and the quality and standards required of the worker. However, inspection is basically an independent function unconcerned with any other part of the plant except inspection of the work which is produced.¹

Inspection is usually coordinated with the Manufacturing, Production Control and Plant Engineering Departments. The Chief Inspector reports to the operating executive; that is to say, he reports to the Chief Engineer or the Production Manager who is directly concerned with manufacture and quality of products. The Engineering Department sets the design, the Manufacturing Superintendent puts the design into effect. The Production Manager administers the laws; the Inspection Department interprets Engineering design and reports if the Manufacturing has fulfilled all requirements.

Violations to the fundament that inspection is an independent function occur in plants where inspection time may

¹. p. 624.
be insignificant compared to production hours. Hence, inspection is incorporated as a part of the function of other departments. The violation becomes prominent in organization of medium to small plants. However, varying degrees of independence do exist in the aforementioned plants. Large plants tend to consider inspection an independent function and place it with equal rating to such departments as Engineering, Methods & Equipment, Production, Sales and Financial.

Personnel requirements

The Chief Inspector must be a man of administrative and executive ability. He should know how to make use of assistants when necessary. Wide general experience in industry is preferable rather than any specialized knowledge of a particular job. Some of the responsibilities of the Chief Inspector are:

1) Selection of staff.
2) Training of staff.
3) Organizing of department and planning of inspection work for most efficient production.
4) General supervision of gages and tools used for inspection and testing purposes.
5) General supervision of salvage work.

1. p. 631.
6) Expense budget for his department.

The Assistant Chief Inspector aids the Chief Inspector in directing the work of the department. He takes the place of the Chief Inspector in his absence, and also takes charge of some important special operations, changes in methods, and so forth.

In some plants a "complaints" division is also in the Inspection Office. This division handles complaints concerning defective workmanship or defective material received from the field. This division also acts as the clearance house for the disposal of defective material produced within the plant.

Qualifications of Inspectors

An inspector must be a person who can be depended upon to follow instructions implicitly. He must also have a degree of intelligence such that he may ascertain the purposes of tests and their relation to the part manufactured. A certain amount of factory experience is valuable, but it should be realized that shop work is not inspection work and that inspection involves entirely different techniques.

Bench workers should be of a temperament which can follow rigid instructions on repetitive work. Floor inspectors are required to exercise judgment on products with which they should have had some previous experience.
Women, having the characteristic of being generally careful and patient, are better suited to repetitive types of inspection.

**Training Inspectors**

In instructing an inspector on a particular piece of work as to how it should be examined, the instruction should not be casual, but should be given by someone with technical knowledge. The inspector at this time should be provided with readily accessible reference data such as samples and large scale drawings. It sometimes helps to have gage points distinctly marked and instruction cards available. If the above cannot be had at the bench, the inspector should be shown where to get the material for reference.

**Nature and Extent of Inspection**

Oftentimes many inspection operations can be eliminated; hence inspection procedures always should be under the scrutiny of the methods man. Many times fixtures succeeding some operations can be designed to serve as gages to detect incomplete operations. In some cases parts may be of such minor proportions and such slight costs that it might be more advantageous to drop inspection in favor of a more certain test such as the acceptability of the parts for use in the Assembly Department. For instance, this condition can be true of most small screws or minor screw-machine products.
Properties of metal, physical condition of metal, degree of finish, form and dimension, chemical reactivity, and function or performance are all standards that should be specified so that the Inspection Department may properly classify work in process.
Quality Control

The National Industrial Conference Board made statements that many sheet metal fabricators do not have good inspection setups in regard to stampings for defense orders. The Services want two things from a manufacturer: volume production and products to specifications. They also desire a company to have an active or effective quality-control system in force or one ready to be put in operation. Records must be complete and accurate so that quality-control programs can be reliable. Many shops that produce long-run stampings use the statistical approach with frequency-distribution or control-chart systems.

Definition

The term "quality control" is widely and loosely used. Sometimes it means just the functioning of an Inspection Department which accepts or rejects articles on visual inspection. Other times it refers to investigations of a complaint or failure in the shop; or it is referred to as merely partial inspection. The more usual interpretation of quality control today is in the manner of the prevention of defects rather

5. "Statistical Quality Control Can be a Practical Production Aid" -- Industrial Sheet Metal, May, 1951 p. 22.
than the acceptance or rejection of parts by inspection after defects occur. Quality control has also been interpreted to mean the extensive use of statistics as a scientific method of systematic observation to give prompt, corrective action on a cause system.

The Air Forces' definition of Quality Control is as follows:

"Quality Control is the overall management function by which the quality of supplies is established, determined, or improved. Inspection is but one of the tools of Quality Control; it is one of the methods by which quality is determined." 6

A more concise definition of quality control is as follows:

"Quality Control is therefore defined as established, desired standards or regulations for a product, providing the means for getting those standards, and assuring that the product conforms with the standards and regulations." 7

An analysis of this definition reveals the following facts:

1) Definite standards and regulations must be set for a product.

2) Means of obtaining the standards by organization and forms so that control of quality

will not deteriorate due to lack of action.

3) Adequate inspection machines and corrective action to assure that the product conforms with the standards are necessary.

A question may arise as to the size of plant that can utilize quality control methods profitably. The methods can be used in a large plant or a small plant. They are fundamental, however the type of quality control applied will depend on the nature of the product or system.

If a small quantity of stampings with relatively low precision requirements is being manufactured an elaborate quality control system of forms and statistics would be cumbersome and costly. The more direct approach of routine patrol and screening inspection or first piece inspection may be sufficient. With a product of simple design, exacting specifications, and large quantity of production, such as ball bearings, a statistical control system may be justified. Therefore, care and discretion must be used in the type of quality control selected for the manufacture of a product.

To make quality control effective, detailed reports should be prepared to show the cost and the quantity of work spoiled during the manufacturing process. Each report should

1. p. 678.
contain a statement as to the cause of the spoilage; all records should be complete and accurate so that all products can be accounted for.

**Purpose of Quality Control**

The purpose of quality control is to produce a product whose cost is consistent with market price. It is as poor business to sell too good a product at a loss as it is to sell an inferior product at a high profit. Quality control must protect the quality of a product at minimum cost and also insure interchangeability of parts.

If leadership in the field is desired in quality of product, added research and development activities are needed. Depending on the place management desires in the field, control of quality can be regulated accordingly. Quality control is basically a statistical function in a broad sense that provides the Inspection Department with historical data in regard to the manufacture of a product. Quality control should indicate amount of inspection on incoming and other parts. Inspection can be expensive and should be subject to continual examination. This will reduce cost and improve effectiveness. Many inspections may be done by the worker subject to checks by the Inspection Department.
Securing Quality Control

It is not uncommon to find that quality control in a plant is set by shop standards which are determined merely by an understanding between the shop and the engineering department as to tolerances that will be held. These unwritten laws are subject to various interpretations; thus some parts are made too well and others made inferior. Poor material and poor workmanship can lose customers for the company; therefore, the following measures must be determined before instituting an effective quality control program:

1) Setting of standards for all products manufactured or purchased.
3) Providing organization for routing recommendations of the quality control department.
4) Securing action.

Setting Standards

Standards for a product should be written clearly and specified so that only one interpretation can be made. Normal spoilage of material should be set at a definite level by management; that is to say a statement must be made as to whether or not 6 percent damaged material or 10 percent or 2 percent is considered normal spoilage. The Inspection

Department should have proper gages to measure work to keep it within the tolerances specified.

**Organization of a Quality Control Department**

Inspection has two important organizational functions which must be clearly defined. 1) Authority and 2) relationship to other departments. Top management must be quality minded. The inspection foremen should be on the same level as other foremen so that his decisions will not be useless in another foreman's opinion. Inspection is a staff function and must be set up as such in the organization chart. Inspection is like an umpire; it does not tell how or why plays are made, but whether or not they are made correctly. Quality control is a definite management responsibility; inspection is one of management's tools for maintaining quality control. Hence it is seen that the Inspection Department is not considered management but rather a tool of management. The five basic steps for instituting quality control are:

1) Determine quality desired; then set up specifications and limits for manufacture.

2) Build an attitude of quality mindedness throughout the organization.

3) Have a properly organized Inspection Department installed that will enforce quality standards set.

8. p. 266.
4) Provide records and charts that are simple and will give the current score of the Operating Department.

5) Train inspection personnel so that they know what they are doing and why, and also how to be fair and honest judges of workmanship.

**Sampling Plans**

Statistical Quality Control uses mathematics to save the trouble and cost of 100% inspection. It also spots production bugs. If a company manufactures any product for the military, the contract specifies that an Inspection system be set up that meets the standards of the government's Procuring Agency.

When life depends on an item a 100 percent check is a must, but piece by piece inspection is cumbersome on many items. Sampling now steps into the picture; the theory of statistical quality control is that in adequate sampling, rejects show up in the same proportion as in the batch. If sampling shows fewer rejects than allowed by specifications, the batch is satisfactory. For example; a batch of bolts is examined to see if they are within specifications; only a fraction of the total number is needed to provide an adequate sample. If the discrepancies within the batch are within the allotted specifications, the batch is satisfactory.

An important phase of sampling is that the size of sample
does not rise proportionately as the size of the batch. Two hundred parts may need a sample of 30, and according to the probability formula 3200 parts need only a sample of 150. The size of the sample varies with the closeness of tolerances to be maintained.

In regard to 100 percent inspection it has been found that the sampling technique in quality control is more effective than 100 percent inspection. Below is a chart showing the results of 100 percent inspection. It will be noted that the first lot had 100 defectives and 68 spotted. It will be noticed that in the second inspection the lot had 32 defectives and 18 were spotted, and it will show that when the third lot, which had 14 defectives, only 8 were spotted. The above were three consecutive inspections on the same product; therefore, this chart shows that 100 percent inspection does not mean 100 percent quality because of the fact that operator fatigue and monotony are human factors that cannot be accounted for. Other equally important factors which may defeat an inspection program may be caused by the poor selection of inspectors, since often, little attention is paid to alertness, coordination, ability to make quick decisions, conscientiousness and stamina to withstand monotony.

"The overall average for accuracy in 100 percent inspection seems to be about 80 percent."8

8. p. 136 Statistical Quality Control; What it Really Is -- Factory Management, C. W. Kennedy, Jan. '50
CHART I

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<td>100</td>
<td>68</td>
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<tr>
<td>2nd</td>
<td>32</td>
<td>18</td>
</tr>
<tr>
<td>3rd</td>
<td>14</td>
<td>8</td>
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Results of 100% Inspection

When installing a statistical sampling plan it should be used in parallel with existing inspection routines. It should not be intended to replace or interfere with the present system. The technique has to fit the situation.

Statistical techniques are also used in the application of reliability of measures for production processes. In any manufacturing process a deviation always exists in individual parts from the set standard. At times the percentage and the range of deviation can be predicted. The function of statistical quality control is to record the range and percentage of deviations and to indicate the probability of deviations varying from the set standard. Hence, statistics are not only applied to sampling techniques, but are used to determine if cause systems are under control by applying laws of probability.

When the probability of defects occurring is known, proper corrective action can be initiated immediately.

Executives of 39 companies report the following reasons for failures and successes of a quality control program:

Failures:

1) The importance is overrated.
2) Management cannot sit back and await returns.
3) Companies have no broad and clearly defined program.
4) The changes must be sold.

Successes:

1) Leadership has been entrusted to a person who has a proven record.
2) Basic objective of the program is the correction of defects.
3) The shop man will accept the change when it is made logical and desirable.
4) Managerial competence of the man at the head.
5) Quality control reports build up the prestige of the line supervisor.

To minimize the resistance to change to a quality control program, management must consider 3 points, 1) the program must be explained in familiar terms, 2) it must proceed in gradual and understandable steps, and 3) human relations must be kept smooth.

**Quality Control Reports**

Quality control reports vary according to the product being manufactured. Reports contain the type of sampling plan or control charts used. The lot size and other data pertinent to the manufacture of the product are also included. Provision is made to identify the quantity and nature of defects in addition to indicating disposal of rejects. Reports are submitted by foremen or supervisors to the Quality Control Department where they will be analyzed so that proper corrective action may be applied.

All reports should build the supervisor's prestige. They should preferably be drafted for his signature. The reports should emphasize results rather than sell quality control. Quality control engineers should not utilize reports to publicize the program.

---

A company manufacturing a stamped angle that was to be held to $90^\circ$ plus or minus $1/3^\circ$ was told by its engineers that it could not be done because of the variation and thickness of stock. The quality control engineers made a correlation chart where the angles and the thicknesses of metal were plotted. This chart showed the tolerance could be held regardless of the thickness of metal. Upon investigation it was shown that the initial adjustment of the die was not correct. A correction in the die was made, and the parts were produced.  10

The Apex Electrical Manufacturing Company had a problem of spotty production quality in 1946 and 1947. Material shortages and drop in assembly-line efficiency resulted in uneven quality. Although inspectors caught some sub-standard appliances, many got to customers resulting in complaints. The complaints about poor products were discussed with unions as to the questionable workmanship. As a result the time cards had slogans stating that every employee must be an inspector. Shop stewards made union members toe the line on quality. This is

10. 157 "Statistical Quality Control of Metal Stampings" by G. R. Armstrong, Iron Age, Feb. 21, 1946
an example of how cooperation with the union was one method of making quality control work.\textsuperscript{11}

"In most companies the cost of defectives is between $500.00 and $1000.00 per productive worker per year."\textsuperscript{9} This is noted from a survey made of 39 companies; hence its cost is incentive enough to install a properly managed quality-control program in any company.

It is estimated that lost time due to poor quality control and inspection is costing industry three billion dollars annually. When any piece has to be scrapped the time lost is double as the lost time might have been used to make a good piece.\textsuperscript{12}

A prominent manufacturer of electrical devices reports that Quality Control was able to bring a reduction in manufacturing cost amounting to $88,000.00 in approximately one year. The methods used were basically the same in all cases. The value of quality control has been proved and thus established as a necessary function of a company.\textsuperscript{13}

\begin{itemize}
\item \textsuperscript{11} "Workers Aid Boss; Apex Electrical Mfg. Co. Tackles Problem of Spotty Quality of Products", \textit{Business Week}, p. 94
\item \textsuperscript{9} p. 108.
\item \textsuperscript{12} "Better Inspection Lowers Costs"-\textit{American Machinist}-Apr. 3, '50
\item \textsuperscript{13} "Profitable Experiences in Quality Control", Leo Harrington, \textit{Tool & Die Journal}, Oct., '51
\end{itemize}
CHAPTER II

COST REDUCTION
Cost Reduction Methods

Cost reduction plans are many and varied, and seem to be affected by the type of industry involved. For example: screw machine companies emphasize cutting of costs by using most recent developments in cutting tools for longer life, and also higher speeds and feeds. Industries producing precise instruments that require 100 percent inspection place emphasis on inspection techniques and quality control where inspection time is a greater factor than production time. Thus major emphasis on where to control costs depends on the particular type of industry.

Cost reduction is a part of every department including clerical and administrative activities, and is usually measured in terms of quantity and time. The three major categories of cost reduction are as follows:

1) Administrative or plant burden
2) Product design
3) Fabrication methods

Administrative

In the administrative area, reduction of costs is accomplished by analyzing organization structure. All departments are surveyed as to efficient use of manpower. Adjustments in manpower are made in critical areas.

The paper work of an organization is another administrative cost which may be reduced by analysis. Other administrative costs are heat, light and power. Also included in this program is the systematic method of purchasing from lowest bidders.

Analysis of past or current records provides a means of determining where cost reduction should start. This phase of record keeping by management is extremely important as to when direct action should be taken because in many cases the barn door is closed after the horse is stolen. Likewise closed records showing a loss which cannot be regained are not valuable except that they may be applied for future work.

Product Design

A cost conscious engineering department must be constantly alerted to possibilities of using new materials. Coordination between the manufacturing department and design department must exist so that cost-reducing ideas may be put into action.

Imagination is the most important characteristic an engineer can have when applying cost reduction through design.
Although this characteristic is supposedly an inherent part of an engineer, industry has found that engineers with imagination for original thoughts are not plentiful.

When considering cost reduction through design the following must be analyzed:

1) Use of substitute materials
2) Use of fabrication design, i.e., Can a welded part be substituted for high-cost casting.
3) Rearrangement of components
4) Redesign of entire unit
5) Study of function of components. Can some be eliminated?
6) Finish -- is it adequate or too much for its purpose?

Fabrication Methods

The field of fabrication seems to present the best opportunities for cost reduction by using the following methods:

1) Time and motion study
2) Work simplification plans
3) Plant Layout
4) Flow Charts
5) Materials handling
6) Machine capability study
Operation of Cost-Reduction Plans

Experience has shown that management may be solidly behind cost reduction plans yet failure can result. There does not seem to be any half-way measures; cost reduction procedures either work or fail completely.¹⁵

In the past war the slogan was production at any cost. During this period money was plentiful, and any fairly good product could be sold at an unreasonable price. Hence, for a while, there was widespread indifference to high production costs. When the picture changed to widespread layoffs, it became a matter of cutting costs or going out of business.

Some companies cut costs by widespread slashing of the budget such as payrolls and other expenditures. The drinking cup became a rationed item in more than a few companies. Failure of the above plans may be attributed to the following:¹⁵

1) Management personnel had lost their ability to do an effective cost control job.
2) Lower echelons of management, foremen, etc., cooperated half-heartedly, sometimes even bucked managements plans.

Supervisors react in many ways to cost-reducing programs. Some feel as if management is already making too much money; others become hurt because management does not recognize when

¹⁵. "Here is Cost Cutting That Really Works"—Auren Uris & John H. Kostmayer American Machinist, Jun. 12, '50
expenses in a department have been cut. Still others are confused by conflicting orders from management.

Successful cost reduction programs may be developed by four major steps:15

1) All members of management should participate in the program.

2) Cooperation of foremen should be enlisted.

3) A sincere effort should be made to include rank and file employees a part of the campaign.

4) Top management must be sold on the cost-reduction program.

SECTION B

SOURCES OF COST REDUCTION
IN THE PLANT UNDER CONSIDERATION

Description of Plant to be Analyzed

The corporation, hereinafter referred to as the plant or the company, to be analyzed in the following pages of this report is a small job order shop of approximately 200 employees. The principle products are metal stampings and finished items which require metal stampings as a part of their design. The company has the following departments: stamping, welding, paint, assembly, shearing, plating and inspection. An office force of approximately seven employees controls sales and purchasing. Approximately ten employees are required for general administrative services. An engineering department consisting of six engineers design new products, and maintain flow of production.

Sources of Cost Reduction in the Plant

Sources of cost reduction in the company may develop in many ways. Sometimes ideas are originated in the Engineering Department by designing a better part, using a substitute material, or by a direct method improvement. Probable reduction in cost may originate in the Accounting Department and when reported to the management it is turned over to the Engineering Department for investigation. Sometimes cost reduction is forced by top management in a simple statement that
the end product must be cheaper. The entire effort of the Engineering Department is then devoted to reducing the cost, mainly by redesign.

Cost reduction is also started from the shop although it may not actually be thought as such when the plant supervisor or foreman become "stymied" on an assembly or method of producing parts and Engineering is called upon to improve the method or technique so that money and time will not be lost on the job. In a few instances cost reduction comes about by a foreman or a worker suggesting a substitute material or better methods.

The Procurement Department has a cost reduction program in regard to purchased parts. By means of obtaining quotations from various companies and comparing costs, the purchased parts price may be decreased. This particular department has applied itself in many cases to reduce costs. The method is systematic in that orders are released for a portion of the product or the first run on a shop order. On all following runs estimates are requested so that parts may be purchased more cheaply on subsequent runs.

Top management in the company is continually reviewing costs and receives monthly statements from the plant auditor. This historical record is kept for many products that have more than one run. If some jobs are repeat orders management
consults the record and then can make a better quotation by referring to previous costs. Foremen are notified at regular meetings if their costs are high, and the assignable cause is then sought. Management then makes its decision as to whether or not the cause should be investigated immediately.

**Actual Cases of Cost Reduction in the Plant**

A study of the organization chart (fig. 2) reveals that the company partially is following the scientific method of management. The project engineer is responsible for installation of methods in the plant. There is also a Methods Improvement position. The above positions supply management with information as to methods improvement. The Project Engineer's time is spent mainly on plant layout for flow lines of new products that have involved assemblies. The methods improvement man is concerned with spotting operations in the shop falling below estimated hours. This man is a shop man and has production hour records on jobs readily accessible. Hence, a setup exists to attack high costs where they occur. In all cases the scientific method of motion study and flow lines is used as a tool for methods improvement.

**Application of Flow Charts and Plant Layout**

An example of how coordination works between the Project Engineer and Methods Improvement man is the assembly of a poker chip dispenser. This particular project was new to the
company. The aforementioned men made time studies of operations to be performed; in addition a flow chart was made to eliminate needless travel. The plant was studied with top management as to where the assembly area should be located. Once this was decided the assembly area was constructed according to the flow chart. The Methods Improvement man stayed with the job until necessary minor revisions were made. The results of this approach can be seen in the chart II below:

CHART II

ASSEMBLY HOURS FOR POKER CHIP DISPENSER

<table>
<thead>
<tr>
<th></th>
<th>Hrs/Units</th>
<th>Percent Saving</th>
</tr>
</thead>
<tbody>
<tr>
<td>Estimated Assembly Time</td>
<td>129</td>
<td>---</td>
</tr>
<tr>
<td>Actual Assembly Time 1st run</td>
<td>86</td>
<td>33%</td>
</tr>
<tr>
<td>Actual Assembly Time 2nd run</td>
<td>80</td>
<td>38%</td>
</tr>
<tr>
<td>Actual Assembly Time 3rd run</td>
<td>80</td>
<td>38%</td>
</tr>
</tbody>
</table>

The above chart shows what intensified study of a job can do. Over 33 percent savings were made on each run.

Application of Materials Handling

In the Shearing Department considerable time was consumed in unloading sheet steel from trailer trucks. Top management, aware of time consumed, installed an elaborate system of traveling cranes. This reduced the time of unloading a 20-ton
trailer from 32 man hours to 8 man hours. Another saving was achieved in the fact that on some jobs shearing time would be recorded as eight hours whereas only four hours were consumed in actual shearing and the remainder in getting the steel to the machines. In addition it must be kept in mind that the men unloading the trailer were productive workers; thus production also was lost at the same time. Further savings were gained from reduced heat losses in the cold weather periods. Installation of the overhead crane has resulted in an estimated annual savings of $1500.00.

Another example of time saving by materials handling was the construction of a chute between the second and first floors of the assembly building. With the high rate of production, finished products piled up on the assembly floor since they had to be stacked on skids and then taken down a slow elevator to the storage area. Now as soon as a pile-up of finished products occurs on the assembly space it is only a matter of minutes until the floor space is clear.

Cost Reduction by Redesign

The automotive spark plug cleaner-tester made by the company has three valves requiring mechanical packing to prevent air leaks. The Project Engineer through research studied the use of preformed packings in the cleaner-tester as a substitute for the method of cutting off rope packing, winding it around the stem, and then assembling in the unit.
A comparison of costs is as follows:

**Rope Packing Method**

<table>
<thead>
<tr>
<th>Description</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost of Material</td>
<td>$5.13</td>
</tr>
<tr>
<td>Cut-off packing 4 hrs @ $2.80 Labor and Burden</td>
<td>11.20</td>
</tr>
<tr>
<td>Assembling to valve 28.6 hrs @ $2.80 Labor and Burden</td>
<td>80.20/96.53/M units</td>
</tr>
</tbody>
</table>

**Preformed Packing Methods**

<table>
<thead>
<tr>
<th>Description</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost of Material</td>
<td>$23.30*</td>
</tr>
<tr>
<td>Assembling to valve 10 hrs @ $2.80 Labor and Burden</td>
<td>28.00/51.30</td>
</tr>
</tbody>
</table>

From the above it can be seen that a 46.8 percent savings was attained by redesign of the packing. This saving is further amplified when the total number of units is considered. The total, to date, manufactured is 40,000 using preformed packing or (40 x $45.25) $1800.00 has been saved. Again it must be considered that this saving is tripled as three valves are used in the unit. Prior to the use of preformed packing, workers hands became black and grimy. Proper lengths were not cut off because of the toughness of the material. Hence morale also was raised by better design.

The above is an example of cost reduction through design. To cite every case would require volumes, and this

* Nov. 1950 Cost
case is only intended as an illustration.

Cost Reduction Through Research

Cost reduction also comes about in the form of research. A rectangular aluminum box was to be drawn for a manufacturer of television products. After many tryouts in the shop the engineering department was called upon to solve the complicated drawing problem. Rejects were running as high as 50 percent. It so happened that at the time research on drawing compounds was being carried out by the Project Engineer. A suitable compound was selected to use in the drawing operation. Rejects dropped to less than 1 percent. This example serves to illustrate that the fruits of continuous research may be plucked at any time. If the separate research had not been under progress, frantic last-minute calls of help to many manufacturers would have had to be made, and since many compounds were unsuitable the program might have been delayed considerably.

Cost Reduction by Analysis-of-Parts Function

Referring to p. 29 of this report the fifth consideration for cost reduction through design is considered. i.e. "Study of function of components." Can some be eliminated? Figure 1 is a sketch showing a study of the cause of leaks in a tester casting. It will be noted that there are two washers under the glass resting on a flat surface. This particular assembly was causing many rejects on the line. The rejects were sporadic; some days they would be as high as 40 percent, and other days
Conclusions

1. As temporary measure, pipe compound is being applied to stud retention type assembly.
2. Casting seal revised as shown in sketch.

FIG. 1

SKETCH SHOWING STUDY OF LEAKS IN TESTER CASTING

No work to be done unless this form is properly and completely filled out.
there would be none. The sketch shows an analysis of the probable path of air leaks. From this, it was concluded that leaks were caused by unevenness in the seat of the casting, and as a result the sealing washer did not provide a 100 percent seal. To remedy this, a seat was made in the form of a hill so that any unevenness in the seat would permit the sealing washer to flow; thus irregularities were filled. This improved design resulted in cost reduction by eliminating one part, and, in addition, rejections due to air leaks was decreased to an insignificant number. Here, cost reduction was not the aim, but through a study of components, cost reduction was achieved.

Conclusions

The scientific methods of cost reduction are sporadically used in the company. The three major categories of cost reduction: 1) Administrative or plant burden; 2) Product design, and 3) Fabrication methods are applied in various forms.

In fabrication methods cost reduction is mainly applied by methods study, plant layout, and flow charts. Inspection has not been considered as a source of cost reduction nor has rigid quality control been considered to reduce costs.
CHAPTER III

COST OF REJECTS IN THE PRESENT SYSTEM OF MANAGEMENT IN THE COMPANY
Cost of Rejects in the Present System

Case Histories

The following is a list of the costs of some rejects in the plant under consideration (see page 32). In many instances the cases are not exact because there is no system of counting rejects due to poor quality control; therefore, some will be descriptive and others will be estimated:

<table>
<thead>
<tr>
<th>Case #</th>
<th>Description</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>The base for a juice dispenser had 4 spotwelded nuts which became defective after welding because of splash over. This situation was not discovered until approximately 5,000 were ready for assembly. As a result, assembly time was lost because screws would not fit. Further time was lost to retap all nuts. This was partially corrected by using piloted weld nuts. Estimated time lost: -- Operat: Retap 4 nuts Operat./hr: 120 Cost of correcting rejects $4 x 5,000 \times $2.80 \over 120 = $467.00</td>
<td></td>
</tr>
<tr>
<td>Case #</td>
<td>Description</td>
<td>Cost</td>
</tr>
<tr>
<td>-------</td>
<td>-------------------------------------------------------------------------------------------------------</td>
<td>------</td>
</tr>
</tbody>
</table>
| 2     | Back grills for the juice machine have weld nuts which are supposed to be re-tapped after welding so that they may fit readily. In 10,000 units made, approximately 1800 have reached assembly without being tapped. Estimated time lost: = Operat: retap 1 nut Operat./hr: 120 Cost of correcting rejects \[
\frac{1500 \times 2.80}{120} = \$35.00
\] |
| 3     | Holes in 1000 abrasive hinge covers were supposed to be 0.191" dia. They were made 0.187" dia., and as a result all hinge covers had to be reamed to size because the axle stud would not fit. Operat: Ream holes to size Operat./hr: 150 Cost of rejects: \[
\frac{1000 \times 2.80}{150} = 18.70
\] |
| 4     | The assembly foreman estimates that 25% of his assembly time is spent correcting shop errors on parts fabricated for the cleaner tester. This seems high, but |
Case #

4

even though the foreman may be exaggerating the condition it is obvious that it exists to a marked or noticeable degree and should cause concern for investigation. Again poor quality and shop records cannot refute or substantiate this statement. An engineering estimate of lost time due to poor quality would seem to be approximately 10 percent of assembly time.

<table>
<thead>
<tr>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>even though the foreman may be exaggerating the condition it is obvious that it exists to a marked or noticeable degree and should cause concern for investigation. Again poor quality and shop records cannot refute or substantiate this statement. An engineering estimate of lost time due to poor quality would seem to be approximately 10 percent of assembly time.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
</tbody>
</table>

| Average assembly hrs/M units |
| (Canadian not included) |
| 1032 |

| Estimated hrs/M |
| 903.9 |

| Lost time hr/M |
| 128.1* |

| Cost for 14 runs 14 x 128.1 = 1790 hrs. |
| 1790 x $2.80 |
| $5002.00 |

5

2,500 Valve Castings were received and accepted in the plant. Approximately a month later the same castings were receiving secondary operations and resulted in 125 defects out of 900 castings. The secondary operation became worse; however,

**NOTE:** It may be argued that this lost time could be reduced by a methods improvement. However, according to the organization chart a person is working on methods at all times. Even so, many methods could not be improved unless the parts are first made to assemble correctly.

An analysis of the chart III showing production hours illustrates that with the learning period accomplished,
Case # | Description | Cost
--- | --- | ---
5 | a limited number were drilled to maintain production. This could have been prevented by proper sampling techniques. An engineering investigation revealed that mold pins were loose in the die making the part. As a result the costs of defects were recovered from the vendor. 
Time lost machining defects: 
Percent rejects machined \( \frac{128}{900} \times .139 \) 
Oper: Clean two holes by drilling 
Oper/hr 300 
Cost of rejects \( \frac{2500 \times .139 \times 2}{300} \times \$2.80 \) \$ 6.48
6 | One hundred Marine covers were welded to a wrong dimension. As a result the welds had to be ruptured and rewelded to the proper dimension. 
Operat: Break open welds and reweld 
Operat/hr. 3 
Cost of Rejects \( \frac{100 \times \$2.80}{3} \) \$ 93.30 
Cost of revising jig \$ 80.00

assembly hours with the exception of 3 runs (7, 8, and 12th runs) still exceed the estimated time. It should be assumed that at runs 7 and 8 the learning period was over; at any rate the figures show that the estimated time can be made. The question now is "are the increased times after the 8th run due to poor quality control?" That is to say are the pieces readily assembled or is force required thus consuming the extra time?
Case #   Description                                             Cost
7        Six hundred bottom fittings (fig. 19) were accepted in the plant having an I.D. of 0.500" - 0.508". The correct requirement was 0.500" - 0.502", and as a result valuable time was lost in subsequent operations because an added jig had to be designed to accommodate the rejected parts. If this were not done production on the juice machines would have come to a standstill. The cause of this again was improper inspection tools. The diameter should have been measured with a "go no-go" gauge. Then the error could have been detected sooner for the vendor to correct his pieces in time.

Operat: Solder bottom fitting to elbow
Operat./hr: due to rejects  =  8, stand.  =  20
Cost of rejects $2.30 \times \frac{600}{12} = $140.00
Cost of jig $100.00

8        On the cleaning machine approximately 45,000 units have been made with defective copper tubing parts. In this case defective is taken to mean a variance
<table>
<thead>
<tr>
<th>Case #</th>
<th>Description</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>from specified dimensions. This causes a misfit in final assembly and requires valuable assembly time to form the parts by hand or hammer to force fit them in the final unit. This was called to the attention of the manufacturer by the company purchasing the cleaning machines. The situation is finally being corrected by redesigning jigs. Correction is late because no production inspection was made on the parts before they reached final assembly. This cost is reflected in Case #4. Cost of rejects shall not be totaled here as parts were not a total loss.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>It is well to note, however, that 1060.3 hours were spent producing defective parts for final assembly.</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>A special requirement of the cleaner-tester export unit receiving underwriter approval is that a splice in the switch should be covered with an incombustible housing. This special covering was omitted in approximately 400 units. The problem is serious as approval</td>
<td></td>
</tr>
</tbody>
</table>
Case # | Description | Cost
--- | --- | ---
9 | could be revoked because proper inspection and quality control was not exercised in the manufacture of the product. | 

Cost of rejects in this case is inestimable. The reputation of the company is at stake.

Critical Analysis of Cases

Quoting the above instances it may appear that the percentage is very small which may be classified by management as normal spoilage. But there are not any figures available to show how many pieces are made wrong. The problem is continuous. The above are a few cases brought to the attention of one person in the Engineering Department. The number that are brought to the attention of others would increase the above manifold.

In many instances jigs and fixtures cannot be designed properly because of poor quality control. When a jig is designed according to the print of a part, a difference arises when the actual part is put in the jig because of variances in dimensions.

At one time the shop engineer was removed from his post in the plant to become the Estimator for the Sales Department.
Within a few months the quality of work deteriorated to such an extent that another transfer was again made so that the same man returned to the shop to try to maintain closer control over quality. This poses a serious problem for the future of the plant. If such a time occurs that the shop engineer is no longer available what will happen to quality? Whereas with a good system of quality control the loss of one key man should not affect quality.

An important consideration in analyzing the above cases that does not appear is the threat to production. If the valve castings in Case #5 were more than 14 percent defective, a complete assembly line would be shut down causing a time loss in thousands of dollars. A second significant factor is that at the present time of rush business all shop production hours are needed to produce good work. More help can be hired, but by making the product correctly the first time, valuable production time is not lost.

**Analysis of Production Hours**

Chart III shows all hours required to produce cleaner testers. An important revelation is that total production hours after the breaking in point have been less than the estimated. Thus a profit is made on most of the runs. Again the figures do not reveal quality of product. An examination of the times to fabricate the cabinet assembly show that they are fabricated in less time than estimated. However, every
<table>
<thead>
<tr>
<th></th>
<th>EST</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
</tr>
</thead>
<tbody>
<tr>
<td>SHIELD SUB ASSY.</td>
<td>40.6</td>
<td>43.4</td>
<td>34.8</td>
<td>34.8</td>
<td>27.0</td>
<td>27.0</td>
<td>32.0</td>
<td>32.0</td>
<td>30.9</td>
<td>30.9</td>
<td>29.4</td>
<td>29.4</td>
</tr>
<tr>
<td>COVER</td>
<td>115.4</td>
<td>136.2</td>
<td>95.5</td>
<td>95.5</td>
<td>95.6</td>
<td>95.6</td>
<td>94.5</td>
<td>94.5</td>
<td>118.8</td>
<td>118.8</td>
<td>104.5</td>
<td>104.5</td>
</tr>
<tr>
<td>PARTS FOR LAMP S.A.</td>
<td>206.4</td>
<td>284.8</td>
<td>173.2</td>
<td>173.2</td>
<td>179.3</td>
<td>179.3</td>
<td>177.2</td>
<td>177.2</td>
<td>179.8</td>
<td>179.8</td>
<td>193.5</td>
<td>193.5</td>
</tr>
<tr>
<td>GENERAL ASSY.</td>
<td>363.4</td>
<td>366.5</td>
<td>127.4</td>
<td>105.8</td>
<td>105.2</td>
<td>97.0</td>
<td>78.9</td>
<td>83.5</td>
<td>89.5</td>
<td>104.5</td>
<td>104.9</td>
<td>105.9</td>
</tr>
<tr>
<td>LAMP ASSY.</td>
<td>90.0</td>
<td>136.2</td>
<td>136.2</td>
<td>136.2</td>
<td>145.6</td>
<td>131.9</td>
<td>130.2</td>
<td>135.6</td>
<td>135.6</td>
<td>137.6</td>
<td>137.6</td>
<td>137.6</td>
</tr>
<tr>
<td>CABINETS FABRICATE</td>
<td>521.3</td>
<td>638.2</td>
<td>498.0</td>
<td>487.5</td>
<td>478.6</td>
<td>462.4</td>
<td>491.9</td>
<td>475.8</td>
<td>460.7</td>
<td>460.7</td>
<td>455.0</td>
<td>455.0</td>
</tr>
<tr>
<td>PAINT. CABINET</td>
<td>126.2</td>
<td>153.4</td>
<td>127.9</td>
<td>130.5</td>
<td>126.5</td>
<td>128.5</td>
<td>116.1</td>
<td>126.6</td>
<td>111.9</td>
<td>119.0</td>
<td>118.0</td>
<td>118.0</td>
</tr>
<tr>
<td>PAINT LAMP &amp; BAG CLAMP.</td>
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<td>26.0</td>
</tr>
<tr>
<td>PAINT. MISC.</td>
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<td>136.4</td>
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<td>104.9</td>
<td>97.5</td>
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<td>75.0</td>
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<td>117.5</td>
<td>78.8</td>
<td>78.8</td>
<td>91.1</td>
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<td>86.7</td>
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<td>TESTER</td>
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<td>263.6</td>
<td>263.6</td>
<td>254.4</td>
<td>254.4</td>
<td>254.4</td>
<td>254.4</td>
<td>278.4</td>
<td>278.4</td>
</tr>
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<td>48.0</td>
<td>39.6</td>
<td>39.6</td>
<td>41.0</td>
<td>41.0</td>
<td>42.3</td>
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<td>41.8</td>
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<tr>
<td>TUBING</td>
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<td>80.9</td>
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<td>64.2</td>
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<td>53.4</td>
<td>53.9</td>
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<td>48.3</td>
<td>48.3</td>
<td>66.5</td>
<td>66.5</td>
</tr>
<tr>
<td>MISC. STAMPED PARTS</td>
<td>74.6</td>
<td>88.0</td>
<td>44.4</td>
<td>44.4</td>
<td>42.4</td>
<td>42.4</td>
<td>48.8</td>
<td>48.8</td>
<td>50.4</td>
<td>50.4</td>
<td>58.6</td>
<td>58.6</td>
</tr>
<tr>
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<td>2.0</td>
<td>2.0</td>
<td>2.0</td>
<td>2.0</td>
<td>2.0</td>
<td>2.0</td>
<td>2.0</td>
<td>2.0</td>
<td>2.0</td>
<td>1.8</td>
<td>1.8</td>
</tr>
<tr>
<td>BASE STRAP</td>
<td>2.5</td>
<td>9.2</td>
<td>9.2</td>
<td>9.2</td>
<td>7.0</td>
<td>7.0</td>
<td>9.1</td>
<td>9.1</td>
<td>9.1</td>
<td>9.1</td>
<td>8.9</td>
<td>8.9</td>
</tr>
<tr>
<td>VALVE CAST. BRACKET</td>
<td>4.0</td>
<td>1.6</td>
<td>1.6</td>
<td>1.6</td>
<td>1.6</td>
<td>1.6</td>
<td>2.0</td>
<td>2.0</td>
<td>2.0</td>
<td>2.0</td>
<td>2.0</td>
<td>2.0</td>
</tr>
<tr>
<td>PLATING</td>
<td>2.0</td>
<td>43.8</td>
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<td>32.4</td>
<td>24.4</td>
<td>24.4</td>
<td>25.0</td>
<td>25.0</td>
<td>20.0</td>
<td>20.0</td>
<td>22.5</td>
<td>22.5</td>
</tr>
<tr>
<td>VALVE ASSY.</td>
<td>33.5</td>
<td>33.5</td>
<td>22.8</td>
<td>22.8</td>
<td>22.8</td>
<td>22.8</td>
<td>22.8</td>
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<td>22.8</td>
<td>22.8</td>
<td>22.8</td>
<td>22.8</td>
</tr>
<tr>
<td>TOTALS</td>
<td>1873.4</td>
<td>4133.7</td>
<td>3044.5</td>
<td>2835.4</td>
<td>2810.0</td>
<td>2701.0</td>
<td>2665.7</td>
<td>2582.0</td>
<td>2656.8</td>
<td>2799.7</td>
<td>2863.7</td>
<td>2770</td>
</tr>
</tbody>
</table>

production hrs./m. units — cleaner 1
week cabinets are being rejected because of poor welding, misalignment, and other causes. At times as many as 50 to 100 cabinets per week are sent back for repairs.

Chart IV shows production hours for manufacturing a simple box. This chart is more or less ideal as production hours closely match estimated hours. What it does not show is that even with perfect control errors in the shop are still made. In a recent production run several hundred twist drill holders had a hole omitted. Hence the hours are deceiving as all the time consumed was used to produce bad pieces.

Discussion on Welding

Retapping all weld nuts does not seem logical as the author has successfully welded nuts without flashover. Either the setup men are not capable of timing machines properly or something is wrong with the machines. This should lead to two points of investigation. One is the manufacturer of weld nuts should be called upon to investigate the problem as it is doubtful that the nuts are made so they have to be retapped. A second point of investigation is to make a correlation chart as one done in the case of a manufacturer bending angles.* The chart showed that the angles could be bent to $90^\circ \pm 1/3^\circ$ regardless of metal thickness and an investigation showed that the initial adjustment of the die was incorrect. Hence

---

* p. 24 this report.
# Chart IV

**Kit Box Production Hours**

<table>
<thead>
<tr>
<th>RUN #</th>
<th>EST.</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
<th>13</th>
</tr>
</thead>
<tbody>
<tr>
<td>QUAN. IN RUN</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TWIST DRILL HOLDER</td>
<td>36.0</td>
<td>38.0</td>
<td>38.0</td>
<td>32.6</td>
<td>32.6</td>
<td>46.3</td>
<td>46.3</td>
<td>45.0</td>
<td>43.0</td>
<td>44.1</td>
</tr>
<tr>
<td>SHELF</td>
<td>25.0</td>
<td>25.1</td>
<td>27.6</td>
<td>26.0</td>
<td>29.4</td>
<td>25.7</td>
<td>22.4</td>
<td>27.5</td>
<td>26.1</td>
<td>29.7</td>
</tr>
<tr>
<td>STONE SUPPORT</td>
<td>7.0</td>
<td>5.5</td>
<td>5.3</td>
<td>6.3</td>
<td>6.3</td>
<td>8.8</td>
<td>8.8</td>
<td>5.7</td>
<td>5.7</td>
<td>10.2</td>
</tr>
<tr>
<td>WHEEL BRACKET</td>
<td>20.0</td>
<td>21.2</td>
<td>22.0</td>
<td>21.0</td>
<td>21.6</td>
<td>20.6</td>
<td>20.5</td>
<td>20.6</td>
<td>19.3</td>
<td>25.0</td>
</tr>
<tr>
<td>TOP</td>
<td>75.0</td>
<td>65.8</td>
<td>64.1</td>
<td>64.0</td>
<td>72.5</td>
<td>69.7</td>
<td>66.3</td>
<td>70.5</td>
<td>66.7</td>
<td>71.6</td>
</tr>
<tr>
<td>BODY</td>
<td>217.0</td>
<td>243.7</td>
<td>206.0</td>
<td>198.0</td>
<td>230.1</td>
<td>216.0</td>
<td>209.0</td>
<td>230.0</td>
<td>224.0</td>
<td></td>
</tr>
<tr>
<td>ASSY.</td>
<td>190.0</td>
<td>196.0</td>
<td>161.0</td>
<td>171.5</td>
<td>193.5</td>
<td>194.6</td>
<td>190.9</td>
<td>182.0</td>
<td>188.0</td>
<td>197.5</td>
</tr>
<tr>
<td>PAINT</td>
<td>5.0</td>
<td>7.0</td>
<td>7.0</td>
<td>8.3</td>
<td>8.3</td>
<td>8.2</td>
<td>8.2</td>
<td>8.6</td>
<td>8.6</td>
<td>8.5</td>
</tr>
<tr>
<td>TOTAL - HRS./M UNITS</td>
<td>575.0</td>
<td>592.9</td>
<td>532.3</td>
<td>533.7</td>
<td>594.3</td>
<td>589.9</td>
<td>572.2</td>
<td>564.8</td>
<td>570.4</td>
<td>610.4</td>
</tr>
</tbody>
</table>


if the correlation chart shows the nuts can be welded satisfactorily, inevitably the setup process should be investigated. This should be done immediately as the shop attitude is that retapping is always done after spotwelding a nut. Spotwelding of nuts is a very frequent operation on most of the products by the company.

**Conclusions**

There is a lack of quality control on many products because of poor or no inspection on setup procedures.

The Inspection Department does not have proper standards of procedure.

The shop is not permanently organized for quality control as was evidenced by the decline in quality when the shop engineer was removed.**

Although cost sheets show profits for operations, hidden loses due to poor quality are not exposed, i.e., profits are not as great as they might be. Also, the company's reputation is at stake when products below specified quality levels are produced and shipped.

** This poses another question since partial control has returned with the return of the shop engineer. Is he taking on more normal inspection than required? Perhaps inspection should be governed by the rule of exceptions; that is to say, shop men should be capable of making normal inspection and the shop engineer should inspect critical work.
CHAPTER IV

AN ANALYSIS OF THE PRESENT SYSTEM OF INSPECTION AND QUALITY CONTROL
Analysis of Inspection Procedures in the Plant

The place of the Inspection Department in an organization should be based on the following fundament: "An Inspection Department does not set quality standards; Management does that through Engineering" (page 3). An analysis of the data presented indicates a violation of this fundament as the Chief Inspector is in charge of quality control as shown in Fig. 2. Therefore, the first correction to be applied is to the Chart of Responsibilities & Authority, Fig. 2, so that Quality Control is administered by the Chief Engineer by listing that responsibility under the Chief Engineer. In practice this has been achieved as indicated by the connecting line on the chart between the Chief Inspector and Chief Engineer.

The importance of proper distribution of technical information is indicated by the fundament: "The Engineering Department must provide the Inspection Department with proper tolerances on drawings and specifications on products for the Inspection Department" (page 7). An examination of the Engineering Department organization chart, Fig. 8, reveals that a system is present to provide this information, but is not utilized to the fullest extent. A few specifications have been issued, but not nearly enough to cover questions asked by the Chief Inspector. Further annoyance is caused by the fact that many prints have been issued to the shop by top management, by-passing engineering entirely. As a result when the
shop is fabricating parts the Engineering Department is called upon to solve production problems for which it does not have prints or specifications. Thus considerable Engineering time is consumed in investigation before recommendations can be made. The Engineering Department does provide tolerances on all drawings; thus part of the fundament is not violated.

To obtain good inspection procedure a comparison of present methods shall be analyzed with the aid of the five essential characteristics mentioned on page 5 of this report:

1) "Eliminate non-essential operations. Products should be classified according to defects such as:
   a) Critical
   b) Major
   c) Minor"

Drawings made by the Engineering Department usually show critical dimensions. However, customers prints often lack this information, or it is mentioned in some voluminous data so that the shop or Inspection Department completely overlooks it. Thus it is seen that a better system of passing on information should be devised.
2) "Improve working conditions." The inspector's office is not located so as to be near all operations. It is on the second floor of an assembly building. The office is small and cannot accommodate routine inspection procedures.

The inspection equipment consists of the following instruments:

<table>
<thead>
<tr>
<th>Quan.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1-inch micrometer</td>
</tr>
<tr>
<td>1</td>
<td>2-inch micrometer</td>
</tr>
<tr>
<td>1</td>
<td>12-inch square</td>
</tr>
<tr>
<td>1</td>
<td>1-inch depth micrometer</td>
</tr>
<tr>
<td>1</td>
<td>shadowgraph</td>
</tr>
<tr>
<td>1</td>
<td>continuous circuit tester</td>
</tr>
<tr>
<td>1</td>
<td>hardness tester</td>
</tr>
<tr>
<td>2</td>
<td>magnifying lights</td>
</tr>
<tr>
<td>1</td>
<td>radius gage</td>
</tr>
<tr>
<td>1</td>
<td>insulation tester</td>
</tr>
</tbody>
</table>

The above equipment is inadequate to provide proper inspection service. When the Chief Inspector has to inspect a part in the main building and a 1" micrometer is not available, he may have to borrow a micrometer from a bench inspector, thus slowing routine inspection. The alternative may be to borrow a micrometer from someone in the main building. The latter is far from satisfactory as people are reluctant to lend precise instruments. Workers do not consider it necessary to lend their instruments because if
management does not think enough of inspection to provide the proper tools they do not regard it as an important function.

The company also possesses several hundred gages which have been classified and stored in the Engineering building. When the Chief Inspector needs one of these gages a trip has to be made to the Engineering Department. At present anyone who walks in the Inspection Office does not receive a favorable impression of the inspection function at the company. It would be better if all gages were in the Inspection Office. Then any observer would not only be impressed by the slogan "Make it better than good", but would know from the business-like atmosphere of the Inspection Office that parts will not leave the plant until they have been inspected by a "Better than good" Inspection Department.

3) "Fit the worker to the position." Again an analysis of the organization chart should be made. This chart reveals that the Chief Inspector is in charge of Quality Control which is erroneous as he has no authority over the Plant Superintendent to force him to make
products a certain way. It is seen that the Chief Inspector reports directly to the Chief Engineer and only communicates with the Customer's Service Engineer. Yet this is more than communication. The Customer's Service Engineer actually has authority to dispose of rejected parts in addition to using judgment on acceptance of parts that may be rejectable. The Customer's Service Engineer administers the Inspection Department. However, the chart shows no inspection under the Customer's Service Engineer's duties. Many inspection duties require engineering knowledge, a characteristic which limits the versatility of the Chief Inspector.

4) "Use of Inspection Reports." The Customer's Service Engineer has had charge of inspection for approximately six months. Prior to this period inspection reports never passed through Engineering; thus Engineering was never aware of the quality of work in the products. There were times too numerous to mention that, because of poor inspection, the entire effort of the Engineering Department was needed to correct mistakes.
The greatest failure of present inspection reports is that Engineering or Management does not know if work in process is correct or is being inspected properly. Quality of work is not known until the run is completed.

Figure 3 shows the present Inspection Report being used in the plant. This form is used for all types of inspection. A study of these forms on file revealed that they are used mainly for inspection on incoming parts and not to examine any work in process. The form is sporadically used to report rejected work returned from customers. An original and three copies are made of the form when the part is inspected. The original is routed to the Engineering Department, and a copy is routed to the Purchasing Department which will pay for the material if it is accepted. If it is not acceptable the material is shipped back to the vendor if the part is not urgently needed. However, if the part is needed immediately, corrective action may be taken by the plant to make it usable for production. The third copy remains with the material where it is stored in the stockroom. The fourth copy is filed in the Inspection Department.

Figures 4, 5, and 6 are photostatic copies of some actual reports.
<table>
<thead>
<tr>
<th>Source</th>
<th>A. L. Hyde</th>
<th>Our P. O.</th>
<th>7663</th>
</tr>
</thead>
<tbody>
<tr>
<td>Customer Name &amp; Order No.</td>
<td>Plastic bowls</td>
<td>J. O.</td>
<td></td>
</tr>
<tr>
<td>Size</td>
<td>Name</td>
<td>Part No.</td>
<td>564</td>
</tr>
<tr>
<td>Quant. Previously Accepted</td>
<td>758</td>
<td>Date</td>
<td>10-12-67</td>
</tr>
<tr>
<td>Quant. Received</td>
<td>758</td>
<td>Receiving Rep't No.</td>
<td></td>
</tr>
<tr>
<td>Quant. Accepted</td>
<td>758</td>
<td>Lot No.</td>
<td></td>
</tr>
<tr>
<td>Quant. Rejected</td>
<td></td>
<td>Remarks:</td>
<td>1st checked for dimensions &amp; visual</td>
</tr>
</tbody>
</table>

**Disposal:**

**Action taken:**

<table>
<thead>
<tr>
<th>Insp.</th>
<th>Date</th>
<th>Foreman</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>10-12-67</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
An examination of these reports reveals the following:

a) "Quantity previously accepted" is very seldom used as considerable reference work would be involved to locate the previous acceptance list.

b) Regardless of the lot size inspected the term "spotchecked" is the only indication of the sample size examined.

c) "Quantity rejected" appears on the inspection report, but no statement is made as to the total quantity in the lot. It also will be noticed that if parts are rejected no reason is given for rejection.

5) "Everyone must help on inspection problems."
Perhaps the most common excuse used by workmen and foremen for poor work is "the inspector never told me it was bad". The workers attitude is that inspection is not part of their job, thus they assume that they are excused for turning out bad products. This is very aptly illustrated by the case of the Apex Electrical Mfg. Co. (page 24 of this report).
In analyzing inspection procedures, the question of wasted motion should be considered. To inspect a finished part in the company being discussed an inspector must travel approximately 300 feet to the stockroom (see Fig. 7 Layout of Plant and Inspection Routes) and procure samples to be inspected. Procuring the part is again time consuming as a wait is required for the Stock Clerk to locate the part. The Stock Clerk is not always readily obtainable as he may be away from his office to receive materials from a truck. Upon procuring the parts another 300 feet is traveled to the inspection station. More travel is involved in procuring the measuring instruments from the inspection office. This involves 250 feet of travel. Once the inspector is at the station, inspection begins amid the noise and chatter on an assembly line. The surroundings are poor, littered with debris, and inadequately illuminated. To a trained engineer or an executive, these conditions reflect inefficiency and are not conducive to good inspection.

Analysis of Quality Control Procedures in the Plant

Divided authority for the control of quality is indicated on the Chart of Responsibilities and Authority (Fig. 2) which shows the Chief Inspector and the Shop Engineer in charge of quality control. In practice the Chief Engineer is responsible for control of quality and his policies have been carried out by the Shop Engineer in the fabrication department of the
plant. The Shop Engineer checks first pieces in the Shearing, Stamping and Welding departments. The Chief Inspector checks parts in the Plating, Painting, Grinding and Assembly departments. Critical parts sometimes receive first inspection by the Chief Engineer or a member of his staff especially appointed for the particular task.

Referring to the fundament "to make quality control effective detailed reports should be prepared to show the cost and the quantity of work spoiled during the manufacturing process"¹ a basis is provided for investigation into the functioning of a quality control department. To start on the aforementioned basis four measures for securing quality control shall be considered (p. 17 of this report) as follows:

1) "Setting of standards for all products manufactured or purchased."

The setting of standards is aptly covered under the analysis of inspection procedures. Figure 8 shows the organization of the Engineering Department. It will be noted that this chart shows Quality Control under the supervision of the Chief Engineer. The chart also shows that the setting of standards is the responsibility of the Administrative Engineer. Standards and

¹. p. 678.
**CHIEF ENGINEER**
- Quality control
- New product design
- Customer consultations
- Production methods & equipment
- Equipment repairs
- Estimating (sales)
- Bills of materials (new & revisions)
- Inspection service
- Product manuals & handbooks
- Internal technical service
- Plant safety
- Supervision: Engineering
- Department personnel
- Member: Plant Executive Committee

**CHIEF INSPECTOR**
- Incoming materials
- Work in progress
- Sub-assemblies
- Completed assemblies
- Finished goods
- Supervisor: Department personnel

**ADMINISTRATIVE ENGINEER**
- Technical services
  - Specification
  - Planning
  - Materials
  - Service notes
  - Standards
  - Cost control

**SERVICE ENGINEER**
- Customer service
  - Customer education
  - New products
  - Returned products
  - Repairs to returned products

**PROJECT ENGINEER**
- Design
  - Functional design
  - Development
  - Testing
  - Research
  - Patents
  - liaison
  - Customer
  - Sub-contract
  - Factory
  - Methods
  - Safety
  - Inspection
  - Recommendations
  - Follow through

**CHIEF DRAFTSMAN**
- Drafting
  - Production design
  - Drafting
  - Checking
  - General services
  - Blueprints
  - Records
  - Library
  - Timekeeping
  - Bills of materials

**ESTIMATOR**
- Job analysis
  - Listing from parts
  - Material take-off
  - Shop take-off
  - Tool up
  - Estimate summary
  - Comparative saving

**SHOP ENGINEER**
- Setup
  - Layout - samples
  - Production layout
  - Production models
  - Plan setup
  - Check work in progress

**ENGINEERING CLERK**
- Stenography
- Clerical filing

**TOOL ENGINEER**
- Tool planning
- Tool design
- Tool lining

**TOOL & ADVERTISING MANAGER**
- Department personnel
- Member: Plant Executive Committee

---

**Fig. 8**

**ENGINEERING DEPARTMENT RESPONSIBILITIES & AUTHORITY**

**LEGEND**
- Line of authority
- Line of association

**OCTOBER 26, 1931**
Engineering Department

- Clerical
  - Stenography
  - Clerical Files
- General Services
  - Blueprints
  - Records
  - Library
- Drafting
  - Design
  - Drafting
  - Checking
  - Bills of Materials
- Tooling
  - Tool Planning
  - Tool Design
  - Tool Liaison
- Technical Services
  - Specifications
  - Planning
  - Materials Service
  - Notes Standards
  - Cost Control
- Personnel
- Design
  - Procurement
  - Wages
  - Complaints
  - Terminations
- Liaison
  - Functional Design
  - Development
  - Testing
  - Research
  - Patents
- Safety
- Estimating
  - Customer Sub-Contracts
  - Factory Methods
  - Inspection
  - Recommendations
  - Follow-Through
  - Job Analysis
  - Noting Purchasing
  - Parts
  - Material Take-Off
  - Tool-Up
  - EGT, Summary Conference
  - Pricing
- Customer Service
  - Customer Education
  - New Products
  - Returned Products
  - Repairs to Returned Products
  - Planning
  - Set-Ups
  - Production Models
  - Production Layout

Chief Engineer

Personnel

- Admin Eng'g
  - Technical Services
- Tool Eng'g
- Chief Drafts
- Drafting General Services
- Project Eng'g
- Design Liaison
- Safety
- Estimator
- Estimating
- Customer Service
- Shop Eng'g
- Engineering Clerk

Fig. 9

Engineering Organization Chart
specifications have been issued, but they have proven inadequate to cover all circumstances. This is not necessarily the fault of the Administrative Engineer since much of his time is consumed correcting mistakes incurred in the shop by poor quality. In fact, the Chief Draftsman, Service Engineer, Project Engineer, and Estimator all spend considerable time checking quality. The Shop Engineer's prime duty is to maintain quality in production. In view of the aforementioned it requires five engineers and a Shop Engineer to control quality in the shop. In other words engineers are checking work in the shop which ordinarily should be done by set-up men or foremen. In addition the Chief Engineer is called upon to correct situations of quality control which require a higher degree of professional experience. A question now arises as to the necessity of so many engineers for control of quality when their time could be better utilized in developing products and new designs. This is apparently caused by a lack of standards in the shop.

The organization and system is present for specifications but when issued, their importance
is not gotten across to the foreman, and all effort is lost. This reflects poor training and liaison on the part of management.

In regard to standards, no specifications are set on purchased parts which often necessitates engineers to leave their posts to investigate the parts for acceptance or rejection.

2) "Measuring performance." Figure 10 is the front side of an actual shop Route Card; Figure 11 is the reverse side of this card. The form itself is a practical type for the job shop under consideration. Referring to the reverse side of the card it is seen that a column is provided for inspection. The inspection column, even on this limited basis, is not filled out. This indicates that not one operation on the Lamp Cup was checked. It is assumed that all set ups are checked by the shop engineer. However, this assumption is not entirely correct as the Lamp Cup has caused considerable trouble on the final assembly line in two ways. The first cause was that on initial runs the cup was drawn too shallow.
FIGURE 10

ACTUAL ROUTE CARD
USED IN THE COMPANY
(Front)
### FIGURE 11

**ACTUAL ROUTE CARD**

*USED IN THE COMPANY*

(Reverse Side of Fig. 10)
The drawing operation is indicated by "1st Form" on the front of the Route Card, Figure 10. As a result of drawing a shallow lamp cup, suction tubes contacted the bottom of the hopper on the final assembly. The corrective action taken was to cut the suction tubes shorter to eliminate contact on this particular run. Because of this error the shop is more careful when setting up the "1st Form" operation. In subsequent runs this error has not reappeared. To investigate the second cause of trouble the operations, "pierce and emboss center" and "pierce and emboss sides" shall be considered. Because of the construction of the punch and die it was possible to make errors on this operation. However, these errors were not discovered until the pieces were ready for the welding operations and they would not fit in the jig. In spite of this some were forced in the welding jig. When the parts reached assembly, trouble occurred because of interdependent relationships. The use of a heavy hammer on final production made a force fit and assembly was thus completed.
However, at times a heavy hammer was not enough and the part was scrapped.

As a result of the experience gained from the first runs, punches, dies and fixtures were redesigned so that the errors would not occur again; however, limited rejects are still present in this Lamp Cup production.

Thus, the inspection indicated on shop cards was not carried out as it should have been and a measure of performance was not recorded.

To measure performance a standard should be set. The Route Card calls for six operations: sq. shear, 1st form, trim, pierce two (0.130") holes, pierce and emboss center, pierce and emboss side. No mention is made of the importance of these operations. If an indication were made on the Route Card that the forming and embossing operations were critical, a measure of performance to a set standard could be provided.

3) "Providing organization for routing recommendations of the Quality Control Department."

A procedure is now being provided (see organization chart, Fig. 2) for systematically routing
recommendations. It will show the status of the Inspection Department in relation to Quality Control. It will also show other foremen that Quality Control is an important function of the plant organization.

In addition the problems of rejected work will now pass through Engineering in which Management is represented. Previously Management did not really know the quality of work being performed.

4) "Securing action." The company shows indications of securing action by the fact that an organization for authority and responsibility is now becoming clearly defined. The Engineering Department through the appointment of the Service Engineer is now securing action on rejected parts. The Service Engineer has the authority to dispose of defective parts that do not involve major sums of money. Therefore it may be said that the means for securing action is established. However, the point where action is to originate by an organized system of inspection has not been established.
Analysis of Inspection and Quality Control Personnel

Since the Inspection and Quality Control procedures in the plant have been analyzed in regard to the fundamentals of scientific management it would be proper to investigate the personnel carrying out these functions. Hence, an analysis of job descriptions seems to be indicated. The author has no reasons based on facts except that conversations with bench inspectors always lead to the following remark: "I'm not being paid to read blueprints; therefore I shouldn't really be doing this job." This remark seems significant. The following job descriptions are excerpts from the union contract which in the author's opinion directly affect quality control in the plant.

**Group G**

Press Brake Operators
(Own Set Up)

Operate power driver press brakes, making own set up of dies, punches, stops, etc. in brakes. Bending piercing and forming operations.

**Group H**

Set Up Man Assembly

Sets up any of the miscellaneous machines, jigs fixtures, on any of the assembly lines. Do actual production or assembly work when there is no set-up work to be done.
Set Up Man
Welding

Sets up welding heads and machines for welding of metal parts. Improvises, makes, and sets holding jigs, fixtures, welding tips. Selects proper current capacities for welding. Understands fundamental electrical characteristics of welding machines.

Set Up Man
Machine Tool


Set Up Man
Press Brakes
(and oper. brakes)

Sets up press brakes for his own work as well as for other operators. Operates brakes on bending, piercing, forming operations.

Group I

Set Up Man-
Punch Press

Handles and sets various size punches and dies in punch presses and power press brakes of various capacities. Ordinary, compound, progressive and Wales type dies. Considerable responsibility. Works to close tolerances. Inspects production runs.
Group C
Inspectors B
Diversified bench inspection. Close tolerances. Limited responsibility for decision as to quality and finish. Use ordinary gages and make necessary set ups.

Group D
Inspectors A
Diversified bench inspection. Close tolerances. Considerable responsibility for decision as to quality and finish. Use precision instruments - micrometer, shadowgraph.

Group E
Floor Inspectors
Inspect parts as they come off machine in shop, going from machine to machine. Must be familiar with all parts used in the manufacture of the various products. Ability to read drawings. Inspect work coming from all machines. Knowledge of precision tools. On feet all day.

Group J
Asst. Foreman
(Working)
Lead man in the department. Does production work as assigned to him by departmental foreman or shop superintendent.
Helps foreman with working details on production. Assumes charge of department during foreman's absence. Limited responsibility for department discipline.

A critical evaluation of job descriptions reveals that the inspector was correct in stating that bench inspectors are not required to read blueprints. The analysis also shows that the set-up men are not required to read blueprints even though they are responsible for the set up of any operation. In fact, they are not even required to inspect their own work. This leads to a continuous parade of set-up men to the shop engineer's office to have their set ups inspected.

An exception to the above is the "Set-Up Man, Punch Press", who is required to read blueprints and to inspect production runs. In spite of this requirement, checks on production runs are not being made by the "Set-Up Man, Punch Press."

Another serious situation arises in the shop when parts are to be made like a sample and prints are not used. Frequently the investigation of an error on a piece will reflect back to a faulty sample. Again there are also indications that too much reliance is made on the assumption that tools, dies, jigs and fixtures are made correctly and need no checking with prints. One need only refer to the cost of rejects to find that errors can be made in tools and dies.
Production is at an all time high and the company appears to be making profits, however the margin of profits might be increased further by reducing the reject rate through good quality control. This is also important when business is slow as rejects cannot be afforded. The company foremen, supervisors, and management become alarmed when an electric light bulb is burning and not used for any apparent reason. Yet for the second that they are looking at the light they may be losing dollars in rejected work.

**SUMMARY**

The procedure and organization exists to a minor degree for control of quality in the plant, but they are not used efficiently. The Inspection Department lacks the proper number of measuring tools and is poorly located for accurate inspection work. In addition, the method of getting information across so that it is understood is not effective in the plant. Information by-passes Engineering for products manufactured in the plant causing double the amount of work to determine standards of quality.

Control of quality in the fabricating departments is not exercised by the "rule of exceptions". All work seems to pass through one key man.
According to the job descriptions, setup men responsible for quality are not required to read blueprints, thus leaving an escape route for poor quality setups.
CHAPTER V

CORRECTIVE ACTION
CORRECTIVE ACTION

Organization

To accomplish a goal an organized effort must be made. Therefore, the first consideration shall be to place the Inspection and Quality Control functions in their proper categories on the organization chart. The change in fig. 8 from fig. 2 removes the quality control from the Chief Inspector and Shop Engineer by placing it under the Chief Engineer. Since inspection does not set quality standards but management does through engineering, the organization chart has been corrected so that Quality Control is under the cognizance of the Chief Engineer.

This change suggested by the author has been accepted by the company and is now in effect.

The second change in organization should occur in the Service Engineer's title. According to the chart the Service Engineer merely has communication with the Chief Inspector, but this is not so as he actually has control of the disposal of rejected work in addition to doing actual inspection. The Chief Inspector recognizes the Service Engineer as his department head. If the chart is to be displayed the Service Engineer's title should be Quality Engineer since his responsibilities all involve quality of products manufactured by the plant. He is also in the best position to analyze the
quality of the products since he has direct contact with customers using the company's products, and in addition he has charge of repairs on all products. The duties and responsibilities of personnel will remain as they appear in fig. 8.

**Physical Location of Inspection Department**

The Automotive Spark Plug Cleaner Tester manufactured by the company contains approximately 50 parts purchased from outside vendors. Each lot of parts purchased requires inspection. Since 300 feet of travel is involved in the inspection of a lot (p. 67) 15,000 feet would be the minimum distance traveled by an inspector to check parts for a run of Automotive Spark Plug Cleaner Testers. The proposed location of the Inspection Department shown on fig. 7 will eliminate the time consuming travel to inspect parts for the Automotive Spark Plug Cleaner Tester and for any other product.

The inspection room should contain all the necessary equipment conducive to good inspection as necessitated by the requirements of the plant. By having a proper atmosphere in the Inspection Department the slogan "Make it better than good" will have meaning as the inspection room will have facilities to determine if the product is being made "Better than good."
**Inspection Equipment**

A plastic bowl, which is part of the juice machine manufactured by the company, has a 10 inch inside diameter specified to thousandths of an inch. Present equipment in the Inspection Department cannot measure this dimension as an inside caliper and a vernier caliper of at least 10 inch capacity would be required. In the past, measurement has been accomplished by borrowing a vernier caliper from the tool room. Central locations of circular parts and angle measurements cannot be measured accurately as a combination square and degree gages are not a part of inspection equipment. Simple tests to determine different types of stainless steel used by the company cannot be made, as a magnet is not available in the Inspection Department. Customers parts have been returned because of defective screw threads. Shipment of parts with defective screw threads could have been prevented if proper inspection gages were available.

Since the lack of necessary inspection tools has cost the company money and threatened production, the following tools should be added as inspection equipment:

<table>
<thead>
<tr>
<th>No.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3&quot;-micrometer</td>
</tr>
<tr>
<td>1</td>
<td>1&quot;-micrometer</td>
</tr>
<tr>
<td>1</td>
<td>5-32 commercial ring &amp; plug thread gages</td>
</tr>
<tr>
<td>1</td>
<td>8-32    &quot; &quot; &quot; &quot; &quot; &quot; &quot; &quot; &quot; &quot; &quot; &quot; &quot; &quot; &quot; &quot; &quot; &quot; &quot; &quot;</td>
</tr>
<tr>
<td>1</td>
<td>10-32   &quot; &quot; &quot; &quot; &quot; &quot; &quot; &quot; &quot; &quot; &quot; &quot; &quot; &quot; &quot; &quot; &quot; &quot; &quot; &quot;</td>
</tr>
<tr>
<td>1</td>
<td>10-24   &quot; &quot; &quot; &quot; &quot; &quot; &quot; &quot; &quot; &quot; &quot; &quot; &quot; &quot; &quot; &quot; &quot; &quot; &quot; &quot;</td>
</tr>
</tbody>
</table>
No. | Description
--- | ---
1  | 1/4-20 commercial ring & plug thread gages
1  | 5/16-18 " " " " " "
1  | 5-40 " " " " " "
1  | 2-56 " " " " " "
1  | 4-40 " " " " " "
1  | 12" combination square
1  | 24" square
1  | Small inside calipers
1  | 6" T square angle
1  | 12" Inside and outside calipers
1  | magnet
1  | degree gage
1  | 12" vernier caliper to read in thousandths of an inch
1  | Insulation Tester

The Function of Quality in the Plant

Interviews with inspection personnel and the shop engineer reveal that inspection is a distinctly divided department. The Shop Engineer assumes charge of inspection and quality control in the Stamping, Welding, Shearing and Grinding Departments. The Chief Inspector assumes responsibility for inspection in the Painting, Plating, Machine Shop, and Assembly Departments. Fig. 12, page 90, shows a breakdown of these responsibilities with the approximate number of production personnel involved.

Referring to the Functional Organization Chart, Fig. 12, both the Shop Engineer and Chief Inspector check work in progress, and are responsible for quality control, yet the Functional Organization Chart, Fig. 12, does not show the
**CHIEF ENGINEER**

**SHOP ENGINEER**
**ASST. SHOP ENGINEER**

**Duties and Responsibilities:**
- Layouts
- Planning of Setups
- Check Work in Progress
- Quality Control

**Depts. involved:**
- Stamping
- Shearing
- Welding
- Grinding

**Production Personnel:** 59

**CHIEF INSPECTOR**

**Duties and Responsibilities:**
- Incoming materials
- Work in Progress
- Sub-Assemblies
- Completed assemblies
- Finished Goods
- Supervisor - Dept. Personnel

**Personnel:**
- 2 Bench Inspectors
- 3 Line Inspectors

**Departments involved:**
- Plating
- Assembly
- Machine Shop
- Paint Shop

**Production Personnel:** 55

**FIGURE 12**

**CHART SHOWING PRESENT FUNCTIONAL OPERATION OF QUALITY CONTROL AND INSPECTION IN THE PLANT**
responsibilities that these employees really assume. Thus it is seen that divided authority and responsibility exists which causes friction in the shop.

Analyzing figure 12, which shows the functional operation of Quality Control and Inspection in the shop, an unbalanced ratio of inspectors to production personnel is revealed. The Chief Inspector has five assistants to inspect work produced by 55 production employees. However, the Shop Engineer with one assistant is expected to control the quality of work produced by 59 employees. There is a ratio of one inspector (including Chief Inspector) to every 9.3 employees in the Chief Inspector's area, whereas in the fabrication area of the Shop Engineer there is a ratio of one inspector to 29.5 employees. This is definitely unbalanced and it also seems ironic that a junior executive of the plant should be expected to do routine inspection work whereas his time should be spent on more exceptional cases. To cite an example, the operation of retapping all spotwelded nuts shall be considered. This is an unnecessary operation if the heating and timing cycles of the welding operations are controlled. It is a definite quality-control operation. Investigation of the welding operations by the Shop Engineer is difficult as much of his time is consumed inspecting other products and making layouts for future work. Hence, it is recommended that two additional floor inspectors be added to the Inspection Department to relieve the Shop Engineer of the inspection burden.
It is also recommended that the organization be changed as shown in Figure 13 so that the checking of work in progress be eliminated from the Shop Engineer's responsibility. Inspection will then be the total responsibility of the Inspection Department subject to advice and recommendation from the Shop Engineer when fabrication specifications are involved, and from the Quality Engineer when assembly and finish is involved. It will be noted that the Chief Engineer is in charge of overall quality control which is broken down into two distinct phases; this follows the fundament that management sets quality. A further advantage is gained in that Inspection is a clear and distinct department providing service for quality control.

QUALITY CONTROL FORMS

Since all inspection is to be centered around standards set by engineering a form should be provided to define the specifications clearly. This form will be a basis to set standards and a procedure for measuring performance as mentioned on page 17. Figure 14, page 94, shows a proposed form to initiate a systematic method of quality control procedures in the plant.

By means of the proposed form, specifications are classified into varying degrees of importance. The form shows how dimensions should be measured. Quality levels are assigned to the categories indicated by symbols. Symbols were selected
FIGURE 13
CHART SHOWING PROPOSED FUNCTIONAL OPERATION OF QUALITY CONTROL AND INSPECTION IN THE PLANT
QUALITY CONTROL SCHEDULE

PART NAME: Layout
PART NUMBER: Assy. Fore.
CUSTOMER: Purchasing Inspection
DATE: Mach. Shop
APPROVED

- Critical  ▼ - Semi-Critical  A - Non-Critical

<table>
<thead>
<tr>
<th>Group</th>
<th>Dimension or Characteristic</th>
<th>Meas. Method</th>
<th>Revisions Appr.</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>▼</td>
<td>See Print</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>▼</td>
<td>0.500&quot; - 0.502&quot; Taper</td>
<td>Plug gage</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

FIGURE 14
PROPOSED FORM FOR QUALITY CONTROL
as they are used on present drawings. This form or layout should be attached to each engineering drawing and placed on each job in the shop.

The form serves as a guide to the inspector, assures proper inspection coverage, and standardizes quality in measuring methods. Classifying should not be done by inspectors as it is being done now because they do not fully understand the purpose of each part. When qualified engineers set the standards, liberties previously taken by inspection personnel, who were unaware of the function of the part, will be eliminated.

By predetermining measuring methods proper measuring techniques will be correlated with design needs. Hence calipers will not be used to measure diameters in thousandths. In addition procurement of expensive gages will be eliminated for insignificant dimensions. Advantages will also result from the fact that critical dimensions will not be measured by poorly designed or useless gages.

With this form the "breaking in" of inspection personnel will be greatly facilitated, and detailed information can be routed to the shop.

The proposed Quality Control schedule will also be useful to vendors. It will enable them to inspect the product and duplicate gaging methods so that proper weight may be given to critical dimensions.
Inspection-Working Conditions

Figures 15, 16, and 17 are actual photographs of the inspection station in the plant. Figure 15 is a photograph of the inspection station to test spark coils. Figure 16 is the general inspection station for incoming parts and is adjacent to the testing station for spark coils. "A" is the location of measuring instruments, "B" magnifying lens, "C" insulation tester, "D" continuity tester, and "E" parts to be inspected. "F" is the location of eyeleting and riveting machines in Figure 17.

An examination of the photographs reveals that inspection at the plant is taken lightly. The area is loaded with debris which shows extremely poor housekeeping. The surroundings are not conducive to good inspection. They are located in a noisy assembly room as evidenced by the nearby presence of riveting machines. If the products are to be "Better than good" the photographs do not show a "Better than good" inspection area; i.e., good quality is commensurate with good inspection facilities.

Therefore, corrective action should be taken to improve the working conditions of the Inspection Department. Detailed information as to changes shall not be a part of this report. The inspection room should be neat in appearance, adequately lighted, and sufficiently quiet for concentration.
FIGURE 15
INSPECTION STATION
TO TEST SPARK
COILS

FIGURE 16
GENERAL INSPECTION
STATION
FIGURE 17

VIEW OF BENCH
INSPECTION STATION
Personnel and Job Qualifications

A review of the job descriptions shown on pages 79 to 82 reveals that of the workers concerned directly with quality control or inspection only one, the Floor Inspector, is required to read blueprints. But if quality is to be maintained, the people responsible should be able to interpret blueprints so that the standards set by engineering may be realized. Therefore, it is recommended that the job descriptions of Press Brake Operators (own Set-up), Set-up Man Assembly, Set-up Man Welding, Set-up Man Machine Tool, Set-up Man Press Brake (and oper. brakes), Set-up Man Punch Press, Inspectors B, Inspectors A, and Assistant Foreman (working) have the following phrase added to their job description:

"Ability to read and interpret blueprints."

Two important characteristics of Inspectors are the quality of the individual worker and his mental capability. That the inspectors in the company are not of the best quality is difficult to describe. However, it is recommended that the company use more discretion in the selection of inspectors, as it is doubtful if the present floor inspectors could do a "better than good" job of inspecting work in the Stamping and Welding Departments.

Since release of all products manufactured by the company relies on the inspectors, a critical job analysis and worker selection program is needed so that only employees with proper
background and education are selected. The job analysis and worker selection program is beyond the scope of this paper, but is recommended so that selection of qualified inspectors will be assured.

**INSPECTION REPORTS**

Figure 18 is an illustration of an inspection report to replace the present form. It has a block to indicate the acceptance or rejection of the work. It is well to note that this report has a specific notation as to the amount of the sample taken which has an important aspect for future inspection. For example, if a particular vendor's material continually shows a low quantity of rejects the inspection sample can be decreased thus using less inspection time. The form also has advantage in that engineering can readily evaluate the inspection since there is a particular column for the listing of all attributes inspected. Previously inspection forms had the words "spotchecked for dimensions" and "visual" which meant nothing, as no indication was made as to what was measured.

The recommended form also has advantage in that dimensions to be measured can be copied from the proposed Quality Control Schedule and referred to on the print. Another advantage is that the inspector does not use his or her judgment as to the evaluation of the importance of dimensions. Case #7, page 46, is an illustrative example of how an inspector's evaluation of
<table>
<thead>
<tr>
<th>PART NO.</th>
<th>PART NAME</th>
<th>LOT ACCEPTED</th>
<th>LOT REJECTED</th>
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

( ) check one,
if 100% inspection denote number
accepted or rejected

SUPPLIER: __________________________
PRODUCT PART IS FOR: __________________________
OUR P.O. #: __________________________
NAME OF OPERATION: __________________________
QUANTITY REC'D: __________________________ DATE: __________________________
INSPECTION SAMPLE: __________________________

) QUANTITY: __________________________ DATE: __________________________

) NO. REJECTS: ___________ NO. ACCEPTABLE __________________________

<table>
<thead>
<tr>
<th>CHARACTERISTIC</th>
<th>NO. ACCEPT.</th>
<th>NO. REJECT</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

ACTION TAKEN:

Inspector
Approved
Chief Inspector

FIGURE 18

PROPOSED INSPECTION REPORT
the importance of a dimension caused a loss of money to the company.

Human Relations

Quality is important if companies desire to maintain a favorable position in a competitive market. Companies possessing a "name" for quality would most likely obtain purchase orders for their products if the prices of competitors' equipment were approximately equal. Inferior quality of products caused the Apex Electrical Manufacturing Co. to lose customers until the problem was solved by management selling employees the importance of quality. Hence a manufacturer's position in a competitive market is endangered if management does not exercise proper control of quality. Poor quality also results in high scrap loses, interruptions on production lines, loss of capacity, and costly salvage operations.

Management in American Industry is now convinced that the best of quality-control programs applying the technical "know how" of the engineer's skill are of no use unless the employees are cooperating wholeheartedly. 17 The recent trends are for companies to sell quality control to the employees by showing pictures and costs of competitors' equipment on bulletin boards; end uses of products are explained to employees; quality is stressed to new employees; and lastly, a good slogan for the company is publicized.

An exceptionally good slogan of the Ford Motor Company suggested by an employee is "Build as though you were buying." If plants are not satisfied with their slogans they may have a contest to obtain a new one.

The slogan for the company under consideration is "Build it better than good." Interviews with employees reveal that this slogan is not inspirational. In fact some employees laugh at the slogan when they see amateurish set-ups such as the debris around the inspection station. Their thoughts are that management itself pays no heed to the slogan so why should they. The same interviews revealed that an overwhelming majority of employees are intensely interested in the products the plant manufactures. However, no information is disseminated so that the employees know how their products stand in competition. In fact this feeling also exists in the junior executive level. There seems to be a reluctance on the part of management to give information on competitors' products.

It is therefore recommended that the management of the company start a contest or use other means to get a better slogan. A contest is preferred because the employees feel as if they are participating with management as a team. To inspire better workmanship and quality, competitors' equipment and end uses of products manufactured should be posted on bulletin boards to keep workers informed. Use of these methods

will sell quality to the worker. When the workers are aware of the competition they know that good products must be manufactured if the company is to survive.

**Possibilities of Applying Statistical Quality Control**

To secure quality control in a manufacturing organization standards for all products should be provided, organization is required, and means of securing action is necessary.²⁹ The corrective action provides a means of setting standards by the proposed Quality Control Schedule. A system of measuring performance will be developed by reorganizing the Inspection Department and using a new form. With these changes in effect, organization for securing action will be available.

With the above in effect a statistical quality control program can be initiated. Statistical quality control requires a systematic check of cause systems to determine if quality is under control. One advantage to quality control by applying statistics is that 100 percent inspection is eliminated. In many cases, statistical techniques can be applied so that 99 percent of the piece parts being manufactured will fall within the specified tolerance. The control charts used in statistical techniques will also point out when to make tool repairs and when to correct a process before scrap parts are produced as well as locate other assignable causes.

²⁹. See p. 17 - "Securing Quality Control"
Application of statistical techniques will relieve the burden of 100 percent inspection on some parts manufactured by the company. The thoroughness of the present inspection system is questionable as evidenced by the word "spotchecked" on inspection reports which in no way indicated the reliability of inspection. However, with reorganization of the Inspection Department and with set standards, statistical sampling techniques can be applied. Figures 20 and 21 are examples of the sampling techniques applied by the General Electric Company. It may be noticed that a lot size of 3,201 to 8,000 pieces requires a sample of 200 parts inspected to determine whether or not the lot is within the chosen acceptable quality level. However, if inspection were to be carried out with the assumed 10 percent inspection which is the percent used by the company's present Inspection Department, 800 pieces would have to be examined or four times as much labor would be consumed as is necessary.

The above is of considerable importance if the company negotiates a contract to manufacture an article like fuzes for the government. In the World War II period inspectors were a significant proportion of productive employees in the company when fuzes were manufactured. The same number of employees are being used in present estimates. However, with statistical techniques applied the inspectors may be halved and an inspection technique fully endorsed by the government will be utilized.
GENERAL ELECTRIC SAMPLING PROCEDURES FOR THE INSPECTION OF INCOMING MATERIAL.

A. This drawing outlines a sampling table and procedure for its use in the determination of the acceptability of incoming material by the General Electric Company. This sampling table and procedure are based on accepted systems of statistical quality control. The sampling procedures of each part of this table give the sampling basis which will be used by the General Electric Company for the inspection of incoming material. The application of the sampling procedures of this table in no way removes any of the vendor's responsibility for supplying all parts in accordance with the applicable drawings and specifications. The purpose of this sampling procedure is to provide a convenient and quick system for determining overall quality of a particular lot or shipment with reasonable surety and without 100% testing.

B. Each part on this drawing (shown top of columns in table) covers a different percentage acceptable quality level and the sampling necessary to obtain reasonable assurance of the maintenance of this quality level. The appearance of this drawing number on the face of a part drawing indicates the particular sampling procedure which will be used for the inspection of incoming parts.

C. Where sample failures from incoming material shipments in excess of the failures permitted by the applicable acceptable quality level column are encountered, the following shall apply:

1. The complete lot or shipment may be returned to the vendor at the vendor's expense for retest or other disposition at the vendor's option. No rejected material is to be returned to the General Electric Company without being accompanied with satisfactory written evidence or statement of re-work and/or retest as required.

2. The lot or shipment may be retained by the General Electric Company and subjected to 100% inspection at the vendor's expense in order to obtain parts for the maintenance of production.

3. Any units from any lot or shipment found defective either on the basis of 100% inspection or sampling may be returned to the vendor at the vendor's expense for credit.

4. The decision as to whether (1) or (2) above shall be applied under terms of the above shall be determined by and at the option of the General Electric Company.

FIGURE 19
<table>
<thead>
<tr>
<th>LOT SIZE</th>
<th>FIRST SAMPLE</th>
<th>SECOND SAMPLE</th>
<th>ACCEPTABLE QUALITY LEVEL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N₁</td>
<td>N₂</td>
<td>PT.1</td>
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<td>UNDER 25</td>
<td>7</td>
<td>14</td>
<td>X</td>
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<tr>
<td>25 TO 50</td>
<td>10</td>
<td>20</td>
<td>↓</td>
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<tr>
<td>51 TO 100</td>
<td>13</td>
<td>26</td>
<td>↓</td>
</tr>
<tr>
<td>101 TO 200</td>
<td>20</td>
<td>40</td>
<td>↓</td>
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<tr>
<td>201 TO 300</td>
<td>25</td>
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<td>301 TO 500</td>
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<td>70</td>
<td>↓</td>
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<tr>
<td>501 TO 800</td>
<td>50</td>
<td>100</td>
<td>↓</td>
</tr>
<tr>
<td>801 TO 1300</td>
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<td>150</td>
<td>↓</td>
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<tr>
<td>1301 TO 2200</td>
<td>100</td>
<td>200</td>
<td>↓</td>
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<tr>
<td>2201 TO 3200</td>
<td>300</td>
<td>600</td>
<td>↓</td>
</tr>
<tr>
<td>3201 TO 5500</td>
<td>500</td>
<td>1000</td>
<td>↓</td>
</tr>
<tr>
<td>550,001 &amp; OVER</td>
<td>1000</td>
<td>2000</td>
<td>↓</td>
</tr>
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</table>

![Table showing acceptance numbers for quality levels](image)

USE SAMPLE SIZE IN FIRST ROW BELOW WHERE ACCEPTANCE NUMBERS ARE SHOWN FOR ACCEPTABLE QUALITY LEVEL INVOLVED.

USE SAMPLE SIZE IN FIRST ROW ABOVE WHERE ACCEPTANCE NUMBERS ARE SHOWN FOR ACCEPTABLE QUALITY LEVEL INVOLVED.

X - INSPECT EACH UNIT IN LOT.

IF SAMPLE SIZE EXCEEDS LOT SIZE, INSPECT ENTIRE LOT.

PROCEDURE FOR USE OF ABOVE TABLE

(A) SELECT FIRST SAMPLE (N₁) INDICATED IN TABLE FOR LOT SIZE INVOLVED.

(B) DETERMINE IN THE FIRST SAMPLE THE NUMBER OF UNITS (D₁) WHICH CONTAIN DEFECTS:

(1) IF D₁ DOES NOT EXCEED C₁, ACCEPT THE LOT.

(2) IF D₁ EXCEEDS C₂, REJECT OR 100% INSPECT THE LOT.

(3) IF D₁ EXCEEDS C₁, BUT NOT C₂, SELECT A SECOND SAMPLE (N₂) OF SIZE INDICATED IN THE TABLE. DETERMINE IN SECOND SAMPLE THE NUMBER OF UNITS (D₂) WHICH CONTAIN DEFECTS. THEN IF D₁ + D₂ DOES NOT EXCEED C₂, ACCEPT THE LOT. OTHERWISE REJECT OR 100% INSPECT THE BALANCE OF THE LOT.
Potential Savings

Cases 1, 2, and 7 show costs of some rejects on the juice machine. The costs of these rejects are due to poor control of quality; that is, defective parts reached final assembly and could not be used, thus causing loss of time to correct defects. Chart V, page 109, shows the production time to produce the juice machine. However, the chart does not show that the original estimate to produce the machine was 2577.8 hrs./M units. The chart shows 4556.3 hrs./M units or 1.64 times the original estimate. A large part of the difference was due to costs of materials and difficulty in manufacturing. The largest time-consuming operations are S.S. Cone Assembly, Side Panels, Paint, Assembly and Packing. Of these, S.S. Cone Assembly and final assembly rely on the fitting of parts.

Considerable engineering effort was expended in reducing the assembly time by improving the quality of parts to make them fit better. It will be noticed that a continual reduction in assembly hours has been realized. Part of this is attributable to skill acquired by practice and part by better quality of components. It is estimated that approximately half of this reduction came about by better control of quality. Costs were reduced \( \frac{500 - 389}{500 \times 2} = 10.4\% \) because of the improvement in quality. This verifies the author's estimate that

20. See Chapter III
<table>
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<tr>
<th>Description</th>
<th>EST</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6 &amp; 7</th>
<th>8</th>
<th>9</th>
<th>10</th>
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<td>263.3</td>
<td>283.0</td>
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<td>240.0</td>
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<td>578.0</td>
<td>255.0</td>
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<td>401.0</td>
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<td>189.5</td>
<td>177.8</td>
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<td>208.5</td>
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<td>150.0</td>
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<tr>
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<td>Pack</td>
<td>400.0</td>
<td>532.0</td>
<td>576.4</td>
<td>384.7</td>
<td>341.4</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>26.7</td>
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</table>

**Totals:**
- 1566.3
- 5169.9
- 4284.1
- 3376.6
- 3407.7
- 3482.4
- 3630.2
- 3800.4
- 3701.6
- 4022.1

**Production Hrs./Munits — Juice Machine**
10 percent of assembly time is lost in the company by poor quality. 21

Referring to the S.S. Cone Assembly which involves silver soldering, it is noted that assembly time has not been reduced to any great extent. Failure to realize continually decreasing labor hours was caused by the use of substitute material and the inability of the fabricating departments to maintain critical dimensions which were necessary for efficient silver soldering. With better control of quality the production hours on this operation could be reduced by 10 percent or more.

Selling the New Program

Any new program will always have to overcome initial starting resistance. This resistance is encountered in two ways: one is the inherent resistance of workers to accept changes and the other is the reluctance of management to change when profits are being made by the present system.

To sell the program to the employees a contest for a better slogan should be inaugurated. This will make them feel as if they are really a part of the program. Once the employees have felt that management is interested in their participation, acceptance of form changes and changes in organization will occur because of the realization of their purpose. This viewpoint should be approached cautiously as

21. See page 44.
it is wiser for management to start slowly with stress on quality, than to start on a program with much publicity and have it die suddenly.

Since management is interested in cutting costs the fact that 10 percent of all assembly time can be saved by better fitting parts should be incentive enough to install the program. Another gain would be an Inspection Department that would impress any visitors to the plant. Lastly, a basis would be formed for a statistical quality control program that would greatly reduce the number of inspectors if a job similar to manufacturing fuzes is obtained from the government. With the present day shortage of available labor management should be sold on this latter point as it will simplify the procurement of inspection personnel as well as government contracts.

**Summary**

To obtain better quality control and inspection procedures the company should do the following:

1) Change the organization chart to have quality control under the direction of the Chief Engineer.

2) Change the title of the Service Engineer to Quality Engineer as that is the type of work he is doing.

3) Relocate the Inspection Department as recommended so that excessive travel will not be required.
4) Add two line inspectors to the Inspection Department personnel so that quality in the Fabricating Departments may be better controlled by the Shop Engineer.

5) Install the proposed Quality Control Schedule so that inspection procedures may be clarified and made standard.

6) Clean up the Inspection stations so that surroundings will be conducive to good work.

7) Include the phrase "Ability to read and interpret blueprints" in job descriptions of all personnel involved in inspection and quality.

8) Install the new form of inspection reports so that overinspection may be avoided and that assurance is guaranteed that all critical dimensions are being measured.

9) Sell quality to the employees by means of a better slogan and by keeping them informed as to how the company's products compare with competitors' products and end uses of other products manufactured.
CHAPTER VI

CONCLUSIONS
Conclusions

To some degree the problem of quality control confronts all companies. Large companies have accepted statistical techniques and have found that not only is the quality of products improved but also reduction in costs result. All companies applying the latest techniques have a soundly organized Inspection Department which is supplied with proper specifications and information.

Organization for quality control in the company under consideration is not clearly defined, as overlapping of authority occurs causing confusion among employees. A systematic method of checking production is not used. The Inspection Department lacks personnel and equipment to be fully effective. Dissemination of information is poor, specifications are lacking on products, and some information bypasses engineering entirely.

Through a planned quality control program designed to cover all products manufactured a cost-conscious management will reduce costs and manufacture superior products. Quality control is a continuous program, and changes will be required to accommodate the manufacturing versatility of the plant. The benefits to be derived from the proposed program are as follows:

1) The Shop Engineer will be relieved of routine inspection duties; thus he will have more time
for such important functions as layout work
(sheet metal), estimating, model making,
and control of quality.

2) If the Shop Engineer should for some reason
become unavailable for work, essential
routine inspection and control of quality
will continue automatically.

3) Less engineering time will have to be spent
on routine inspection, thus more effort
can be utilized in the development of future
products.

4) A basis for statistical techniques of in-
spection is developed.

5) A program of quality control meeting
government requirements will be established.

6) Responsibilities are centralized.

7) A system is provided for quickly spotting
defects.

8) Cost reduction of approximately 10 percent
will be attained in final assemblies and
sub-assemblies.

Discussion

The research required by the author to obtain data for
this paper uncovered many other problems that the plant
under consideration should investigate if it desires to
reduce costs and improve production methods. A scientific investigation of the Stamping, Welding, and Plating Departments might yield further savings for the company. Observation of production indicates a "grasshopper" scheduling of parts. A great deal of time seems to be lost by changing jigs and fixtures more often than necessary, thus preventing smooth flow of material. The tool room should also be scrutinized as much expense seems to be incurred in the overdesigning of dies.

Another department which indicates tremendous waste by poor methods and scheduling is the Maintenance Department.

Also indicated is the need for a complete job analysis and worker selection program so that employees may be better chosen for their jobs.

The above statements are only indications and need investigation before proof of inefficiency can be obtained. However, it is believed that the company would do well to incorporate an Industrial Engineering Section so that the foregoing items may be continuously investigated. An Industrial Engineering Section could maintain training programs so that quality control personnel would be able to read and interpret blueprints, welders could have refresher courses on latest techniques developed, and a
sounder worker selection plan would be available to place employees in positions best suited for their talents.
CHAPTER VII

CRITICAL EVALUATIONS
The President, Plant Manager, and Chief Engineer of a small manufacturing company were requested to review this manuscript in the practicality of its application and their comments are contained on the succeeding pages.
Mr. Walter R. Kuzmin  
The Oiljak Mfg. Company, Inc.  
Montclair, New Jersey  

Dear Mr. Kuzmin:

I have carefully read your thesis on "Cost Reduction Through Closer Control of Quality" and have discussed it with Mr. Faber, the Plant Manager.

You have evidently made a conscientious study of a most difficult problem in a plant of this sort.

I would like to see you make a resume of your recommendations and submit them to the Plant Executive Committee for the purpose of installing as many as we reasonably can.

Very truly yours,

L. C. Vannan  
President.
February 29, 1952

Mr. Walter Kuzmin
The Oiljak Manufacturing Co. Inc.
18 Depot Square
Montclair, New Jersey

Dear Walter:

I have carefully read with a great deal of interest your report on "Cost Reduction Through Closer Control of Quality" and I am especially interested in your comments where you apply your research to problems in our own plant.

A great deal of what you report is known to all of us, but it is obvious that there is much room for improvement. It is healthy to have these weaknesses brought out in the open, because frequently when one lives in the woods he fails to see the trees.

On pages 111 and 112 you summarize your recommendations, and my comments on your recommendations are as follows:

1, 2. An organizational chart is never static. It must be continually revised and improved to keep it up with the changing conditions in a plant, especially in a plant such as Oiljak, where nothing is static. If the Chief Engineer is in agreement with the suggested organizational changes in his department, they have my approval.

3. The suggested relocation of the Inspection Department requires further study. Space is at a premium in our plant and the relative use of space must be considered carefully. Regardless, however, of where the Department is located, there will always be excessive travel, because the inspectors must go to the product, and we are spread over a number of buildings. I am thoroughly in agreement with your recommendation given elsewhere in the report -- that Inspection should have a more adequate set of equipment and that all inspection equipment should be located in one place.

4. I question the need of two more floor inspectors in Building #1. I recognize that inadequate control now
exists, but I think it possible that better supervision by the persons responsible could accomplish the same thing.

5. I am not clear as to what this recommendation refers to.

6. Good housekeeping is desirable, not only in the Inspection Department, but throughout the plant, and I am all for it.

7. I think the adding of words to job descriptions while keeping the same person in the job will accomplish nothing. You overlook the Union contract implications, that place great stress on seniority in the filling of jobs, and also you overlook the fact that job descriptions are a part of the Union contract, and that if you try and negotiate additional responsibilities into a job you are at the same time inviting the Union to ask for a higher rate of pay for that job. I also question the desirability of a large number of employees in the shop having access to the drawings in the Layout Room and making as one of their responsibilities the consulting of those drawings.

8. A frequent solution to a problem is a new form or another form. Make sure that a new form really solves the problem. If the Chief Engineer approves the suggestions you have my approval.

9. I question the merit of a new slogan or, in fact, of any slogan as far as personnel in the plant is concerned. "Ballyhoo" rarely works except where a worker's life or his pocketbook is involved. Individual personal contact and education will have effect, but in my opinion mass ballyhoo rarely does.

I agree with you that a proper Inspection Department in any plant is vital, and that ours is possibly something of an improvisation and there is no doubt that there is much room for improvement. I would like for you to give the Chief Engineer and me a concise and concrete plan for improving our Inspection Service so that we can consider it and put it into effect.

I found your report very provocative and I am sure that as a result of its study and re-study by all of us, much good can be accomplished in our plant. Thank you very much for giving me the opportunity to review it.

Sincerely yours,

THE OILJAK MANUFACTURING COMPANY Inc.

[Signature]

John H. Faber
Plant Manager

JHP: mst
March 3, 1952

Mr. Walter Kuzmin
The Oiljak Manufacturing Co. Inc.
18 Depot Square
Montclair, New Jersey

Dear Walter:

I have read with great interest your thesis "Cost Reduction Through Closer Control of Quality." The paper shows a tremendous amount of detailed study for which you should be complimented. It further shows a wealth of enthusiasm and ideas, some of which can be used to advantage by our company. These are listed as follows:

1. Incorporation of Quality Control under direction of Chief Engineer.
2. Relocation of Inspection Department.
3. Addition of two line inspectors to Building #1.
4. Installation of a Quality Control Schedule.
5. Addition of following phrase to job qualification of "set-up" men - "Ability to read and interpret blueprints within limitations required by the scope of the job."
6. Installation of an improved inspection report form.

I have the following suggestion to offer, which you might have used in the preparation of your paper:

If you were to present a step-by-step plan of just how you would put into effect the proposed recommendations, the job of selling the plan to management would be simplified. Just as your paper required many hours of careful preparation, so would your recommendations require weeks, and perhaps months, of careful planning to effect efficient operation. Management is aware of many of your criticisms. The point is to eliminate the undesirable situations by using the minimum amount of detail and red tape. You must remember that the Company grew into this situation and it might be that it will have to be pruned out of it. A concrete plan commensurate with good timing may be the answer.

Very truly yours,

THE OILJAK MANUFACTURING COMPANY Inc.

George Persak
Chief Engineer

STAMPINGS • • • • METAL PRODUCTS • • • • ASSEMBLIES
APPENDIX A

SKETCHES OF COST OF REJECTS CASES
CASE #1

SPOTWELD NUTS

BASE - JUICE DISPENSER
MAT: C.R.S.

W. R. KUZMIN
JAN. 1952
CASE #2

BACK GRILL — JUICE DISPENSER
MAT: C.R.S.

SPOTWELD NUT
CASE #3

HINGE—ABRASIVE COVER
MAT: C.R.S.

W. R. KUZMIN
JAN. 1952
CASE #5

DRILL THROUGH

VALVE SEAT

VALVE CASTING

W. R. KUZMIN
JAN. 1952
CASE #6

GAS WELD

MARINE COVER

MAT: C.R.S.

W.R. KUZMIN
JAN. 1952
CASE #7

BOTTOM FITTING

NOTE: TAPERED SHANK TO FIT WYNNIT FAUCET SERIES.

NOTE:
REAS TO FIT ELBOW TUBES RUNNING ON MAX TOLERANCE

MATERIAL: 18-8 STAINLESS STEEL TYPE 304
PREFERRED (302 OPTIONAL)

ALTERNATE MTL.: STAIN, STEL TYPE 430
REQUIRED: (1)

FINISH: 180 GRIT AT 3"
CASE #8

BLOWOUT TUBE

MAT: $\frac{1}{4}$ O.D. COPPER TUBING

REQ: 1

W.R. KUZMIN
JANUARY, 1952
CASE #8

AIR TO CLEANER TUBE

MAT: $\frac{3}{4}$ O.D. COPPER TUBING

Req: 1

W.R. KUZMIN
JANUARY, 1952


Control Chart Method of Controlling Quality During Production, New York, American Standards Association Incorporated, April, 1942.


