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A STUDY OF THE EFFECT OF PACKAGE SIMPLIFICATION ON A TOTAL CORPORATE SYSTEM

By

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ABSTRACT

A STUDY OF THE EFFECTS OF PACKAGE
SIMPLIFICATION ON A TOTAL
CORPORATE SYSTEM

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Donald Herman Shervey

A major corporation stocked a wide variety of corrugated box sizes for packaging service parts. A case study was conducted within the company to determine the overall effects of simplification of the boxes.

In the study, four similar sized boxes were combined into one. The effects and costs related to this variety reduction on all affected departments were documented and summarized. A history and background of simplification in industry was presented along with an overview of the firm studied.

The results of the study revealed that eighteen departments were affected by the box changes. The effects on these departments were both positive and negative. The major savings were due to decreased box and storage costs. The major cost increases were due to increased dunnage and distribution costs.

The final cost analysis revealed that combining the four boxes resulted in a $2,430.20 cost savings for the company.

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TABLE OF CONTENTS

TABLE OF CONTENTS (Cont.)

LIST OF TABLES

LIST OF FIGURES

KEY TO NOMENCLATURE

Box. A three dimensional shipping container made of corrugated fiberboard.

Carton. A folding box generally made from boxboard for merchandising consumer products, but never used as a shipping container.

Common Carrier. A commercial transportation medium used to move a product from one destination to another.

Corrugated Fiberboard. A packaging material consisting of a central fluted medium with flat sheets of paperboard glued on each face forming a single-faced board.

Cube. A conventional method of expressing volume which represents one cubic foot.

Dunnage. Blocking, lining or other interior cushioning material used to fill excess space to prevent free movement of an object in a package.

Full Overlap Container. (FOL) A corrugated fiberboard box with the outer flaps completely overlapping.

Kraft Paper. A brown paper made entirely from wood pulp produced by a modified sulphate pulping process used to manufacture corrugated fiberboard, paper bags and other packaging materials.

Manufacturers Joint. The seam of a corrugated box where the two edges of the box blank are joined by stitching, taping or gluing by the box manufacturer.

Master Container. A large fiberboard box used to overpack a multiple of individual boxes or containers for shipment.

Mullen Test. Also known as the bursting test, measures the ability of a sheet to resist rupture when pressure is applied to one of its sides, Pallet. A low, portable platform used to facilitate handling, storage and transportation of material as a unit.

Regular Slotted Container. (RSC) A corrugated fiberboard box with the outer flaps meeting in the middle of the box.

Chapter I

Introduction

Background

The world of American industry has become more complex and more competitive with each passing day. Every year, thousands of new products have been introduced into the market place and thousands more have been changed to meet the ever changing needs and desires of the consumer. The goal of all manufacturing industries has been to produce a product to attract the consumer, sell that product and in so doing, make a profit.

All too often, people involved in the various disciplines of manufacturing organizations became so involved in their own special areas, that other related areas were overlooked. The individual's main goal tended to be one of solving the day to day problems. These problems were the most visible part of the individual's work and it was the solving of these problems and the efficiency with which they were handled by which the individuals were judged, and in turn, by which levels of responsibility and salaries were determined. Thus it was that the overall goal of the organization, the profit, was often not considered in decisions and actions by the individual.

The packaging function was no exception to this problem. Packaging was affected by almost every other area within the organization and crossed the total spectrum of corporate strategy.[1] Due to its enormous

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[1]Raphael Olsson, Package Production Management, 2nd ed. (Westport, Connecticut: The AVI Publishing Co. Inc., 1976), p. vii.

size and visibility, the function of packaging had often been referred to as an industry in itself. This however was not the true case. The packaging function provided a service to industry and to the economy in general.[2] That service was to provide a safe means for moving a product to the customer at the least total cost to the organization. In that way, the packaging function was helping to maximize profits for the organization.

In its most fundamental state, packaging's function was to prevent the environment from damaging a product and in some cases, to prevent the product from damaging the environment. Basically, a package was designed to protect a product during its storage and distribution. This in turn reduced waste and ultimately reduced cost. A package was also designed to contain a product, which provided a means for it to be handled and also provided a means of identification for the product.

In 1968, Friedman stated that people were often preoccupied with loss and damage statistics and not enough concerned about the systems contribution of packaging.[3] This implied that packaging was involved in much more than its fundamental protection function. Anthony agreed with this in 1984 when he stated that the only feasible way to manage the packaging and material handling functions was to remain committed to a systems approach that recognized the interrelatedness between packaging, material handling and other corporate functions.[4]

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[2]Arthor D. Little Inc., The Role of Packaging in the U.S. Economy (Report to - The American Foundation For Management Research, Inc. 1966), p. 1.

[3]Walter F. Friedman, "The Role of Packaging in Physical Distribution," Transportation and Distribution Management, pp. 34-39, February 1968.

[4]Sterling Anthony, JR, "Improve In-Plant Material Handling With Standardized Packaging," Material Handling Engineering, pp. 83-86, July 1984.

In an article written in 1978, John Phillips described what he called the systems approach to package development. This theory stated that five functional areas needed to be considered in a package design. The five areas included marketing, package development, manufacturing, distribution and transit. The reasoning behind the involvement of each of these areas was:

Marketing - concerned with unit size and shape for customer acceptance and maximum sales.

Package Development - concerned with an economic size, design, materials, protection and satisfying shipping regulations.

Manufacturing - concerned with packaging equipment, size restrictions and the labor time involved.

Distribution - (warehousing and stores) concerned with size restrictions, maximum weights and storage space dimensions.

Transit - (traffic) concerned with maximizing trailer loading and vehicle weight restrictions.[5]

Basically, the systems approach looked at all considerations before the development or redesign of a package. This produced a package to fit the goals of an established corporate system, rather than one that attempted to manipulate the system to work around it.[6]

At first glance, this seemed to handcuff the packaging engineer and diminish the importance of the package itself. Just the opposite

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[5]John D. Phillips, "Computer-Aided Package Design Yields Major Savings In Distribution Costs," Paperboard Packaging, pp. 85-87. September 1978.

[6]Ibid.

was anticipated to be true. The package probably received more recognition. If the package design was judged important enough to warrant a high degree of consideration, it was recognized as an important part of the system and given a high priority in the final decision. It was very conceivable that the established corporate system was more likely to be changed following this approach, because most of the important areas of the system were involved in the study and had been since the beginning. Because of this, they were more likely to understand the overall situation and be less protective of their own functions. All areas were more aware of the ultimate goal and of what each area needed to achieve that goal.

The personal experiences of the author have proven that decisions made without full knowledge or consideration of the effects on other related areas, often resulted in the creation of problems and injured feelings. In many cases, the problems created were worse than the ones originally corrected. Experience has shown that people became very protective of their own functions when problems arose. This seemed to be especially true when the problems were caused by actions that they were unaware of. This protective nature seemed to diminish as more information was made available to them and the situation was better understood. It was the opinion of the author that a great deal of time and effort could have been saved by involving those directly affected by a decision in that decision. This would have eliminated many questions and problems before they arose.

In Sweden, total-system thinking dominated in the area of packaging. It was seen as the key to efficient and economical distribution. Although only a small country, many packaging trends have come from Sweden and Sweden has been referred to as a microcosm of the United States packaging world.[7]

In the Swedish total system thinking, there were strong feelings in favor of standardization and simplification in packaging. This involved reducing the number of shipping package sizes to reduce total costs.[8]

The variety reduction concept has also been a popular area for reducing packaging costs in the United States.[9] Friedman has stated that reducing the number of packages rarely had any effect on the surface designs or functional characteristics of the package, but they have produced substantial economies in procurement, production, material handling, warehousing and packaging.[10]

In a report prepared for the U.S. Navy, the Arinc Research Corporation confirmed the authors other findings in the literature. The report stated that the literature agreed that standardization was generally conceded to be cost-effective, but was usually considered in qualitative form rather than quantitative terms. There was a great deal of background information which addressed types of costs and savings involved in standardization, but there were few examples of actual dollar savings.[11]

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[7]"Distribution-Minded Swedes Gear Innovations To Total-System Packaging," Packaging Engineering, p. 63, June 1979.

[8]Ibid.

[9]"Packaging: How It Can Cut Your Distribution Costs," Modern Materials Handling, pp. 70-72, December 1979.

[10]Friedman, op. cit., p. 37.

[11]Arinc Research Corporation, The Cost-Effectiveness of Standardization for Hull, Mechanical, and Electrical Equipment, (Prepared for the Department of the Navy, April 1978), p. 1-2.

From inquires to various companies, the author found that many companies had not done a size standardization cost analysis or if they had, the results were for internal use and they had not been published.

Purpose of the Study

The purpose of the study was to determine the cost effectiveness of reducing the variety of shipping packages following the systems approach. That was to look at the effects and the costs that resulted in all areas of a company due to a reduction in the number of sizes of shipping packages. The results of the study were to be applied to future research in the area of standardization and the systems approach and also to benefit companies who attempted to justify the implementation of a standardization program in the area of packaging.

Author's Intention

In undertaking this study, the author's personal intentions were to first, document the economic effects of packaging material simplification within a functioning organization and secondly, to gain a better personal understanding of the packaging function and its working relationship with the other areas in a company. This knowledge was to be used in future studies and in day to day decision making where time did not allow the luxury of an in-depth study.

Chapter II

Standardization and Simplification

History

Before August of 1928, there were no known books written on the topic of standardization in the English language. This was not to say that standardization had not existed before that time, only that its importance and potential had not been fully realized.[12]

The vast amount of material published by various authors since that time had often referred to and defined standardization and simplification in somewhat conflicting ways. Simplification was sometimes regarded as a part of standardization while standardization was sometimes regarded as a part of simplification.[13]

The following definitions have been given to help clarify this author's interpretation of the two terms. All were the approved definitions of the International Standards Organization (ISO).

> "Standardization is the process of formulating and applying rules for an orderly approach to a specific activity for the benefit and with the cooperation of all concerned, and in particular for the promotion of optimum overall economy taking due account of functional conditions and safety requirements"

> "A standard is the result of a particular standardization effort"

> "Simplification (variety reduction) is a form of standardization consisting of the reduction of the number of types of products within a definite range to that number which is adequate to meet prevailing needs at a given time"[14]

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[12]Norman F. Harriman, Standards and Standardization (New York: McGraw-Hill, 1928), p. v.

[13]National Industrial Conference Board, Industrial Standardization (New York: N.I.C.B., 1929), p. 28.

[14]Rowen Gile, Speaking of Standards (Boston: Cahners Books, 1972), p. 34.

From these definitions, a few key words and phrases have been highlighted to further aid the reader in understanding these principles.

From the Standardization definition:

"formulating and applying rules" - A standard was a guideline for future use.

"orderly approach" - A standard eliminated that was different or unusual and helped to keep things more organized.

"cooperation of all concerned" - Standards were only effective when everyone followed the same guidelines.

"optimum overall economy" - The purpose of a standard was to maximize profit by reducing costs.

"functional conditions" - The finished product or item in question was of no value unless it fulfilled its design function.

From the Simplification definition:

"variety reduction" - Simplification was basically standardizing by reducing the variety if similar items.

"within a definite range" - The principle had its limitations and applied only to that which was already in existence.

"adequate to meet prevailing needs" - Simplification could not go beyond the point of full coverage.

"at a given time" - The principle had to be flexible enough to change as conditions and requirements changed.

The principle of standardization has been around for a long time. Roman road builders standardized the construction and design of the military roads that ran throughout their empire. In 17th Century England, the style of armour was standardized to avoid the costs involved in altering and changing to keep up with fashions.[15]

Eli Whitney introduced the principle of interchangable standard parts in his production of muskets. In 1799, after receiving an order for 10,000 of these muskets from then Vice President Thomas Jefferson, Eli found it impossible to meet his deadline using the then conventional piece part manufacturing so he developed the now common technique of interchangable parts.[16]

Standardization had often been fiercely opposed in the United States. Exceptions occurred when cost-savings or other obvious benefits accrued to a company. However, due to increased governmental pressures, recognized benefits of reduced inventories and the spread of standardization programs in many European countries, it was considered likely that it would continue to grow in the United States. Companies in the United States were also becoming more aware of the not so obvious benefits of standardization and were better able to justify standardization programs.[17]

Four basic levels of industrial standardization were recognized in the literature. They were:

1. Company Level - Standards internal to and unique to a particular company.

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[15]Benjamin Melnitsky, Profiting From Industrial Standardization (New York-Chicago: Conover-Mast Publications, 1953), pp. 34-35.

[16]Lal C. Verman, Standardization: A New Discipline (Hamden, Conn: Shoe String Press, 1973), p. 8.

[17]Olsson, op. cit., p. 21.

2. Industry Level - Intercompany standards such as those initiated by trade associations such as the American Society of Mechanical Engineers (ASME) and the Institute of Electrical and Electronic Engineers (IEEE).

3. National Level - Interindustry standards such as those initiated by organizations like the National Standards Institute (ANSI)

4. International Level - World wide standards initiated by an organization like the International Standards Organization (ISO).[18]

In the United States, most standards were written by engineering societies like ASME and IEEE and by trade associations like the National Fiberbox Association. To help coordinate these activities, bodies like ANSI and ISO had been established. Their purpose was to prevent overlapping and conflicting activities.[19]

In 1972, The British Standards Institute published the results of a study which stated, "there were no known merit in standardization for its own sake: it must make improvement on the economics of situations or provide other benefits such as convenience, reliability or safety." It was the responsibility of all parties involved at all four levels to assure that when standards were developed, they met this criteria.[20]

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[18] Jessie V. Coles, Standards And Labels For Consumer's Goods (New York: Ronald Press Co., 1949), pp. 151-153.

[19] David Hemenway, Industry Voluntary Product Standards (Cambridge, Mass.: Vallinger Publishing Co., 1975), p. 81.

[20] The British Standards Institute, "Packaging Standardization and Relationalisation," Packaging Technology, pp. xvi-xix, November 1972.

The function of simplification most often applied at the company level. The individual firm had to make the decision to simplify and they in turn realized the direct benefits.[21] An exception to this was a study undertaken by members of the Fruit and Vegetable Industry. This study recognized that reducing the number of different size shipping containers used to transport fresh fruit and vegetables had cost saving potentials that could benefit the entire industry.[22]

On March 24, 1917, shortly before the beginning of World War I, the U.S. Council of National Defense started the Commercial Economy Board (CED) to work towards conserving our national resources.[23] The CEB recognized the waste involved in redundancy and began by working directly with over 250 industries to reduce the number of styles and varieties and sizes. This practice continued during the war when the conservation division of the War Industries Board was created to reduce wasted labor, capital, materials and equipment in all industries.[24]

In 1921, after the war was over, Herbert Hoover became Secretary of Commerce and declared an all out war on waste.[25] The war and post war depression brought out a realization of the need for conservation

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[21] Anglo-American Council on Productivity, Simplification in British Industry (London-New York: A.-A.C.P., 1950), p. 6.

[22] American National Metric Council, Report of Industry Panel Presentation on the Fresh Fruit and Vegetable Sector to Officials of the U.S. Departments of Commerce and Agriculture (Washington, D.C. March 21, 1983).

[23] United States, Library of Congress Science Policy Research Division, Voluntary Industrial Standards in the United States Washington: U.S. Government Printing Office, 1974), p. 11

[24] Harriman, op. cit., p. 112.

[25] United States, Library of Congress Science Policy Research Division, op. cit., p. 12.

and more efficient production. Waste had to be eliminated as did unnecessary sizes, shapes and varieties to help cut costs without decreasing production. Simplification offered one important key to the total solution.[26]

Hoover coined the term "simplification" to mean the cutting down of sizes and styles because he anticipated that many people would misunderstand and resist a program titled standardization.[27] A committee he appointed found productivity in American Industry to be only 50% of its maximum, so a nation wide movement of simplification was begun. It was found that reduction in variety of from 24% to 98% was often possible.[28]

In a speech given at a later date, Hoover stated that standards and simplification had made an enormous contribution towards increasing the comfort and standard of living of the people of the United States. He considered them the base of all mass production.[29]

It was noted that standardization and simplification did have their limitations. If overdone, standardizing could have stifled creativity and become a barrier to progress. Standardization was recognized as a tool available to help make permanent and readily available the progress that had been made up to a given point in time.[30]

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[26]National Industrial Conference Board, op. cit., p. 256.

[27]Mrs. Carol (Willis) Moffett, More For Your Money (New York: Public Affairs Committee, 1942), p. 7.

[28]Verman, op. cit., p. 9.

[29]Dickson Reck, ed., National Standards in a Modern Economy, 1st. ed. (New York: Harper and Brothers, 1956), p. 4.

[30]Coles., op. cit., p. 160.

The 1950 Anglo-American Council on Productivity stated that standardization was to be considered a servant of American industry, not the master.[31]

Advantages and Disadvantages

Many sources agreed that reducing the variety of materials used for production had both positive and negative effects on the different areas of a company. As stated earlier, to accurately judge a simplification proposal, the overall effects on the total system had to be considered. Positive and negative effects reported on various areas of a company included:

Advantages

1. Engineering - Less time was required in processing and selecting new items.
2. Stores - Less space was required and fewer records had to be kept.
3. Inventory Control - Reduced capital was required and less funds were tied up in inventory. Less safety stock was required and fewer items needed to be controlled. Obsolescence and deterioration were reduced due to a faster inventory turn over.
4. Purchasing - The larger volume of fewer items gave more purchasing power and more reliable delivery dates. Reduced costs resulted due to the need to issue fewer purchase orders.

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[31]Anglo-American Council on Productivity, Packaging (London-New York: A.-A.C.P., 1950), p. 27.

5. Quality Control - Inspection requirements were reduced due to the fewer incoming items.
6. Manufacturing - With fewer items to choose from, decision times were reduced.
7. Warehouse - With fewer items, better planning and utilization of storage space resulted.[32]

Disadvantages

1. There was a potential for increases in material and part costs.
2. There were costs involved in the standardization study.
3. There were costs involved in making changes.
4. There was a restriction of freedom of choice and loss of flexibility.

The ultimate goal was to weigh these positive and negative factors to determine the overall effect on the company and its profit. This was recognized as the determining factor in the justification of a variety reduction program.[33]

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[32]Ken Kivenko, "How Design Can Help Control WIP Inventory," Machine Design, p. 42, May 26, 1983.

[33]British Standards Institution, The Operation of a Company Standards Department (London, 1979), p. 5.

Chapter III

Overview of Firm Studied

General Background

The Company in which this study was conducted was a large machinery manufacturer headquartered in Midwestern United States. For purposes of confidentiality, because actual cost figures were used in the results of the study, the name of the organization is not used. The organization has been referred to in the report as the "Company".

The Company was incorporated in the early 1900's and grew to world leadership in its field. Corporate products included a broad line of equipment, ranging from large commercial units to major appliance type consumer products. Two major divisions and many sub-divisions existed which supported the two main product groups.

The manufacturing operation involved various facilities throughout the United States, Canada and several international locations. Sales were conducted through a worldwide network of sales offices.

In 1984, the Company employed over 10,000 people worldwide and had sales in excess of one billion dollars. In that same year, the Company was purchased by and became a major division of another large corporation. The acquisition had no effects on the study or its results.

The Company's packaging function was located in the Development Engineering area of the Commercial Equipment Division. The group consisted of two people who had total responsibility for all packaging related activities within the division. The packaging involved was mainly industrial type packaging, which was designed to provide safe, efficient and economical distribution of the manufactured products. The appearance of the package was a concern, but it was generally of a secondary nature.

The packaging group was also responsible for all of the packaging involved in the distribution of service parts. The decision was made to conduct the study in the service area because this area used the widest variety and largest volume of packaging materials.

Service Parts Operation

The Company's service parts operation consisted of approximately 45,000 parts with 10,000 considered active parts. Active parts were defined as higher volume or critical items that were kept in stock for immediate shipment. The inventory of these stocked parts was turned over four times per year.

In general, each plant location stocked the parts that were required to support its product lines. There was some overlapping of parts between the manufacturing locations, but this was very limited and was considered insignificant to the study.

Included in the service operation were parts manufactured by the Company and others purchased from outside suppliers. The physical properties of the parts ranged from small screws and washers to large components weighing hundreds of pounds. Packages for these items included paper and plastic envelopes, padded bags, folding paperboard cartons, corrugated boxes and wooden boxes and crates. Cushioning and dunnage materials included kraft paper, polyethylene sheet foam, loose fill foam, and expanding polyurethane foam.

The corrugated boxes used were a part of a group of general use materials that were used throughout the Company where ever needed. When the study began, approximately 30 different boxes were used, ranging in size from 2 x 2 x 3 inches to 34 x 34 x 20 inches. Occasionally a package or material was added to stock to support a particular item, but this was done only if the value, volume or protection requirements of the item justified it. When a new material was added to stock, it automatically became available for general use unless some special characteristic prevented it.

The packaging group was responsible for selecting the appropriate packaging materials for each of the service parts. This was typically done at the time that the item was set up as a service part.

In the selection of a package, the physical size, shape and weight of the item was considered along with a general determination of its fragility. No actual fragility testing was performed unless it had been specifically requested. Generally, a package was selected that most closely matched the dimensions of the item and provided adequate clearance for the required cushioning materials. Items were packaged to protect against damage and also to prevent any rattle that was unacceptable to some carriers.

In the actual packaging operation, all parts were manually packaged in their primary packages per the instructions given by the packaging group. These packaged items were then labeled for identification and placed in a storage area. Items were stored in racks, skid boxes, bins or drawers, depending on size, weight and the quantity normally held in inventory.

The Company's service parts were sold and distributed through a network of over 125 franchised service agencies. These agencies varied greatly in size and were located world wide to cover the territory of the sales organization. The part requirements of each of these agencies depended mainly on its location and the line of products sold in that location. Orders were generally placed as parts were required but also to take advantage of special promotional price breaks. A minimum order of $25.00 was required.

When an order was received from one of these agencies, the ordered parts were manually picked from the storage area, consolidated in a secondary packing area and manually bulk packed in a master shipping container or containers. Packers followed a general instruction on safe packing but were allowed mainly to use their own best judgement in the packing arrangement.

Depending upon the size and weight of the finished master pack, it was shipped by either United Parcel Service (UPS) or Common Carrier, with UPS being the preferred method. The traffic department was responsible for determining what type of shipment was the most economical.

It was noted that a small percentage of parts ordered were shipped by air. However, this percentage was so small, that it was considered insignificant to the study and it was not included in the analysis.

Upon receipt of a parts shipment, the service agencies either took the parts immediately to a job site or stored them in their own small inventory warehouse. These storage areas were typically back rooms with racks and shelving.

The typical life of the Company's service parts was summarized in the following five steps:

1. The packaging group was alerted that a new item was to be added to stock. A drawing of the item was examined and appropriate packaging materials were selected from the general use materials in stock.
2. The part was then manually packed, labeled and placed in a storage area.
3. When an order was received for the item, it was manually picked from the storage area along with other parts on the order and taken to the secondary packing area.
4. The item was then bulk packed in a master container with the other items and shipped to the ordering service agency by either UPS or Common Carrier, which ever proved to be the most economical.
5. The service agency then either used the part or stored it for later use.

Purchased Material Cancellation

A major factor involved in the implementation of a simplification project was the removal of the items being eliminated. When it was determined that a purchased material such as the corrugated boxes involved in this study were no longer required, a systematic process was followed to remove the item(s) from the Company's stocked inventory. This process involved the approvals of nine different departments. Figure 1 showed the routing taken for these approvals.

When the cancellation was approved, the item was removed from the listing of current materials and the remaining inventory was used up, returned to the supplier for credit, transferred to another manufacturing location or scrapped, which ever was possible and provided the most benefit to the Company. All drawings specifying the cancelled item(s) were then changed to specify the substitute material.

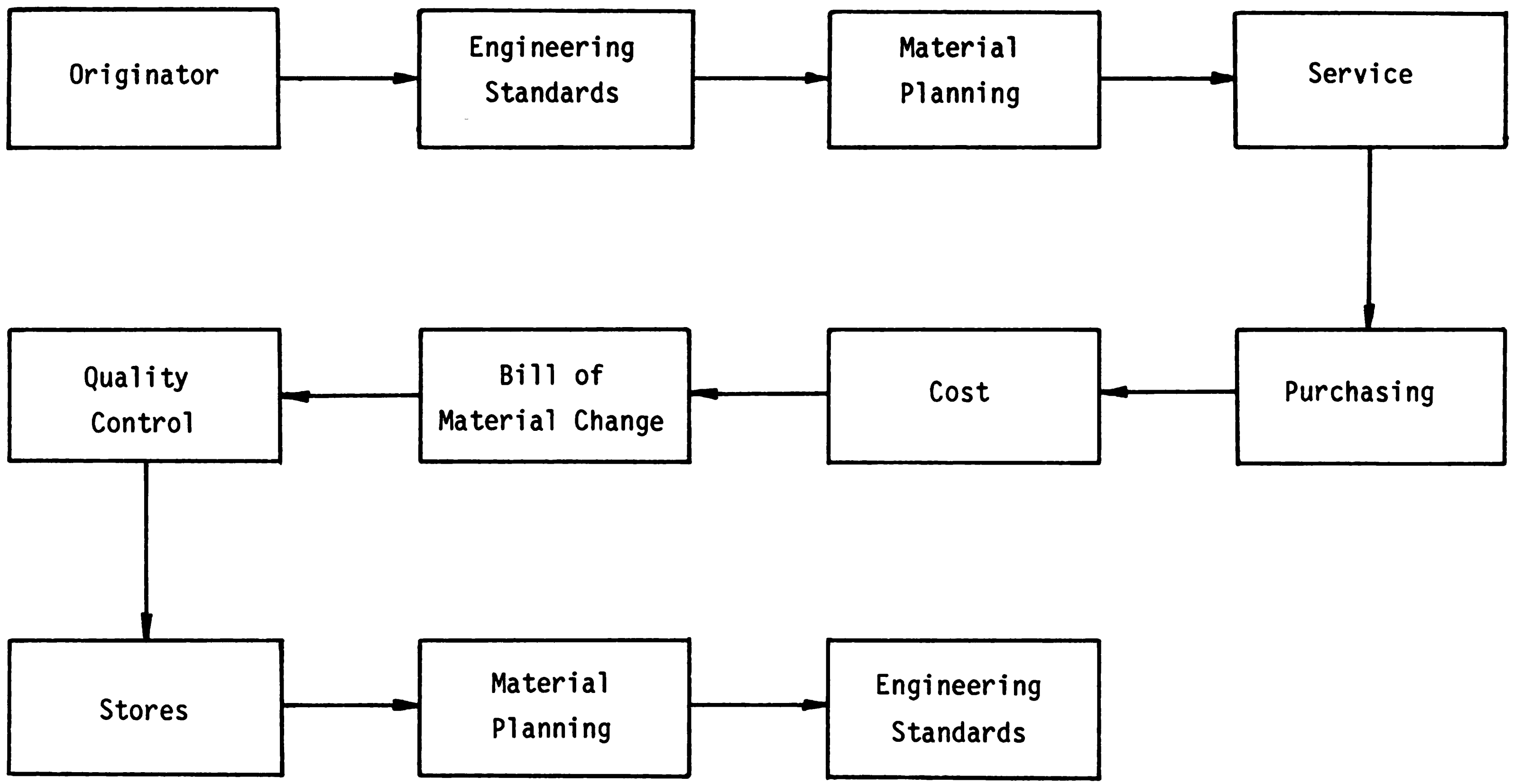

Figure 1

Material Cancellation Approval Routing

Chapter IV

Description of the Study

Basic Overview

The purpose of the study was to determine the overall economic and other related effects that packaging simplification had on a total corporate system. To accomplish this objective, a case study was conducted within the repair service parts area of the Company. The study consisted of a theoretical elimination of three similar sized corrugated boxes and an evaluation of the positive and negative effects that this action had on other related areas of the Company.

From the literature, it was determined that simplification typically affected the areas of purchasing, engineering, manufacturing, stores, inventory control, quality control, and warehousing. The author used this information as a basis, but then expanded the study into other related areas that were identified as the study progressed. These areas included cost, receiving inspection, bill of material, the parts packing area and distribution. Each of these areas was addressed individually and as part of the total system. When possible, the actual costs involved were documented and the effects on efficiency were determined. Intangible effects such as customer goodwill and employee acceptance were also identified and documented whenever possible.

In each of the areas affected by the study, the general topics of materials, labor, inventory, storage and warehousing, obsolescence and general paperwork requirements were examined when they applied. Also considered were the general feelings of interdepartmental coordination and cooperation. Both positive and negative effects were documented in all cases.

The study also included an examination of the effects on the Company's sales and service agencies. These agencies ultimately received the newly packaged items and while their costs were not directly related to the Company's profits, their acceptance and efficient use of the parts had a direct impact on their sales and service performance which ultimately reflected on the Company's Sales and profits.

Occasionally an ultimate consumer who was not a Company sales outlet or service agency was also affected by a packaging change. However, because these cases were outside of the control and direct knowledge of the Company, they were documented as a reference only. No attempt was made to analyze the cost effects in these cases.

Limitations of the Study

Limitations were placed on the study to keep it within the scope of the project. These limitations include:

1. The data collected and the costs involved were current for the three month period that they were collected, September through November 1984.
2. The study was limited to a single plant location within the Company.
3. The study only considered a reduction in the number of items already in stock. The study did not consider the option of adding new items to replace others that were already there.
4. The study considered only domestic shipments in the evaluation of the distribution costs.

Data Collection

To determine the effects in the different areas, the author selected key personnel in each area and presented them with the theoretical packaging material substitutions. Each was requested to consider the effects on efficiencies and costs involved in their area and also to consider the intangible effects.

The author searched for and documented all of the inventory location of the boxes and also all locations where the boxes were actually being used. This included all warehouses and production areas at the manufacturing location being studied. The author also collected all of the data on the annual usage of each box and the information on all of the items that were packaged in the boxes.

The author also physically measured the rack, bins, and other storage locations of both the boxes and the packaged parts inventory. This included taking measurements and weights of the boxes and dunnage materials and collecting all of the applicable cost data.

Container Selection

As mentioned earlier, when the study began, the Company stocked a total of 30 different size corrugated boxes that were available for general purpose packaging. The materials used for these boxes ranged from 175 to 275 pound single wall corrugated fiberboard. All box styles were either regular slotted or full overlap containers with taped or glued manufacturers joints. Printed graphics were typically a one color two panel layout of the Company's corporate logo.

The entire range of boxes was screened to determine which were similar enough to be considered as candidates for the study. Several limitations were set to assure the final substitutions resulted in a package that provided equal or greater strength and protection when compared to the original boxes. The limitations placed on the selection were:

1. The substitute box must have been equal to or larger than the original box in all dimensions.
2. The substitute box must have been no more than one inch larger than the original box in any dimension.
3. The rated strength (mullen test) of the substitute box must have been equal to or greater than the original box.
4. A full overlap container could replace a regular slotted container but a regular slotted container could not replace a full overlap container.

It was determined that in the range of available general purpose boxes, several satisfied the requirements to be considered for the study. After an evaluation of all of the potential candidates, a group of four similar sized boxes were selected for the study. Many one to one substitution combinations were available, but it was the opinion of the author that by increasing the scale of the study to four items instead of two, a more detailed and more thorough evaluation could be documented.

The four corrugated boxes selected for the study were designated simply, box #1, box #2, box #3, and box #4. The largest of the four was box #1. It acted as the theoretical replacement for the other three. Boxes #2, #3, and #4 were cancelled, removed from the Company's inventory and replaced in all cases by box #1.

A comparison breakdown of the physical properties of the boxes at the time of the study has been summarized in Table 1.

Table 1

Physical Properties of the Study Boxes

Inside Dimensions

Box	(L) x (W) x (D)	I.D. (in^3)
#1	7.00 x 7.00 x 4.50	220.50
#2	6.00 x 6.00 x 3.75	135.00
#3	6.25 x 4.50 x 6.38	179.44
#4	7.00 x 7.00 x 3.88	190.12

Outside Dimensions

Box	(L) x (W) x (D)	O.D. (in^3)
#1	7.25 x 7.25 x 5.00	262.81
#2	6.25 x 6.25 x 4.25	166.02
#3	6.56 x 4.81 x 6.69	211.09
#4	7.25 x 7.25 x 4.38	230.22

Material Specifications

Box	Board Test	Flute Size	Box Style
#1	275 lb	B	RSC
#2	200 lb	B	RSC
#3	175 lb	C	RSC
#4	275 lb	B	RSC

General background information describing the boxes was as follows:

1. All were printed with the Company logo on two panels in one color ink.
2. All were identified with the Company's part number, date of manufacture and the box makers certificate. All of this information was printed by the box manufacturer.
3. All were manufactured with a taped manufacturers joint.
4. All were constructed of kraft corrugated fiberboard.
5. All were certified as complying with Code of Federal Regulations Title 49 paragraph 178.205-18 for the shipment of hazardous materials and all were printed with the Department of Transportation (DOT) symbol certifying this compliance.

It was noted that box #3 changed from 175 pound corrugated fiberboard material to 275 pound material. This was a substantial increase, but it was necessary to assure that there was no loss in package strength when the box substitutions were made. Box #1 and box #4 were both originally 275 pound material so the use of a 275 pound material for the substitute box was necessary. These boxes were also used for the shipment of items that were regulated by the Department of Transportation as hazardous. The amount of regulated material that could legally ship in a corrugated box was determined by the boxes burst strength. It was important that the substitute box be 275 pound material so that there would be no reduction in the ability to use box #1 or box #4 for hazardous material shipments.

The standard cost to the Company and the annual usage of each of the boxes at the time of the study has been summarized in Table 2.

Table 2

Standard Cost and Usage of the Study Boxes

Box	Standard Cost Each	Annual Usage
#1	$.374	3047
#2	$.176	7416
#3	$.145	9659
#4	$.224	3882

All of the boxes were purchased from the same three suppliers following an internal material requirements planning (MRP) system for inventory management. All orders for the boxes were initiated by the same buyer and all were received, inspected and warehoused in a similar manner at the same location. All four of the boxes were requisitioned as required by the user department(s) and all were handled and transported to the user in a similar manner.

The primary function of all four of the boxes was to act as the primary package for various service stock replacement parts. Only boxes #2 and #3 showed usage outside of the service department. They were also used to package miscellaneous products in another general shipping department.

A breakdown of the usages of the four boxes has been summarized in Table 3.

Table 3

Packaging Uses of the Boxes

Box	Number of Different Items Packed	Service Related	Other
#1	91	91	0
#2	78	77	1
#3	51	41	10
#4	68	68	0

Typical products packaged in the four boxes included bearings, switches, valves, controls, pistons, gasket and o-ring kits, springs and gauges. The weight of these items varied from less than one pound for some of the kits, to over 30 pounds for some of the bearings and valves. The value of the items also varied greatly from a few dollars to hundreds of dollars.

As indicated in Chapter III, no formal fragility or other package testing was performed on these items unless specifically requested. The amount of protection specified for an item was determined by its nature and appearance and by the general background and experience of the packaging engineer. As a general rule, electronic parts received plastic foam type cushioning while mechanical parts were packed to prevent free movement in the package using the plastic foam, crumpled paper, free flow foam or other available dunnage material.

After the selection of the sample boxes was completed, the author then collected the data from all of the departments affected by the simplification project. This data was then analyzed and summarized in the following chapter.

Chapter VI

Results of the Study

General

The study revealed that many areas of the Company were affected by the packaging material simplification project. These included the areas referenced in the literature and others that were unique to this study.

Effects on Related Functions

The study revealed that the areas in the Company affected by packaging material simplification were:

- Purchasing
- Material Control
- Stores
- Packaging Engineering
- Engineering Standards
- Engineering Drawing Change
- Engineering Drafting
- Engineering Drawing Files
- Manufacturing Engineering
- Quality Control
- Cost Department
- Receiving Inspection
- Service Parts Packaging Department
- Bill of Materials
- Distribution (Traffic)
- General Shipping Departments
- Field Service Agencies
- Ultimate Parts Users

The magnitude of the effects varied greatly from one area to another, but all were in some way affected. A summary of the effects felt in each of the areas has been included.

Purchasing

The Company's purchasing department's responsibility was to identify acceptable and economical sources for required materials and to do the actual buying of those materials. Purchasing benefited from simplification due to lower box costs resulting from higher volume buying, a reduction in the number of orders placed each year and an overall reduction in general paperwork.

Before simplification, the four individual boxes were ordered from two to three times per year. Box #2 was ordered twice annually and boxes #1, #3, and #4 were each ordered three times annually. The order quantities ranged from 1,000 to 3,700. After simplification, box #1 was ordered four times per year in quantities of 6,000. This reduced the number of purchase orders from 11 to 4 and the higher volume orders reduced the annual cost of the boxes.

Purchasing also realized benefits from the reduced number of follow-ups that were required, reduced requirements for supplying vendors with material specifications, reduced requirements for requesting periodic price updates and other miscellaneous paperwork jobs that were required in the ordering and tracking process. Because each item and each order was unique in regard to these requirements, the Company's purchasing department had not assigned standard costs to them. They have been included here as a reference to their existence, but they were not included in the final cost analysis.

Material Control

Material control was responsible for maintaining proper inventory levels using a Material Requirement Planning system. This involved inventory planning and computerized cost maintenance of every purchased item. Savings were realized due to the elimination of the need to plan and maintain boxes #2, #3, and #4.

Inventory carrying costs were also involved. These costs were reduced due to a reduced average inventory value after combining the boxes of from $392.91 to $296.05. These numbers have been summarized in the cost analysis section in Table 13.

The remaining inventories of boxes #2, #3, and #4 were used up before box #1 was substituted. As a result, there were no obsolescence costs involved.

Stores (warehouse and materials storage)

The stores function was responsible for all storage, warehousing and interplant movement of materials. Simplification affected this area by reducing the requirements for storage from four items to one.

The study revealed that two of the four boxes were stocked in four locations and the other two were stocked in five. Boxes #1 and #4 were stocked in the main warehouse and in three separate locations to support parts packaging. Boxes #2 and #3 were stocked in the same four locations as #1 and #4, but in addition, they were also stocked in the shipping department of one of the other local manufacturing plants. This resulted in four storage locations in the main warehouse, twelve to support parts packaging and two in another shipping room.

In the main warehouse, the boxes were stored on the same pallets that were received on from the suppliers. These pallet loads were then broken down and dispersements made as required.

All of the boxes involved in the study were received on standard 40 x 48 inch wood pallets, which required 13.3 square feet of floor space. Because the box storage section of the warehouse had no storage racks, the size of the pallets determined the floor space that each required.

In calculating warehousing costs, stores also included one half of the aisle in front of the stored material. In this case, the aisles were six feet wide. This resulted in an actual storage requirement of 76 x 48 inches or 25.3 square feet for each pallet load.

At the time of the study and on the average, the main warehouse contained two pallet loads each of boxes #2 and #3 and one pallet load each of boxes #1 and #4. This resulted in a total of six pallet loads and floor space requirements of 151.8 square feet.

After simplification, an average of two pallet loads of box #1 were stocked in the main warehouse. This number varied from one when only safety stock remained to four when an order of 6,000 boxes was received in three pallet loads of 2,000 each. It was estimated that over time, the average was two pallet loads, requiring an average of 50.6 square feet of floor space. This compared to the original requirement of 151.8, resulted in a savings of 101.2 square feet or 66.7 percent.

In the parts packaging department, boxes were stored in six foot square storage bays. The aisle was again six feet wide so the actual floor space requirement for each storage location was 6 x 9 feet or 54 square feet.

The 12 storage areas required for the original four boxes required a total of 648 square feet of floor space. After simplification, only three storage areas were required for a total of 162 square feet. This resulted in a space savings of 486 square feet or 75 percent.

In the general shipping room where boxes #2 and #3 were stocked, the quantities were so low that the boxes were simply piled in a storage shelf. Combining the boxes here had very little, if any effect on the amount of space required. No estimate of the savings were made.

Engineering

Reducing the number of boxes affected various areas in the Company's engineering department. These included the packaging group, engineering standards, drawing change control, drafting and files.

The packaging group was responsible for initiating the box changes. The simplification changes had several advantages and disadvantages to the group's future work. The advantages included reduced package selection time due to the fewer choices, simplified mass changes when they were required for all boxes and reduced work required to keep all packaging material specifications up to date. The main disadvantage to the group was the reduced selection flexibility.

A special series of engineering drawings was dedicated to service parts. Each drawing specified a particular service part and also specified the box that it was to be packaged in, the dunnage requirements, the identification label required and any other special requirements for packaging the part.

For the initiation of the change, a packaging engineer's time was required to prepare and issue a drawing change request to revise all of the drawings that specified boxes #2, #3, and #4. Box #2 was specified on 68 drawings, #3 on 35 and #4 on 57, resulting in a total of 160 drawings that required revision. The engineer was also required to initiate a purchased material revision request, requesting the cancellation of boxes #2, #3 and #4 and their removal from stock. It was estimated that this work required two hours of an engineer's time.

The engineering standards group was responsible for controlling additions, deletions and changes to purchased materials. In this case, their responsibility was to approve the purchased material revision cancellation request initiated by the packaging group. When the request was approved, the group was then responsible for updating the Company's code book to alert everyone that the three boxes were no longer available for use. It was estimated that processing these three revisions required one hour the group's time.

For approval, the cancellation request was routed through the nine departments described in Figure 1. The costs involved in the review by all of these areas were real. However, most of these costs were very insignificant and an attempt at accurately documenting all of them was beyond the scope of the study. Those costs that were definable have been included in the cost analysis. Otherwise, these areas have been included simply to document their role in the project.

The engineering drawing change group was responsible for coordinating the drawing changes. These involved processing the drawing change request and alerting other areas of the Company to the changes to the 160 drawings. The group's supervisor estimated that this work required eight hours of her staff's time.

Engineering drafting services was responsible for all of the engineering drawing work. They were responsible for physically changing the 160 original drawings. Because the change was a simple code substitution, the drafting manager estimated that eight drawings were changed in an hour, requiring a total of 20 hours.

Engineering drawing files was responsible for handling and storing all original and microfilmed engineering drawings. For this study, the work involved microfilming the 160 revised drawings and refiling both the original drawings and the film cards. The department supervisor estimated that this work required four hours.

Manufacturing Engineering

All drawing changes were reviewed by manufacturing engineering. Their responsibility was to review the labor time that was required to package the affected service parts in box #1. The study revealed that no changes in labor time were required. It was estimated that this review required four hours of a manufacturing engineer's time.

Cost Department

The cost department was responsible for reviewing the 197 items on the 160 drawings being revised and updating the standard costs applied to the items. This involved revising the cost of the boxes and adding the cost of the extra dunnage material that was required. It was estimated by the manager of the department that this required eight hours of work.

Receiving Inspection

The receiving inspection department was responsible for verifying materials specifications and the quantity of each purchased material shipment. Due to simplification, they were now receiving only four shipments annually instead of eleven. It was estimated by the department foreman that 15 minutes was required to inspect and record each shipment of boxes. This resulted in an annual time savings of 105 minutes.

Bill of Material Change Group

The bill of material change group was responsible for reviewing the 160 drawing changes and updating the bill of material item master. This item master was a computerized listing of all materials that were required to produce and ship each item. In this case, the box requirements for each of the 197 parts affected were updated. The supervisor of the department estimated that this required 16 hours of work.

General Shipping Room

The general shipping room had stocked boxes #2 and #3. These were replaced by box #1. As indicated earlier, this did not affect storage space requirements, but it was indicated that it did simplify paperwork requirements. Instead of keeping track of and requisitioning two items, they now only had to keep control of one. The costs involved were insignificant so they were not included in the cost analysis. However, it was noted that if the volume of the boxes had been greater, the change would have had a very significant effect on the department's workload.

Quality Control

Quality control's responsibility was to screen all material changes to prevent obvious reductions in product quality. Due to the nature of the change, product quality was not affected, or if anything, the larger box provided added protection. Costs resulting from this review were again insignificant and were not included in the cost analysis.

Field Service Agencies

Past experience in working with the Company's field service agencies had revealed to the author that they were mainly affected by the increased size of the packages. They were not concerned with the package itself, but with the safety of the parts and size consistency over time. The agencies storage areas were set up to accommodate packages that had been received in the past. As long as the parts were shipped consistently in box #1 after the change, there were no anticipated problems or extra costs involved.

Ultimate Parts User

In a very few cases, it was found that the ultimate user of a part was someone other than a Company approved service agency. In these cases, the change in box size may have had some effect. However, because the identity of these users were unknown, it was impossible to determine the actual effects. This potential effect was documented as a reference to its existence, but no attempt was made to analyze the costs involved.

Service Parts Packaging Department

The greatest effects of the study were found in the packaging department where the boxes were used. Here the physical advantages and disadvantages of using the larger box were felt.

The foreman of the department and the packers interviewed, all agreed that reducing their box selection from four to one saved them time in searching and selecting on those occasions when the decision had been left up to them. At the same time, they indicated that it reduced their flexibility and ability to select boxes to provide the best fit. This was similar to the concern about flexibility expressed by the packaging group. Overall, the feeling was very positive about combining the similar size boxes.

As indicated in the warehouse and storage section, the boxes were stocked in three locations to support the parts packaging operation. The foreman indicated that reducing the number of items from four to one not only resulted in a cost savings from the space savings, but it also greatly helped to relieve an overcrowding problem that was quite serious in one of the three storage locations. It was not possible to assign a dollar value to this, but helping to relieve the overcrowding problem was a definite benefit to the Company.

In the actual packaging operation, the greatest effect was due to the size of the box. Since box #1 was slightly larger than the three that it replaced, it required more dunnage material to assure a tight pack. The exact amount of this dunnage material was determined by the packer at the time the part was packaged. Only the type of dunnage material to be used was specified by the packaging group, not the amount.

Time studies revealed that increasing the amount of dunnage material used did not increase the average time required to package the parts. As a result, the study revealed that simplification of the boxes had a direct effect on material cost but no significant effect on labor.

The use of the larger box would have had a negative effect on the storage space required to hold packaged parts in stock. The standard storage bin for these parts was 36 inches wide, 36 inches deep and 15¼ inches tall. Using box #1, each bin held up to 75 packaged parts. Using boxes #2 and #4, each bin also held up to 75 packaged parts. However, using box #3, each bin held up to 84 packaged parts or approximately 11 percent more.

Of the four boxes, box #3 had the greatest usage, so the 11 percent difference was significant. On the other hand, the bins were rarely filled to their capacity so it potentially had no effect at all. Due to the variables, it was not possible to calculate the exact effects and costs involved, so an analysis of the extremes was given in the cost analysis section of this chapter.

The larger box also had a negative effect on the amount of space required to pack the master shipping containers that were used to ship orders. As with the storage bins, box #1 required more space than did boxes #2, #3 or #4. A summary of the space requirement differences has been given in Table 4.

Table 4

Packaged Items Storage Space Requirements

Box	Annual Usage	O.D. Increase Due to Change	Annual Increase
#2	7416	96.79 in^3	415.39 ft^3
#3	9659	51.72 in^3	289.10 ft^3
#4	3883	32.59 in^3	73.21 ft^3
		Total Annual Increase	777.70 ft^3

The total increase of 77.70 cubic feet seemed to represent a significant amount of extra master container shipping cube that was now required. However, as with the storage bins, this overall increase number was deceiving.

It was estimated by the department foreman and the master container packers that 90 percent of all master containers were not shipping completely filled. The uniqueness of every order prevented having containers that fit exactly. The voids in the containers were filled with dunnage or the depth of the box was cut down to match the load. Due to this, in most cases, the extra cube that resulted from using box #1 was absorbed by the capacity that already existed in the master containers.

Again, due to the uniqueness of the orders, it was not possible to calculate the exact requirements. As with the storage bins, an analysis of the extremes was given in the cost analysis section of this chapter.

Due to using box #1, extra dunnage material was required to fill the extra void. A summary of the amount of this extra void per box has been given in Table 5.

Table 5

Void Filling Requirements

Box	Annual Usage	O.D. Increase Due to Change	Annual Increase
#2	7416	85.50 in^3	366.94 ft^3
#3	9659	41.06 in^3	229.74 ft^3
#4	3882	30.38 in^3	68.29 ft^3
		Total Annual Increase	664.97 ft^3

Records indicated that the dunnage used to fill the extra voids in boxes #2, #3, and #4 was crumpled 40 pound kraft paper 50 percent of the time and crumpled .031 inches thick polyethylene sheeting the other 50 percent of the time. Testing revealed that 36 square feet of the crumpled kraft paper was required to fill a one cubic foot void and that 63 square feet of the crumpled foam sheeting was required to fill this same space. Using this information, the total annual extra requirements for the kraft paper and the foam sheeting was determined. A summary of these requirements has been given in Table 6.

Table 6

Dunnage Requirements

Material	Extra Dunnage Requirements	Amount Required Per Cubic Foot	Total Annual Requirements
Paper	332.49 ft^3	36 ft^2	11969.64 ft^2
Foam	332.49 ft^3	63 ft^2	20946.85 ft^2

These extra requirements for the paper and foam were real numbers and their cost and weight effects were included in the cost analysis of the study. However, due to the large amounts of foam and paper used annually by the company, these extra requirements did not figure significantly in storage and warehousing costs, so they were not included in the cost analysis. It was noted, that if the extra dunnage requirements resulted in the need to stock new material or added a significant percentage to the already used materials, the storage and warehousing costs would be significant to this type of study and they would have to be included in the cost analysis.

Distribution (Traffic)

The distribution or traffic function was concerned with the costs involved in the shipping and safe arrival of the products. Using the larger box #1 and adding extra dunnage increased the protection properties of the packages, but it also acted to increase shipping costs by adding cube and weight. A summary of the extra weight associated with the larger box has been given in Table 7 and a summary of the extra weight associated with the dunnage required to fill the extra 777.70 cubic feet of void has been given in Table 8.

Table 7

Box Weight Increases

Box	Box Weight (lbs)	Weight Increase Using #1 (lbs)	Annual Usage	Annual Weight Increase (lbs)
#1	.408	----	----	-------
#2	.208	.200	7416	1483.20
#3	.214	.194	9659	1873.85
#4	.388	.020	3882	77.64
			Total Annual Increase	3434.69

Table 8

Dunnage Weight Increases

Material	Total Extra Annual Requirements (ft^2)	Weight Per Sq Ft (lbs)	Annual Weight Increase (lbs)
Paper	11969.64	.01324	158.48
Foam	20946.87	.00570	119.40
		Total Annual Increase	277.88

Combining the extra weight of the box and the extra weight of the dunnage materials, resulted in a total weight increase of 3,712.57 pounds. This total divided by 20,957, the total annual usage of boxes

#2, #3 and #4, resulted in an average increase of .177 pound or 2.83 ounces per package.

Again, because of the unique nature of each order, it was not possible to accurately determine exactly how this extra weight was distributed among the orders shipped over a year's time, nor was it possible to determine what the exact cost increases were. As was done with the extra cube estimates in the parts packing section, the author presented an analysis of the extremes in the cost analysis section of this chapter.

Total System Cost Analysis

As mentioned in the first half of this chapter, reducing the number of shipping packages had cost effects on many areas and departments through the Company. The following analysis covered those cost changes that were significant enough for the author to be able to assign dollar values, and listed as a reference those that were not.

Box Costs

Increasing the annual usage of box #1 from 3,047 to 24,004 resulted in a cost decrease of from $.374 to $.148 per box. This provided a total savings of $1,162.34. These savings were summarized in Table 9.

Dunnage Costs

Standardizing on the larger box #1 resulted in an increased cost of $281.29 for dunnage materials. These costs have been summarized in Table 10.

Purchase Orders

The Company used a figure of $35.00 to represent the cost of preparing and issuing each purchase order. By reducing the number of boxes purchased, the number of annual purchase orders was reduced from 11 to 4. This resulted in an annual savings of $245.00.

Table 9

Box Cost Summary

Box	Cost Per Box	Annual Usage	Annual Cost
Before Simplification			
#1	$.374	3047	$1139.58
#2	$.176	7416	$1305.22
#3	$.145	9659	$1400.56
#4	$.224	3883	$ 869.57
		Total Annual Cost	$4714.93
After Simplification			
#1	$.148	24004	$3552.59 Total Annual Cost

Storage Costs (Main Warehouse)

The manager of stores estimated that the storage space in the main warehouse cost the Company $2.50 per square foot annually. This included rent, taxes, heat, guards and other miscellaneous costs. This and the space requirements presented in the first half of this chapter have been summarized in Table 11.

Table 10

Dunnage Cost Summary

Material	Additional Required	Cost Per Square Foot	Annual Cost
Kraft Paper	11969.64 ft^2	$.006	$ 71.82
Plastic Foam	20946.87 ft^2	$.010	$209.47
		Total Annual Cost Increase	$281.29

Table 11

Main Warehouse Storage Cost Summary

Boxes Stocked	Average Space Requirements	Annual Cost Per Square Foot	Total Cost
4	151.8 ft^2	$2.50	$379.50
1	50.6 ft^2	$2.50	$126.50
		Total Annual Savings	$253.00

Storage Costs (Parts Department)

The manager of stores estimated that space in the parts department cost the Company $5.00 per square foot annually. This again included all of the miscellaneous costs involved. This and the space requirements presented earlier in this chapter have been summarized in Table 12.

Table 12

Parts Department Box Storage Cost Summary

Boxes Stocked	Average Space Requirements	Annual Cost Per Square Foot	Total Cost
4	648.0 ft^2	$5.00	$3240.00
1	162.0 ft^2	$5.00	$ 810.00
		Total Annual Savings	$2430.00

Packaged Parts

The extra annual storage space for packaged parts that was required due to using the larger box was determined to be 777.70 cubic feet. Considering that the parts inventory turned over four times per year, the maximum extra storage space that was required at any given time was 194.43 cubic feet.

Each storage bin provided 11.4 cubic feet of storage space, so a maximum of 17 extra bins were required. Each of these bins covered 18.0 square feet of floor space. However, because the bins were stacked five high, the actual floor space required for each bin was 3.6 square feet. As a result, the maximum extra floor space requirement for the larger box was 61.2 square feet. At the rate of $5.00 per square foot, this resulted in an additional cost of $306.00.

It was also possible that all of the extra space requirements were absorbed by the unused space in the existing bins. In this case, the extra storage space requirement was zero.

From this analysis, it was concluded that the range of additional cost for storing packaged parts was from <u>$0.00 to $306.00</u>.

Master Container Costs

The larger size of box #1 increased the amount of master shipping container requirements by the same 777.70 cubic feet annually. From discussions with the parts packers, an average master container was determined to be 22 x 22 x 18.5 inches. This box did not always ship completely full, but it had a capacity of 5.18 cubic feet and could ship by either UPS or Common Carrier. The material cost of the container was $1.88. Using an existing time study standard of five minutes for packing parts in the container, and the departments labor and overhead rate of $.82 per standard minute, resulted in a packing cost of $4.10. This resulted in a total cost of $5.98 for each completed master container.

Assuming that all of the extra space requirements had to be supplied by new containers, an additional 151 were required. This resulted in a cost of $902.98. If all of the extra space requirements were absorbed by the existing extra capacity, no additional master containers were required. In this case, the extra cost was $0.00.

From this analysis, it was concluded that the range of additional cost for the master containers was from <u>$0.00 to $902.98.</u>

Receiving Inspection Costs

Receiving inspecting labor was reduced by 105 minutes. At a cost of $.82 per standard minute, this resulted in an annual savings of $86.10.

Material Control Costs

Material control costs resulted from the labor time and computer usage costs involved in planning and maintaining inventory levels. The Company used an annual cost figure of $83.00 per stocked item to represent the administrative costs involved in this work. Eliminating the three items resulted in an annual savings of $249.00.

Inventory Carrying Costs

The Company's inventory carrying costs were figured as 30 percent of the cost per piece multiplied by one twelfth of the annual usage. A summary of the inventory carrying costs before and after simplification has been given in Table 13.

Distribution Costs

As indicated, the Company's distribution costs for domestic shipments were affected by changes in the weights of the items shipped and not by changes in cube. As a result of the study, distribution costs increased due to the standardized use of the larger carton #1. The increase was based on the average weight increase of .177 pounds for each of the 20,957 packages affected.

Past records revealed that the Company shipped approximately 85 percent of the parts orders by UPS and the remaining 15 percent by Common Carrier. This resulted in 3155 additional pounds shipped by UPS and 557 additional pounds shipped by Common Carrier.

At the time of the study, UPS rates increased on even one pound increments and were determined by the shipping zone of the point of destination. Common Carrier rates were based on minimum weight charges and additional rate charges that varied by point of destination, from state to state and city to city.

Table 13

Inventory Carrying Costs

Before Simplification

Box	Annual Usage	Average Monthly Inventory	Cost Each	Average Inventory Value	Inventory Carrying Costs	
#1	3047	253.92	$.374	$ 94.97	$ 28.49	
#2	7416	618.00	$.176	$108.77	$ 32.63	
#3	9659	804.92	$.145	$116.71	$ 35.01	
#4	3882	323.50	$.224	$ 72.46	$ 21.74	
				$392.91	$117.87	Total Annual Cost

After Simplification

Box	Annual Usage	Average Monthly Inventory	Cost Each	Average Inventory Value	Inventory Carrying Costs	
#1	24004	2000.33	$.148	$296.05	$ 88.82	Total Annual Cost
					$ 29.05	

To arrive at an average cost increase for UPS shipments, the rates for a zone five shipment were averaged over the entire one to seventy pound range. Shipping room personnel indicated that zone five was the most common point of destination and that the packages shipped would cover the entire one to seventy pound range that UPS accepted. The average cost for a one pound increase was calculated to be $.15.

Assuming that all 85 percent of the 20,957 packages involved or 17,813, each caused a master container to raise to the next higher UPS rate, the annual cost increase was $2,671.95. Assuming that none of the 17,813 packages raised the weight to the next higher rate, the annual cost increase was $0.00. This resulted in a potential cost increase of from <u>$0.00 to $2,671.95</u>.

Arriving at a cost increase range for Common Carrier shipments was found to be very difficult. Because of all of the variables involved in the trucking industries rate system, it was virtually impossible for the traffic department to even estimate accurate averages.

The additional 557 pounds that were added to Common Carrier shipments were considered quite insignificant, especially considering that many of these shipments went below the minimum weight. To arrive at a maximum cost for the study, the traffic department estimated the highest rates at the highest rate destinations and arrived at an annual figure of $412.00. The minimum was again $0.00 if the extra weight caused no increase to the shipping costs.

The author acknowledged that the estimate for the Common Carrier cost increase had not been substantiated in this report. Including an explanation of the complicated trucking rate system was beyond the scope of the study. The estimate of the traffic department has been included to help summarize the results of the study and to act as a reference to its existence.

As a result of these estimates, the total range of the distribution cost increase was determined to be $0.00 to $3,083.95. These costs and all of the other cost results, have been summarized in Table 14.

Implementation Costs

The following analysis outlined the costs that were involved in cancelling boxes #2, #3 and #4 and revising the drawings that called for them to call for box #1. The time estimates given were provided by the heads of the departments involved. The author acknowledged that they were estimates, but they were considered typical.

Engineering time was required to prepare and issue a drawing change request for the 160 drawings affected and to prepare and issue three purchased material revision requests, requesting cancellation of boxes #2, #3 and #4. It was estimated that this work required two hours. The standard cost of an engineer's time was $39.00 per hour resulting in a total cost of $78.00.

The engineering drawing change group was required to process the drawing change request. It was estimated that this took eight hours. At a rate of $15.00 per hour, this resulted in a total cost of $120.00.

Engineering drafting time was required to physically change the 160 original drawings. It was estimated that this required a total of 20 hours. At a rate of $22.00 per hour, this resulted in a total cost of $440.00.

Drawing files was responsible for microfilming and refiling the microfilm cards and original drawings after the drawing changes were completed. It was estimated that this was a four hour job. At a rate of $15.00 per hour, this resulted in a total cost of $60.00.

Table 14

Total System Cost Summary

	Annual Cost Increase	Annual Cost Decrease
Defined Costs		
Box Costs		$1162.34
Dunnage	$281.29	
Purchase Orders		$245.00
Storage Costs (Boxes)		
Main Warehouse		$253.00
Packing Area		$2430.00
Receiving Inspection		$86.10
Material Control		$249.00
Inventory Carrying Costs		$29.05
	$281.29	$4454.49
Estimate Costs		
Storage Costs (Packaged Parts)	$0.00 - $306.00	
Master Container Costs	$0.00 - $902.98	
Distribution Costs		
UPS	$0.00 - $2671.95	
Common Carrier	$0.00 - $412.00	
Total	$281.29 - $4574.22	$4454.49

The cost department was responsible for reviewing the parts affected and updating standard cost files. It was estimated that this required eight hours. At $18.00 per hour, this resulted in a total cost of $144.00.

The bill of material change department was responsible for reviewing the revised drawings and updating the computerized bill of material item master listing. It was estimated that this required 16 hours. At a rate of $18.00 per hour, this resulted in a total cost of $288.00.

Manufacturing engineering was responsible for reviewing the drawing changes and revising the labor standards that had been applied to each. As indicated earlier, the labor did not change so this job was estimated at four hours. At $22.00 per hour, this resulted in a total cost of $88.00.

Purchased material cancellation approvals had to be received from the nine departments illustrated in Figure 1. The departments involved provided time estimates that varied from five to thirty minutes to process the requests. These resulted in an average time of 15 minutes for a total time of 135 minutes or 2.25 hours. At an average rate of $27.50 per hour, this resulted in a total cost of $61.88.

The total implementation costs involved were $1,279.88. These costs were summarized in Table 15.

TABLE 15

Implementation Cost Summary

Department	
Engineering	$ 78.00
Engineering Drawing Change	$120.00
Engineering Drafting	$440.00
Drawing Files	$ 60.00
Cost Department	$144.00
Bill of Material Change Department	$288.00
Manufacturing Engineering	$ 88.00
Matrial Cancellation Approvals	$ 61.88
	$1279.88

Chapter VI

Discussion of Results

Cost Summary

The results of the study revealed that combining the four boxes into one, resulted in a definable annual savings of $4,454.49. They also revealed a definable annual cost increase of $281.29 and an additional potential cost increase of from $0.00 to $4,292.93, resulting in a potential increase of from $281.29 to $4,574.22. The total cost effects of the study ranged from a maximum annual savings of $4,454.49 to a maximum annual cost increase of $119.73.

From experience and knowledge gained during the study, the author anticipated that the actual effect on the Company's profit was much closer to the $4,454.49 cost savings than to the $119.73 cost increase. The following analysis was an attempt to arrive at the actual costs involved.

Estimated Actual Costs

Most of the additional requirements for 194.4 cubic feet of storage space in the parts department were absorbed by the storage space that was already available. A conservative estimate was that the actual cost increase for storing the larger carton would be only one third of the maximum possible or $100.00.

Due to the fact that only ten percent of the master containers shipped fully loaded, most of the annual requirements for the additional 777.70 cubic feet of master shipper space requirements was also absorbed in the existing capacity. A conservative estimate was that the actual cost increase for master containers was only one fourth of the maximum possible or $225.00.

The additional distribution costs resulted from the additional weight of .177 pounds per package. To increase the cost of a UPS shipment, six parts packed in carton #1 were required to increase the total weight of a master container by one pound or the original weight of the master container had to have been within .177 pounds of the next higher rate point. It was conservatively estimated that this would affect no more than 50 percent of the standardized boxes. This resulted in a realistic UPS shipping cost increase of $1,336.00.

To increase the cost of a Common Carrier shipment, the .177 pound increase or some multiple of it, had to apply to a master container that was near to or over the minimum weight for its destination. Due to the fact that an estimated 80 percent of common carrier shipments shipped below the minimum weight, the additional weight of the larger package increased the distribution costs only 20 percent of the time. It was estimated that the actual cost increase for common carrier shipments was a similar 20 percent of the maximum, or $82.00 annually.

A summary of the cost increase resulting from these estimates has been given in Table 17.

Actual Cost Summary

Combining the estimated cost increase of $1,743.00 with the dunnage cost increase of $281.29 resulted in a total cost increase of $2,024.29. Combining this cost increase with the $4,454.49 cost savings resulted in a $2,430.20 annual savings for the Company. The $1,279.88 implementation expense was recovered in roughly seven months, making this a very attractive investment for the Company. Even using conservative estimates, the results of the cost analysis revealed an attractive savings resulting from simplification.

Table 16

Estimated Actual Cost Analysis

Cost Areas	Range	Estimated Actual Cost	Percentage of Maximum
Storage Costs			
Packaged Parts	($0.00 - $306.00)	$100.00	33%
Master Container Costs	($0.00 - $902.98)	$225.00	25%
Distribution Costs			
UPS	($0.00 - $2671.95)	$1336.00	50%
Common Carrier	($0.00 - $412.00)	$82.00	20%
	($0.00 - $4292.93)	$1743.00	

Potential Benefits

The savings percentages given in the results of the study showed the savings potential for a higher volume operation. The annual usages of these cartons, from 3,000 for carton #1 to 9,600 for carton #3 and even the combined total of 24,000 for all four, were quite low from an industry wide view point. Applying the 66.7 percent main warehouse space savings, the 75 percent storage area savings in the parts packing area and the 24.5 percent reduction in the average cost of the boxes to a high volume operation would have tremendous cost saving potential.

Table 17

Final Cost Summary

Total Defined Costs	$281.29		
Total Estimated Costs	$1743.00		
Total Annual Cost Increase	$2024.29		
		Total Annual Cost Decrease	$4454.49
		Total Annual Cost Savings	$2430.20

Department Cooperation

Overall, all of the Company departments interviewed were very positive about the substitution of the boxes. All departments were very willing to share their information for the research. Only those areas that were strictly a paperwork type function, like the drawing change group and the bill of material change group, seemed only to be concerned with their own work effort. Neither department opposed the project, but neither were they in favor of the extra work.

Substitution Example

A question obvious to the reader and one that confronted the author early in the study was, why replace box #3 which originally cost $.145 with box #1 which cost $.148? The answer lay in the overall costs in the system. If box #3 had been eliminated from the study, its annual usage would have been lost from box #1's higher volume buying power. This would have raised the cost of the remaining 14,345 boxes by considerably more than the $28.98 (.003 x 9659) savings that resulted from keeping box #3. There would also have been savings lost due to storage space requirements, purchasing costs and all of the other savings areas. This again pointed out that the true cost effects were only found by examining all of the factors involved.

Chapter VII

Conclusions of the Study

The study verified the author's hypothesis, that simplification of the number of different size shipping packages was beneficial to a corporation's total system and resulted in increased profits. The study revealed that combining four similar sized cartons into one, resulted in a $2,430.20 annual cost savings to the Company, with a seven month payback of the one time $1,279.88 implementation expenses.

The savings resulted from reduced material costs due to higher volume buying reduced ordering costs due to the reduced number of purchase orders required and reduced storage and inventory costs due to the reduction in the number of items stocked. Cost increases were realized in increased dunnage and distribution costs which resulted from the expanded use of the larger box. These cost effects were consistent with the theories and examples found in the literature.

The study also verified the potential danger of simplification in the packaging area. That danger was in looking at the obvious effects and not considering the effect on the total system and the ultimate effect on the Company. Eliminating the three boxes had obvious effects on packaging and distribution, but it also affected 16 other areas of the Company. In this study, most of the effects were positive, but the potential existed for having the positive results in the obvious areas out weighed by negative results in other areas.

Simplification of packaging materials has cost saving potential. Every manufacturing operation and every simplification effort will be unique. To determine the benefits of simplification for a company, the effects on the total system must be analyzed.

Chapter VIII

Recommendations

It was recommended by the author that boxes #2, #3 and #4 be cancelled and replaced by box #1. It was also recommended that other similar size boxes be evaluated for further simplification. The steps taken in this study were to be followed to determine the overall savings potential.

Chapter IX

Areas For Further Study

As a result of the study, the following areas were identified as having potential for further study in the area of packaging material simplification.

1. An in depth analysis into any one of the 18 areas that were identified in the study.
2. A determination of the effects of packaging material simplification on export shipments.
3. A determination of the effects of packaging material simplification on air shipments.
4. A more in depth study into the use of the larger carton and the effects of the trucking industry rate system.

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