WAREHOUSE MATERIALS HANDLING IN THE FOOD CHAIN INDUSTRY

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This is to certify that the

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WAREHOUSE MATERIALS HANDLING IN THE FOOD CHAIN INDUSTRY

By

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TABLE OF CONTENTS

LIST OF FIGURES

CHAPTER I

INTRODUCTION

Purpose of Study

It is the purpose of this study to take the basic principles of materials handling and to show how these principles have been adapted and applied to the problems involved in operating a grocery warehouse. This study will show the methods and equipment that have been adopted in compliance with these principles and will point out how handling efficiencies and economies have resulted through the adoption of these basic principles. It will point out the factors that contribute to an efficient operation. It will also seek to point out certain areas in the grocery warehouse operation where these materials handling principles have yet to be widely applied. These areas represent phases of the operation where greater economies and handling efficiencies may be realized in the future. This work will also present certain measuring devices and yardsticks to be applied to the grocery warehouse operation to determine its efficiency and effectiveness. No discussion of the relative efficiencies of different methods of operation would be complete without some mention being made of the means by which these efficiences can be measured.

Scope of Study

This work will be limited to a study of the equipment, methods and layout of the single-story grocery warehouse as operated by a food chain store organization. It is implied in this study that the warehouses described handle a sufficient tonnage of merchandise to warrant the use

of the mechanical handling equipment described. For many smaller warehouses the purchase of certain materials handling equipment cannot be justified on an economic basis. This study is limited to the larger warehouses of the corporate chains, units serving an average of 50 stores or more. The study is also limited to single-story grocery warehouses, rather than including all types, in order that the field may be thoroughly covered. There are many multiple-story operations but most of these are housed in buildings designed and constructed before modern materials handling methods were evolved. As a result they are often not suited to the adaption of the best materials handling methods. The inclusion of this type of operation would contribute little if anything over and above what can be learned from the single-story warehouse about the application of modern materials handling methods to this business.

Warehouses often handle, in addition to groceries, both produce and meat items. A discussion of the handling of meats and produce has been omitted from this work in order that the handling of dry grocery items may be covered thoroughly. The problems involved in handling meat and produce are quite different from those connected with dry grocery items. Due to their perishability the former products require refrigeration in many instances and a very rapid rate of turnover. Also the nature and physical characteristics of these products as they are received by the warehouse require special handling techniques. None of these factors are present with respect to the handling of dry grocery items. Also the advent of centralized prepackaging for both produce and meats greatly complicates and radically alters the structure of the handling operation as performed by the warehouse. Centralized prepackaging involves processing to be

carried on in the warehouse, while on the grocery side there is no processing done in the warehouse. These factors indicate that enough substantial differences exist in the materials handling problems involved in dry grocery items on the one hand and produce and meat items on the other hand so that the two classes of merchandise should be treated separately.

Most warehouses also handle the cartons and corrugated boxes which are returned from the store. This material is baled at the warehouse and sold to a paper company. This operation will not be included in the present study as it is not of major importance in grocery warehousing. Many warehouses also serve as manufacturing plants for certain items, such as mayonnaise, jams and jellies, but the materials handling procedures and problems incident to these operations will be excluded from the scope of this study. The study then will deal specifically with the receiving, handling and dispersal of merchandise into and from the warehouse and the problems attendant therefrom. This is the core of the grocery warehouse operation.

It might be mentioned here that when the term "warehouse" is used it will be taken to mean a single-story grocery warehouse which serves chiefly as a distribution center. The term will be used in this sense unless otherwise noted.

Certain areas of materials handling, such as truck operator training, plant safety rules and regulations, proper truck and other equipment maintenance and repair, truck operating performances and costs, description of computation of aisle widths, description of effects of floor surfaces on handling efficiency have been discussed only very briefly or not at all. The reason for this is that such information is readily available in any

good book on industrial materials handling and does not warrant repeating. It has been the purpose of the author to limit this work to a presentation of material in a manner that has not been done previously. Some aspects of materials handling (such as the ones mentioned above) remain unchanged whether they are applied to an industrial manufacturing concern or to a grocery warehouse. Other factors take many different forms (from the manufacturing case) when applied to the grocery warehouse. It is the purpose of this work to present only these factors that take a different form and that have not been so presented before. The basic materials handling principles are the same no matter what the application, but the actual details of the principles in operation often vary considerably between the manufacturing company and the grocery warehousing operation.

Historical Background

Warehousing operations have always played a role in our marketing system. In the food chain industry, one of the initial advantages of the chains was their ability to purchase large quantities of foods and thus take advantage of many quantity discounts. The individual stores were fairly small units and they could not handle these large quantities of merchandise. As a result, there was a need for a central receiving area where these goods could be handled and broken down into quantities suitable for each store. Thus, the grocery warehouse came into existence. The grocery warehouse still performs the same function today as it did when it was first used. Although there have been many transformations in the appearance and operation of the warehouse, its purpose is still to serve the stores. In recent years this purpose has been somewhat modified and

extended. The purpose of the warehouse is still to serve the stores but, in addition, it should do this at the least possible cost and in the most efficient manner. More and more the operation of a food chain store company is being viewed as the integrated coordination of the various departments of the company. The warehousing division was once regarded as being one of the least important departments connected with the company. Buying and selling were the activities that predominated and to which other operations were subordinated. This view has been modified to some extent. Now it is held that in order to obtain the best overall results all departments of the organization must work together in achieving their individual objectives which are designed with the view of furthering the major objectives of the entire company.

The following chapter will be devoted primarily to a further discussion of the important role that warehousing plays in a food chain store organization.

Source of Data

There are many books available on the subject of industrial materials handling. These books give much information on the application of materials handling methods to production line operations and to industrial storage problems. However, the grocery warehouse is neither a manufacturing operation nor primarily a storage operation. From the books on industrial materials handling there have evolved certain principles of materials handling which can be applied to any handling situation. Most of the information on the grocery warehouse operation has been obtained from two main sources. The first of these sources includes government, trade and indi-

vidual company publications. These publications generally describe certain aspects of the operation of the grocery warehouse, but this is done without any reference to materials handling principles as such. The other source of information, and one that has proven most valuable, has been personal visits to several chain store warehouse operations.

The American Stores Company, Philadelphia, Pennsylvania, and in particular Mr. Richard Trester, Assistant to the Vice President in Charge of Warehousing and Transportation of that company, have aided considerably in providing information of value to this work.

CHAPTER II

THE ROLE OF WAREHOUSING IN THE FOOD CHAIN INDUSTRY

The Webster Dictionary defines a warehouse as a storehouse for wares, or merchandise. In the food chain store business the primary function of the warehouse is to serve as a distribution center and not as a storage center. The sole reason for the existence of the warehouse is to serve the stores of its chain in the most efficient manner at the least possible cost. The food chain business is concerned chiefly with the selling of various food and related products, as opposed to other types of business such as manufacturing. The retail stores are the heart of the food chain operation. The function and purpose of the warehouse is one of service. This service is to provide the stores with the goods they desire when they are desired. However, the warehouse cannot provide this service by itself. The warehouse must work closely with the buying, sales and merchandising departments. It is these departments that determine what items to carry and what items to discontinue. The warehouse merely serves to distribute these items to the stores as they are needed. The warehouse department can operate more efficiently if it knows when to expect shipments of merchandise purchased by the buying department. This is particularly true when unusually large purchases have been made. The warehouse division must work with the sales and merchandising departments in order that it may be aware of special sales and promotions so that it can plan to handle adequately the increased tonnage of the advertised items during the promotion. Thus, it can be seen that the warehouse division does not and cannot operate by itself in serving and distributing merchandise to the various stores of

the chain. To have the most efficient operation the warehouse division must work in close harmony with the other divisions of the organization.

In order to illustrate better the relationship between the warehousing and other departments of a food chain store company, two organization charts are presented on the following two pages. The first chart illustrates the organization of the Great Atlantic and Pacific Tea Company and the second shows the organization of the American Stores Company. As can be seen from these charts the warehousing operation works directly with the various other departments of the organization such as the merchandising, traffic and transportation, accounting and real estate departments. The warehousing department must work with the accounting department in that the warehouse operation must keep certain records on the costs of its operations and it also provides the buying department, at regular intervals, with inventory figures on the various items in stock at the warehouse. The warehouse department must also work with the real estate department. In locating a new store consideration must be given to which warehouse will serve that store and to the distance of the store from that warehouse.

The warehouse must not only serve the stores in the most efficient manner possible, but it must serve the stores in the most efficient manner consistent with the least possible cost. To some, the phrase "the most efficient manner" might automatically denote the least possible cost but this is not always the case. From the store manager's or superintendent's point of view, the most efficient manner often means that the warehouse should cater to every whim and fancy of the store manager in supplying him with merchandise. This type of thinking is concentrated on getting the

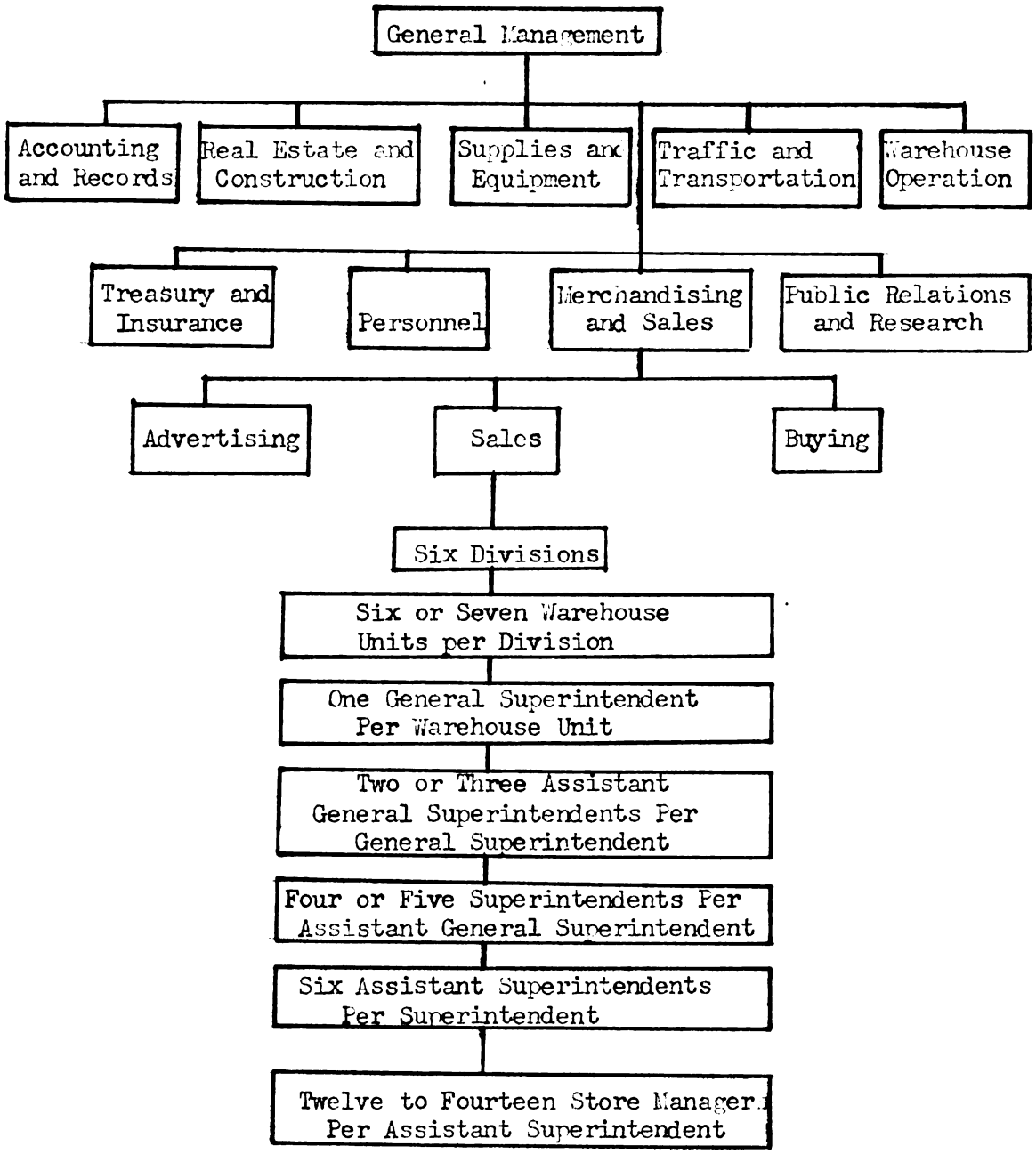

Fig. 1. Organization chart of the Great Atlantic and Pacific Tea Company[1]

1 Duncan and Phillips, "Retailing Principles and Methods", Chicago: Richard D. Irwin, Inc., p. 184.

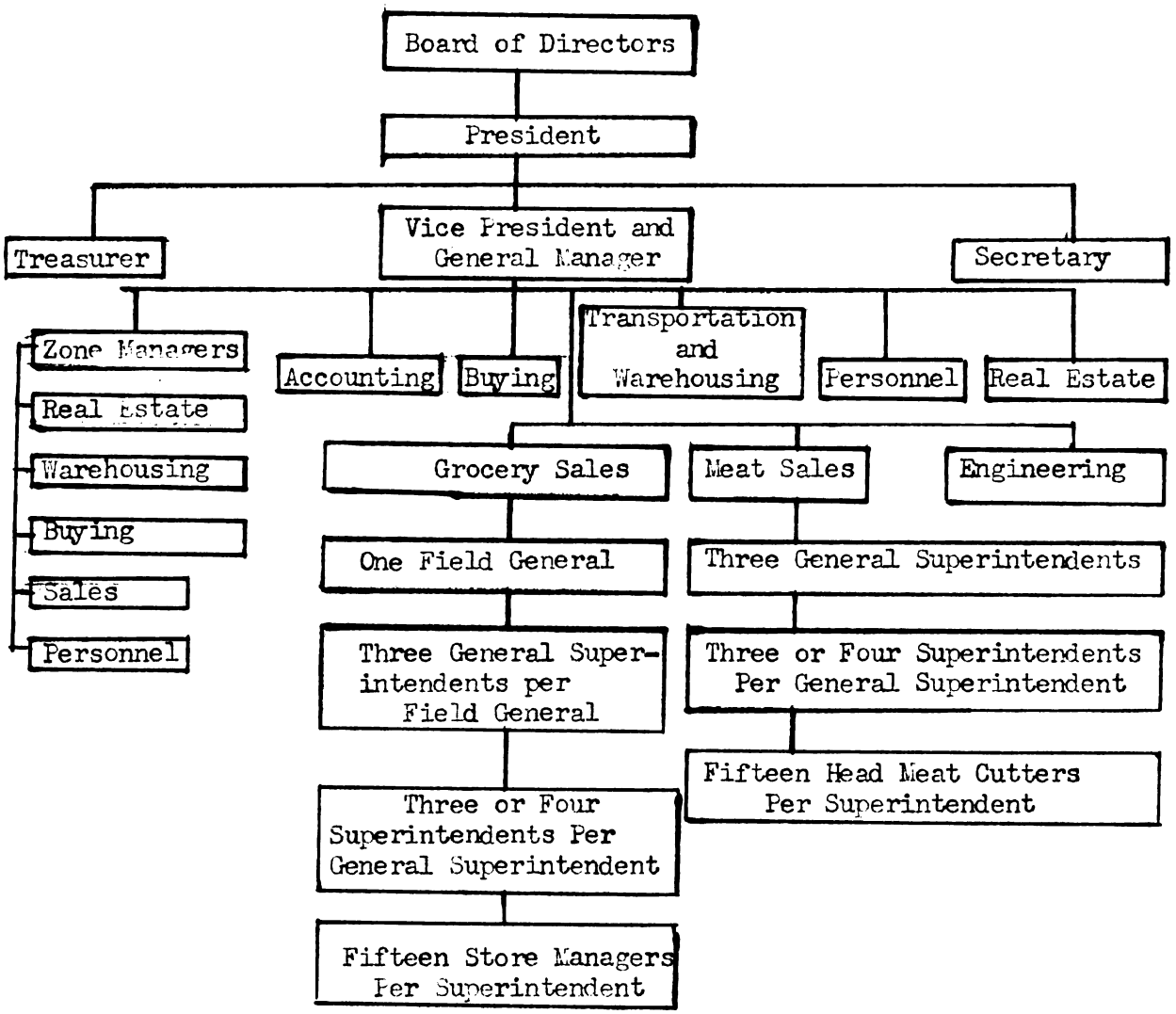

Fig. 2. Organization chart of the American Stores Company

merchandise in the store and on having the warehouse serve the store, but it is completely oblivious to the costs involved in doing so.

Warehouses in the food chain industry exhibit a wide range of operating costs and efficiencies. A recent report by the National Association of Food Chains[2] gives information on the operating efficiency of the warehouses of the 40 reporting food chain store organizations. The chief guide to the operating efficiency, a measurement giving the tons of merchandise handled per man-hour of labor[3] ranges from 0.64 for the least efficient operation to 2.79 for the most efficient operation, a range of over 400 percent. Even within one company operating half a dozen or more warehouses, the range can be just as great. Warehouse expenses, expressed as a percentage of the cost value of the merchandise shipped to the stores, range from about 0.5 percent to over 3.5 percent. The average is about 2.0 percent. This is based upon wage and cost rates prevailing during the latter half of 1950. Assuming that the food chain makes an average gross markup of 18 percent, then a simple calculation will show that a warehouse operating expense of 2.0 percent of the cost of the merchandise sold will work out to 9.2 percent or about one-eleventh of the gross profit (margin). Inefficient warehouses, the operating expense of which is as high as 3.5 percent of the cost of the merchandise delivered to the stores will use up

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2 "Food Chain Grocery Warehouse Operating Efficiency - February 1951", National Association of Food Chains Bulletin, April 21, 1951, p. 11.

3 The National Association of Food Chains data includes only labor hours spent in receiving, stowing, selecting, transporting to shipping platform and loading freight for shipment. It excludes janitor, maintenance, strictly clerical or supervision time unless actually engaged in physically receiving, stowing, selecting or shipping freight. The tonnage part of the measurement consists of the tons of merchandise received into the warehouse plus the tons of merchandise shipped out of the warehouse.

as much as 16 percent of the gross margin made on the sale of that merchandise. Viewed in this light, the warehousing function assumes a significant role in the operation of a food chain store company. Thus, it is in the best interests of the company that the warehouse operation be made as efficient as possible. For a chain with a sales volume of $100,000,000 annually, an increase in the operating efficiency of the warehouse of only one-tenth of one percent would result in a direct savings of $100,000 annually and an increase in profits by this amount (other factors being constant). It must be remembered that excessive handling of the merchandise in the warehouse does not add to its value, but only results in detracting from the profits of the company. Clearly then, when warehouse operating expenses range from 0.5 percent to 3.5 percent of the cost of the merchandise sold, there is a great deal of room for improvement in many operations.

Since warehouses in the food chain business are essentially distribution centers, the problem involved resolves mainly into one of efficient materials handling procedures. Industrial materials handling is concerned to a great extent with the inter-departmental shipments of goods in the various stages of manufacture. Goods with widely varying sizes, shapes and weights have to be transported from one department to another. Materials are received, processed and shipped. In contrast to this, the grocery warehouse receives and ships merchandise. No processing, in the manufacturing sense of the word, is done in the dry grocery warehouse. Nearly all the merchandise handled comes in corrugated cartons whose weights seldom run over 60 pounds per unit and whose maximum dimensions are usually less than 30 inches. In many respects handling problems are

much simpler in the grocery warehouse than in the case of a manufacturing concern. However, the relatively standardized physical characteristics of the items carried has by no means tended to limit the number of solutions to these problems.

Before presenting a more detailed analysis of the materials handling operations and problems incident to grocery warehousing, it would be well to outline briefly a description of the operation in its entirety to serve as background for the material to follow. Figure 3 shows an organization chart of a typical grocery warehouse operation. The chart indicates that the company represented is divided into several zones of operation, each zone being headed by a zone manager. Each zone has one or possibly two warehouses in it and thus one or two warehouse superintendents who are generally responsible to the zone manager. In the main office, there is a director of warehousing. The zone manager is subordinate to the director of warehousing in matters pertaining to the warehouse operation. These three groups, the zone manager, the warehouse superintendent and the director of warehousing, must work in close harmony although the director of warehousing often works directly with the various superintendents.

A description of the warehouse superintendent's duties will be of interest here in order to get a clearer understanding of his job and of the warehouse operation. The warehouse superintendent's duties generally are as follows:

1. Supervise and assist subordinates with production goals
    a. By introducing new and better methods
    b. Install mechanization wherever practical
    c. Periodic meetings with foremen and supervisors

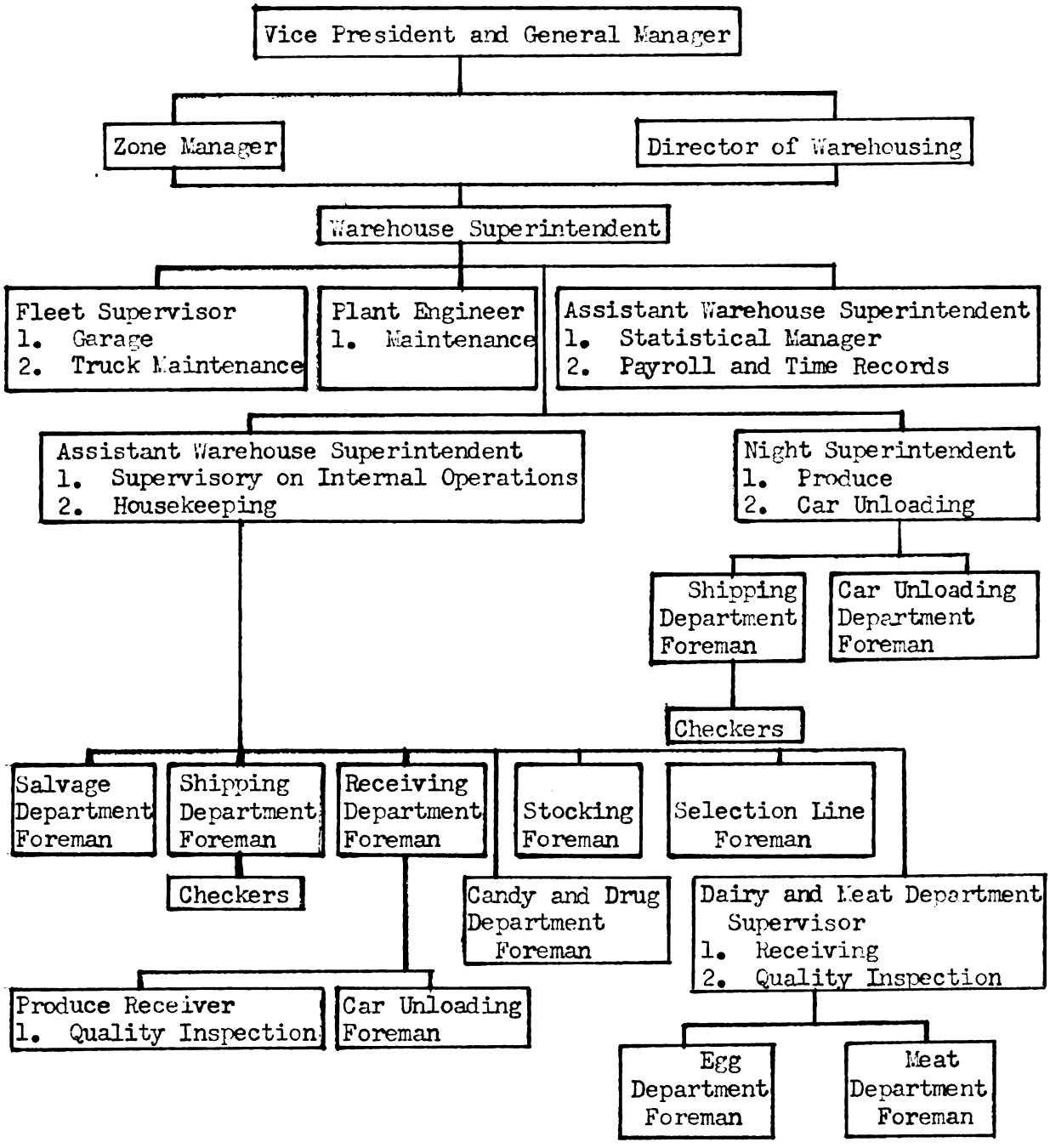

Fig. 3. Typical Warehouse Organization Chart

d. Regular inspections of all operations

e. Review scheduling of work periodically to keep an equalized daily workload

2. Participate in discussions of procurement with the buying department

a. Review with buyers the workable limits of operation

b. Expedite car and truck unloading and give priority to the handling of scarce items

c. Do not allow the warehouse to become overstocked

d. Maintain a real schedule to minimize the buyer's guesswork

3. Participate in discussions on distributions and promotions with sales department

a. Insist on equalization of workload from this department

b. Arrange distributions of heavy moving items

c. Review orders from stores to promote intelligent ordering

d. Review with sales department movement of items both for elimination of slow movers and relocation of fast movers

4. Closely supervise transportation operation

a. Work with superintendents and sales manager on store delivery times

b. Stay on time with deliveries and insist on expeditious handling at the stores

c. Review routes and loads with shipping foremen

d. Maintain proper care of equipment

5. Warehouse planning

a. Analytical surveys and operational layouts

b. Cognizance of utility costs

6. Store Planning

a. Delivery aspects of store unloading facilities

The foregoing gives a fairly descriptive picture of the principal duties of the warehouse superintendent who is responsible for the overall efficiency of his operation. Some of these duties are observed more in theory than in practice at the present time.

To gain an understanding of the basic function involved in the grocery warehouse, one might think of the operation as that of receiving and distributing goods. The storage function is secondary. About 1,500 to 2,800 different types of merchandise flow through the typical grocery warehouse, the average number of different items being about 2,100. Merchandise is received in bulk quantities and distributed to the stores in mixed lots. This is the heart of the whole warehouse operation. To make this point more clear, the following illustration is presented. Merchandise is received as follows: shipment 1, 1,000 cases of item A; shipment 2, 1,500 cases of item B; shipment 3, 1,500 cases of item C and 1,000 cases of item D; and so on. This merchandise is then distributed to the stores in the following manner: shipment 1, 1 case of A, 3 cases of B, 1 case of C and 2 cases of D; shipment 2, 2 cases of A, 1 case of B, none of C and 1 of D; et cetera. The merchandise that is received in bulk quantities lends itself very well to efficient materials handling methods. It is the selection and collection of this merchandise into distribution units, which are comprised of a great many different items and only a few cases of any given item, which present the greatest materials handling problems.

Goods are delivered to the warehouse either by truck or by rail. Railroads formerly delivered almost all the merchandise but in recent years the trucking industry has been steadily encroaching on this phase of the railroad's business. Now, deliveries are split about evenly between the

railroads and trucks. There are many regional and local divergences from this pattern, of course, but the overall trend has been and can probably be expected to continue in favor of truck deliveries over the railroads. Adequate provision must be made in the form of unloading docks for both rail and truck deliveries. The typical warehouse procedure is as follows: As the merchandise is unloaded, by the unloading crew, from the carrier, it is placed on pallets. The stocking crew, equipped with electric or gasoline fork lift trucks, takes the pallets from the receiving area to that part of the warehouse in which that particular item is kept. An effort is made to keep the entire stock of any given item in one location and not have that item stored in two or more different locations throughout the warehouse. This is not always possible, however, as will be shown later. Most modern warehouses are divided into two major areas, one being the selection line area and the other, the reserve storage area. The selection line, or assembly line as it is sometimes called, is an arrangement of the active stock so that the order picker can assemble individual orders conveniently and rapidly. The layout should be such as to permit the selector, or order picker, to assemble any order in a once-around walk along the length of the selection line. The sequence of goods on the selection line must be the same as that in which the goods are called for in the order. The reserve storage area contains those items which are too bulky to be placed on the assembly line, such as toilet tissue and those items with a volume so large that it is easier to select directly from the storage area, rather than to be continually restocking the selection line. The reserve storage area also contains stocks of some items carried in the selection line. This occurs when the entire stock cannot be placed in the

selection line or in the limited reserve space directly above the selection line. As merchandise is removed from the selection line, it is the stocker's duty to refill the selection line from the merchandise that is stored either directly above the selection line or from merchandise that is located in the reserve storage area.

The next step in the movement of goods through the warehouse is order picking. This is the process whereby the goods are rearranged into mixed lots which constitute the store orders. The selector moves along the selection line taking a case here, two cases there, and so on until he has assembled his order. One source[4] puts it in the following words: "This is the job of pulling down, case by case, the block of goods which has been kept intact because of commodity likeness and building it up into a new block having destination likeness." This selection process has always been a case by case hand operation and it probably always will be. The use of the selection line layout has greatly improved the efficiency of this operation. However, this particular job, that of selecting the various orders, still offers one of the greatest opportunities to improve materials handling efficiency in the warehouse. After the orders have been selected, they must be checked. The checking usually does not involve physical handling of the goods but is merely an independent operation to check the items against the order sheet so that any possible errors on the selector's part may be remedied. Checking is also a case by case process. There have been doubts expressed from time to time as to the necessity of the checking function. Some say that it is necessary and others claim that the

4 "Streamlined Wholesale Grocery Warehouses", Washington, D.C., United States Department of Commerce, Industrial Series No. 18, 1945, p. 33

selector can check his own work. In connection with this it is interesting to note that the further west one proceeds, the less separate checking there is of merchandise.

After the orders have been checked, or not, as the case may be, they must be loaded onto the waiting trucks. Depending on the individual chain and on local characteristics these trucks may be owned by the company and driven by company men or they may be owned and operated by contract carriers. If the trucks are owned by the company, they are loaded by a warehouse loading crew and the cost of this operation is charged against the warehouse. If the trucks are operated by contract carriers, the drivers load the trucks and this operation is not performed by a warehouse crew. The trucking rates, of course, are set so that they will cover the cost of the loading. Regardless who performs this task, there is still a great need for improved efficiency and speedier methods. The reason for this is that the operation still remains essentially a hand one where cases of merchandise are removed from the selection trucks one at a time and packed into the delivery truck.

The foregoing covers fairly well the flow of merchandise through the grocery warehouse. Before closing this chapter, though, it might be well to mention briefly a few of the significant differences between the single and multiple-story operations as far as materials handling is concerned even though the multiple-story warehouse will not be discussed further. While the single-story warehouse has a net useable floor space of about 96 percent of the gross area of the building, the multiple-story warehouse only has a net useable space of 82 percent of the gross building area. The difference is due mainly to thicker walls and columns, stairs and

elevators. The chief difficulty or fault with the multiple-story warehouse is that the elevators are often inadequate to handle efficiently the tonnage involved and due to this fact congestions and delays often develop at this point. Another difficulty with the multiple-story building is that ceiling heights are often only ten or twelve feet. This does not permit high stacking of merchandise. In the multiple-story warehouse, each floor can be laid out with its selection line and reserve storage areas just like the single-story arrangement. Mechanical towlines have not been found advantageous in multiple-story operations. Heavier moving merchandise is generally placed on the lower floors so that it will have less distance to travel.

CHAPTER III

MATERIALS HANDLING PRINCIPLES AND EQUIPMENT

Materials handling is as old as history itself. However, handling techniques have generally lagged behind production techniques. As far back as the Civil War two wheeled hand trucks, conveyors, cranes and hoists were in general use in American industry. Between the Civil War and World War I though there was relatively little progress made in the field as compared with the great amount of progress that was made in the field of production. It was World War II, sometimes known as the "War of Supply", that gave materials handling its greatest boost and really developed it into a science in its own right. The field today is one that is growing by leaps and bounds as management becomes increasingly aware of the savings that can be effected through improved methods. Today the increasing cost of unskilled labor and the lack of availability of building space are two of the main reasons responsible for the continued interest in this field.

Just what is materials handling? Materials handling implies the movement of materials, horizontally, vertically, and a combination of both. Harry E. Stocker,[1] Assistant Professor of Transportation, New York University, puts it this way; "All materials handling is transportation, and all transportation is materials handling". This definition is rather broad and excludes the storing of goods which is also a handling function. Another

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1 Harry E. Stocker, "Materials Handling", New York, Prentice-Hall, Inc., 1946, p. 1.

source[2] gives the following definition:

> Materials handling is the mechanical handling of materials by machines scientifically applied to achieve maximum efficiency. Its application includes the materials handling requirements of receiving materials, of moving them through production and of warehousing and distributing finished products.

Perhaps a better definition and one which more nearly approaches the true meaning is the following one given by Curtis H. Barker, Jr.,[3] Sales Manager, Pallet Loader Division, Lamson Corporation, Syracuse, New York.

> Materials handling is the picking up and putting down, moving of materials or products in any plane or combination of planes, by any means, which includes storage and all movements except processing operations and consumption or end use of this material.

The storing of goods is technically a materials handling function in that the goods in storage are occupying space and using equipment such as pallets and skids.

The main objective of materials handling is to save money. While business is always trying to reduce costs wherever possible, it is, nevertheless, true that handling a product does not add to its value. Therefore, less handling means a reduction in costs. A second objective of materials handling is to save time. The more pieces or pounds of materials that can be handled in a given operation, the more time that is saved. A third objective of materials handling is to save manpower. This is especially important in times like the present when manpower is scarce and should be utilized with the greatest efficiency possible. One source[4]

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2 "Materials Handling", General Electric Co., Schenectady, New York, 1948, p. 6.

3 Curtis H. Barker, Jr., "Industrial Materials Handling", Cleveland: The Lincoln Extension Institute, p. 6.

4 "Materials Handling", General Electric Co., Schenectady, New York, 1948, p. 6.

gives the following breakdown of the objectives of materials handling:

> Materials handling should promote good building utilization, make men more productive, speed and smooth production and distribution, reduce packaging problems, materials, and costs, increase efficiency in the use of boxcar and other transportation equipment space, speed loading and unloading, reduce demurrage, keep transportation equipment on the road, make safer working conditions, decrease damage, breakage, and pilferage, decrease dunnage, and bracing, and improve cost and inventory control.

These objectives, while originally written with an industrial operation in mind, can be applied equally well to the chain store grocery warehouse.

Over the years there has evolved a set of basic principles or fundamentals of materials handling. They are often stated in varying forms but their underlying meaning is the same. These principles must be always kept in mind because they act as guideposts in establishing a materials handling system, and also because they help in evaluating a given handling system and enable one to point out certain areas of improvement. Any worthwhile appraisal of a materials handling system cannot be made without a knowledge of the fundamentals involved. It is with this thought in mind that the following ten principles are presented.

1. Materials handling operations are only as good as the physical layout of the plant will permit.

2. Continuous material movement is most economical.

3. Standardization of methods, types and sizes of equipment is desirable for good materials handling efficiency.

4. Storage space is best measured in terms of cubic content.

5. Materials handling economy is directly proportional to the size of load handled.

6. Equipment built for motion should be kept in motion; idle equipment should be as inexpensive as possible.

7. The value of equipment is directly proportional to its flexibility.

8. The use of mechanized equipment instead of manpower generally increases efficiency and economy in handling.

9. The ratio of dead weight to pay load must be kept to a minimum.

10. Productivity increases as working conditions become safer.[5]

In order that these principles may be more clearly understood, a few words of explanation will be given here for each. The first principle states that materials handling operations are only as good as the layout of the plant will permit. This is probably the most important single point. As will be shown in the next chapter, the layout of the warehouse has a determining effect on its efficiency. Layout relates to such factors as the location and amount of space devoted to receiving, shipping, selection area, storage area and width of aisles. Layout determines the flow of traffic through the warehouse and the distance that the merchandise has to be moved. The lines of traffic should not cross, if at all possible. The more these lines of traffic cross each other, the more congestion there is going to be in the warehouse. This tends to reduce the efficiency of the operation. The distance that the merchandise is moved should be kept to a minimum or, to be more exact, the ton-mileage factor for the warehouse as a whole should be kept to a minimum. The ton-mileage figure for any item is the product of the distance that the item must move in passing through the warehouse times the average tonnage of that item handled during the time interval being measured.

Principle number two states that continuous material movement is most economical. This means that materials handling efficiency is greatest when it approaches a steady flow of merchandise through the warehouse. Goods should flow in as straight a line as possible, with minimum

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5 Curtis H. Barker, Jr., "Industrial Materials Handling", Cleveland: The Lincoln Extension Institute, p. 35.

interruptions and backtracking, and approach a continuous rather than an intermittent flow. This principle is probably harder to follow in practice in the grocery warehouse type of operation than in the industrial manufacturing plant. The use of the tow line and the car aisle are two techniques that have been adopted in conformity with this principle.

The third principle is concerned with standardization of methods, types and sizes of equipment. This is important because it allows interchangeability of equipment between departments and between warehouses. It allows the stocking of fewer replacement parts and simplifies maintenance. It simplifies the problem of training employees to use the equipment. However, standardization should not prevent the adoption of new and better equipment and methods when they are presented. Standardization involves careful selection of the right equipment for the right job, as a poor selection of equipment is worse than having no standard at all.

The next principle is that storage space is best measured in terms of cubic content. Warehouse operators formerly thought in terms of area as the limiting factor in determining storage capacity. Today, with the advent of fork lift trucks, pallets and pallet racks enabling merchandise to be stacked 15 and 20 feet high, warehousemen must now think in terms of volume rather than area. Grocery warehouse operators are especially aware of this fact. The capacity of some warehouses has been doubled by the use of high tiered merchandise which now occupies space that was unused previously.

The fifth principle states that materials handling economy is directly proportional to the size of the load. As the size of the load increases, the greater are the savings that are realized. Stated in another way, the

more pieces that are carried per trip the fewer trips that will be required to handle a given volume of merchandise. Of course, there are practical limitations on the size of the load than can be handled at one time. Some of these limitations are imposed by the nature of the building itself, such as door widths and heights, elevator capacities, column centers and floor load limits. The layout of the warehouse with respect to aisle widths represents another limitation on the size of the load. Railroad freight car and truck body sizes will also help to determine the maximum size load that can be handled. A final limiting factor is the size and capacity of the mechanical handling equipment that is used. The unit load idea is one application of this principle.

The sixth principle indicates that equipment built for motion should be kept in motion, and that idle equipment should be as inexpensive as possible. This means that powered equipment, such as a fork lift truck, must be kept in use if it is going to pay for itself. Expensive equipment of this nature is bought to be used and not to remain idle. Equipment with wheels, such as four wheeled trucks, is generally more expensive than non-wheeled equipment such as skids and pallets. Wheeled equipment is built for motion and should not be used in a stationary capacity.

The value of equipment is directly proportional to its flexibility. This means that the greater variety of uses to which a given piece of equipment can be put, the more valuable it becomes from a materials handling standpoint. The fork lift truck is probably the most flexible piece of equipment in use in the grocery warehouse. Fork lift trucks can handle not only skids andpallets but they can transport merchandise horizontally and stack it vertically as well.

The eighth principle states that the use of mechanized equipment instead of manpower generally increases efficiency and economy in handling. The use of mechanized equipment must be able to justify its cost on the basis of savings obtained through the reduction in labor charges. Equipment of this type must usually be able to pay for itself within a period of a year or two years. Properly utilized, mechanized handling equipment usually can perform so much more work than the labor it replaces that it is almost always profitable to replace manpower with machine-power.

Principle nine indicates that the ratio of dead weight to pay load must be kept to a minimum. The less the equipment weighs the greater is the payload that can be carried and the greater is its productivity. The use of lighter equipment, where possible, allows the equipment itself to be handled easier. An example of this is the substitution of light metals in place of heavier steel in portable conveyors of the type often found in retail grocery stores and grocery warehouses.

The last principle states that productivity increases as working conditions become safer. The use of mechanized equipment, while removing some hazards, has created others. In seeking to eliminate these new hazards, the equipment manufacturers have generally strived to make their equipment as safe as possible. Through these efforts working conditions today are probably safer than they were before mechanized handling equipment was in use. Safer working conditions also imply cleaner plants and equipment. As conditions become safer, production increases because there is less time lost due to accidents and other work stoppages caused by cluttered and dirty buildings.

These are the basic principles, or fundamentals of the new science, if it can be called that, of materials handling. While these fundamentals were evolved primarily for industrial materials handling in a manufacturing sense, nevertheless, they can be applied equally well to the grocery warehouse situation. In the following chapter these principles will be applied to chain store grocery warehousing as it exists today. It will be pointed out where these principles have been applied and how greater production and efficiencies have been obtained through their use. Certain areas where these principles have not been applied and where efficiencies could be improved through their application will also be indicated. While many gains have been made through the use of mechanized materials handling, there is still room for further improvement.

Before applying these fundamentals to modern grocery warehousing, it would be well to have in mind the types and variations of equipment that are available for use. The grocery warehouse uses only a small portion of all the types of materials handling equipment that are available. Handling equipment can be classified into three main groups.[6] These are floor operated equipment, floor-to-floor and vertical handling group and overhead handling group. A fairly complete listing of the various types of equipment in each group is herewith presented.

1. Floor operated equipment

    a. Manual floor handling equipment (portable). This includes two wheel trucks, four wheel trucks (both the caster type and the fifth wheel type), semi-live skids and four legged skids, manual hand lift trucks (platform type), manual pallet handling

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6 Curtis H. Barker, Jr., "Industrial Materials Handling", Cleveland: The Lincoln Extension Institute, p. 46.

truck, dollies, pallets and auxiliary container type equipment (portable racks, baskets, tote boxes).

b. Power operated floor handling equipment (portable). This includes motorized non-rider hand trucks (pallet trucks, platform trucks, high lift trucks - both platform and pallet types, and straddle type trucks), industrial rider type trucks (platform load carriers, low and high lift platform trucks, fork lift trucks - both telescopic and non-telescopic types, industrial tractors, ram type lift trucks, crane trucks and straddle trucks).

c. Fixed floor handling equipment. This includes conveyors (of the non-powered gravity type and the powered types), and fixed storage containers (pallet racks, shelving, storage bins and racks).

2. Floor-to-floor and vertical handling group

a. Stationary hydraulic lift, portable elevator, four posted lifter, portable table type lifter, freight elevator, portable inclined belt conveyor, inclined continuous trolley conveyor, chute, spiral gravity conveyor, end-gate lifting devices, continuous vertical conveyor and hoists.

3. Overhead handling group

a. Cranes. This includes the following types: Overhead bridge, portable floor, powerized industrial truck and portable heavy duty cranes.

b. Overhead conveyor. This includes the continuous trolley and cableway systems.

c. Monorail system. Manual propelled and motorized travel.

The grocery warehouse uses only a few of the types of equipment available to it. However, the use of certain types of equipment at the present time should not blind one to the fact that other types of equipment are available and that changing operations or conditions might permit the use of new types of equipment in the grocery warehouse. If one has a knowledge of all the types of equipment that are available, he will be in a better position to choose and select the equipment that is best suited to his particular needs. The field of materials handling is not a static

one - quite the contrary. Newer and better equipment is being constantly introduced by the trade. Much of this equipment is designed for specialized purposes and much of it is multi-purpose. The warehouse superintendent is often faced with the problem of choosing between various types of equipment that are available. The selection of equipment always raises the question as to which handling system is the best. Generally speaking, an integrated system which is a combination of two or more systems usually gives the best results. For instance a truck-skid system can be integrated with a fork truck-pallet system, or conveyors could be integrated with a fork truck-pallet system. This is what is done in actual practice. The three basic factors to be considered in selecting equipment are as follows:

1. The volume of units handled
2. The physical characteristics of the item to be handled, such as size, weight, et cetera
3. Travel characteristics, which refer to the distance traveled.

The grocery warehouse is basically a materials handling operation. Thus, it lends itself admirably well to the adoption of mechanized materials handling systems. It has been said that the ideal handling system is one without lost motions and without manual handling. The fork truck-pallet and the lift truck-skid systems most nearly approach this ideal and, therefore, it is small wonder that these systems are the ones that are most commonly adopted in grocery warehousing. Generally speaking, grocery warehouses use some or all of the following equipment:

1. Pallets
2. Skids
3. Fork trucks

4. Low lift and high lift platform trucks

5. Motorized pallet hand trucks

6. Continuous overhead chain conveyor (often referred to as the "tow line")

7. Four wheel hand trucks

8. Pallet racks

9. Mechanized and gravity floor conveyors

The specific types of equipment used (there are dozens of different types of pallets, for example) and their actual applications in practice will be discussed throughout the next chapter as the ten basic materials handling principles are applied to the problem of grocery warehousing. This chapter will demonstrate how these principles actually are applied, or not applied, as the case may be.

CHAPTER IV

APPLICATION OF MATERIALS HANDLING METHODS TO GROCERY WAREHOUSING

In the last chapter ten basic materials handling principles were presented. It is the purpose of this chapter to show how these principles have been and can be applied to the modern grocery warehouse and to show how increased operating efficiencies and economies have resulted from their application. This chapter will also seek to point out where there is further room for the application of these principles.

The first principle states that "materials handling operations are only as good as the physical layout of the plant will permit". Aside from the use of mechanized equipment such as fork lift trucks, the layout of the warehouse is probably the most important single factor contributing to the operating efficiency. Grocery warehouse layouts have undergone many changes in the past few years, and these changes have been accompanied by the introduction of new and better equipment.

Before giving an actual example of a warehouse layout, it might be well to point out some of the factors that contribute to a good layout and the aims that a good design tries to achieve. Since it has been stated that the type of warehouse under discussion serves as a distribution center, rather than a storage center, it follows that the layout should be designed to facilitate and speed this distribution process. In order to do this, the first point that should be noted is that all the items carried in the warehouse should be easily accessible to the order pickers at all times. Efforts along this line have brought about the use of the selection line and the reserve storage areas, which will be described in more detail later.

Not only must the goods be accessible, but they should be handled the least number of times possible and should be moved the least distance possible. Handling and moving materials requires both time and money. Consequently, both of these factors should be kept at a minimum. A good layout should minimize the travel distance required both of mechanical handling equipment and of the workmen. Put another way, the ton-mileage factor should be as small as possible. Ton-mileage represents the total tons of merchandise handled in the warehouse (during a given period) multiplied by the distance that the merchandise must travel in passing through the warehouse. Ton-mileage can be computed by calculating the average output of each item (a rather tedious process in a warehouse carrying two thousand odd items) and measuring the distance that each item travels through the warehouse. In actual practice it is almost impossible to obtain strict application of this point. One reason is that grocery companies, for the sake of convenience, like to arrange merchandise in groups or "families". A family may consist of all baby food, all canned meat, or all pet food items. While it is convenient to locate all canned meat items together in the warehouse (as well as in the store), these items will all have different tonnage outputs. For instance, if there are 30 items in the canned meat family, it may be that 27 of these items have a relatively small tonnage movement while the remaining three items have a relatively large tonnage output. The problem is whether to keep the family intact and group the items together or to relocate the items strictly on a tonnage basis and to disrupt the family groupings. Concessions are usually made in favor of maintaining the family groups at the expense of increasing the ton-mileage figure. The family groups are then

arranged on the selection line according to their aggregate tonnage output. Of course, exceptions can always be made in the case of extremely heavy moving items. The heaviest moving (tonnage) merchandise should travel the shortest distance possible. For this reason it should be placed closest to the receiving and shipping docks. The positions in the warehouse which require the longer travel distances should be filled with the lighter tonnage merchandise.

Warehouse output is not measured in ton-miles of merchandise handled but in tons per man hour. Since mechanized equipment can handle more merchandise faster than workmen using only hand trucks, it is also the purpose of a good layout to reduce to a minimum the manual handling and movement of goods. Wherever possible merchandise should be moved with mechanized equipment. Manual handling should be limited to short hauls. Thus it is the purpose of a good layout to see that the selection line does not become too lengthy and that the end of the selection line is adjacent to the shipping docks. A good layout will also take into consideration the lines of traffic within the warehouse and will attempt to arrange these lines of traffic so that they intersect and cross one another as little as possible. Such intersections cause delays in the movement of merchandise and are also areas where accidents are most likely to occur. Good layout also insures the aisles are of the correct width. Aisles should be wide enough to permit proper operation of the lift trucks and other equipment and yet should not be so wide as to be wasteful of space. Most books on the subject of materials handling give complete information on how to measure and determine the necessary width of the aisles for a particular operation.

Having seen what some of the requirements of a good warehouse layout are, attention is now directed to a specific example in order that one may observe an actual application of these criteria in practice. The following example is a single story grocery warehouse with a total area of 101,364 square feet. Drawings are included (Figures 4 and 5) which show the relative amounts of space given to the various sections of the warehouse both before and after the layout was rearranged and modified. The following table summarizes the proportion of the total space devoted to each section of the warehouse.

	Before Alteration	After Alteration
Selection Area	36.0%	46.1%
Reserve Storage Area	39.0	25.9
Shipping and Receiving Area (Includes order assembly area)	6.2	7.4
Truck Docks	5.9	5.9
Candy and Drug Room	4.4	5.7
Offices	3.9	3.9
Salvage Area	1.9	1.9
Cooler	1.9	1.9
Shop and Chargers	0.8	1.3
	100.0%	100.0%

The selection area, sometimes called the selection line or assembly line, is that area in which the active stock is so arranged that the order picker can assemble orders conveniently and rapidly. Items are arranged on the assembly line in the same order as they are found on the order sheets. Thus, the order picker moves down the length of the line and selects the items as they are called for on the order sheet. The order picker needs to traverse the length of the selection line only once to fill the entire order. The amount of any particular item carried on the line depends on the average output of that item. Usually an effort is made to keep about one week's supply of each item on the line. The stock on the assembly line

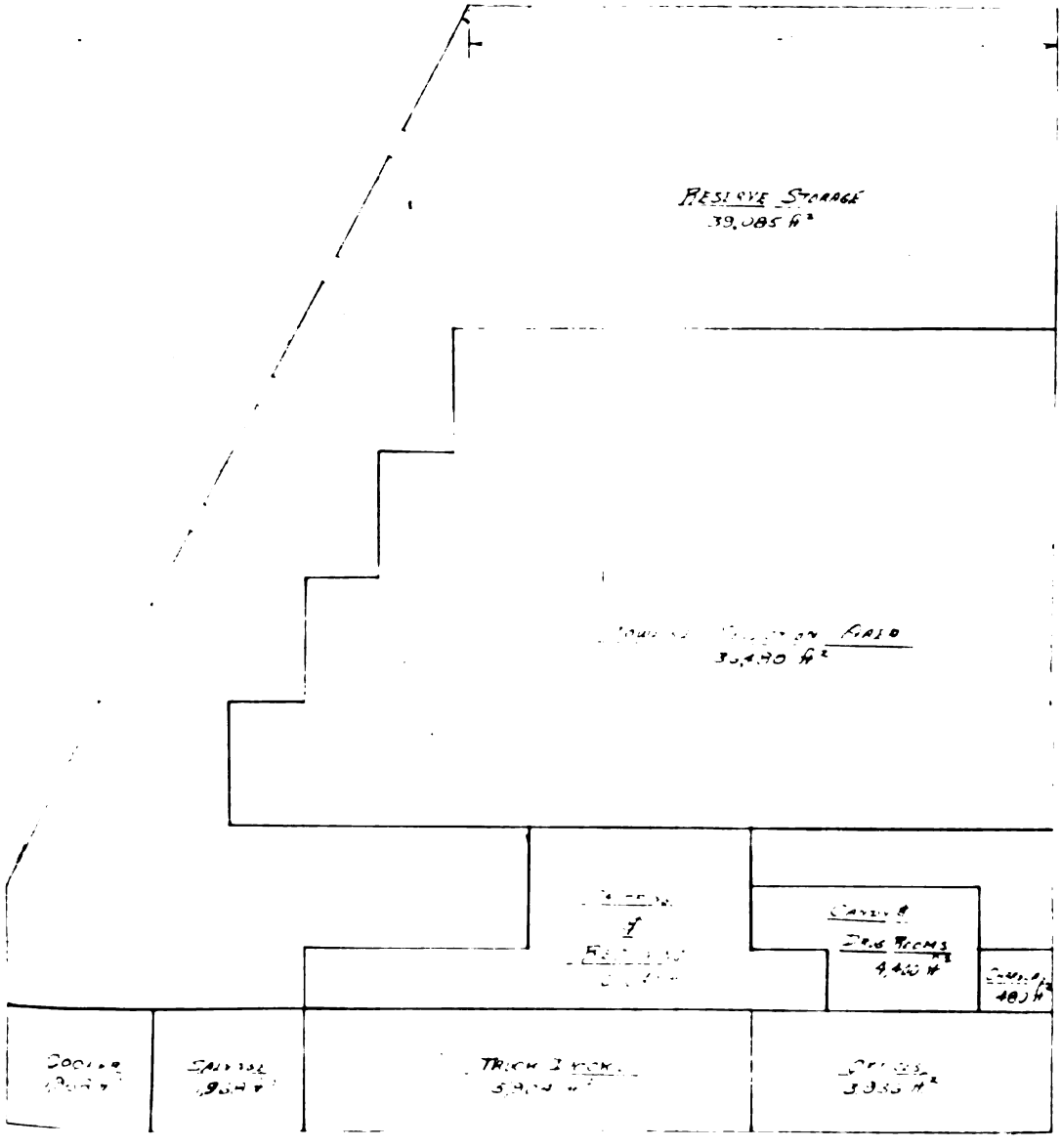


Fig. 4. Warehouse Layout Before Alteration

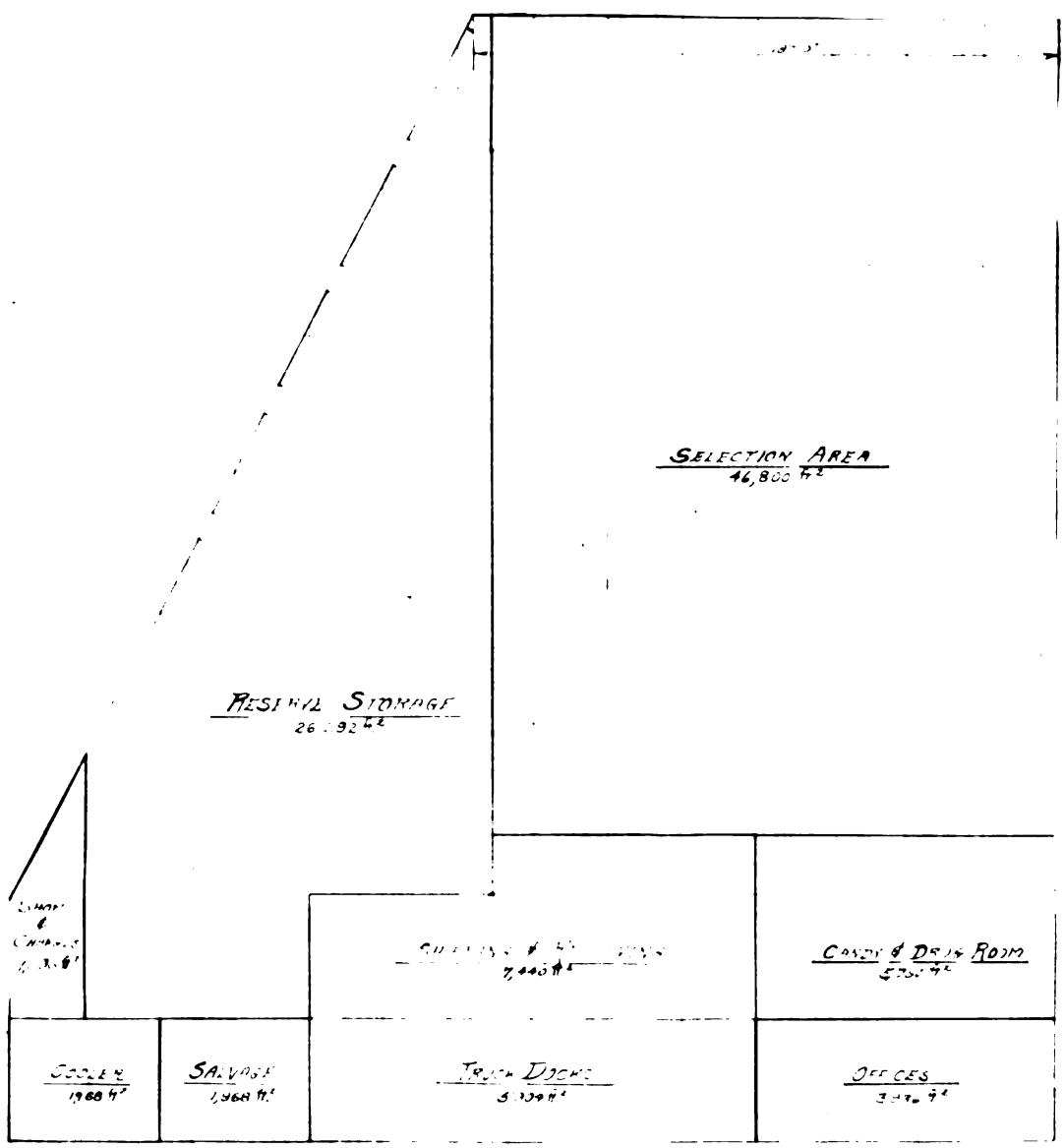
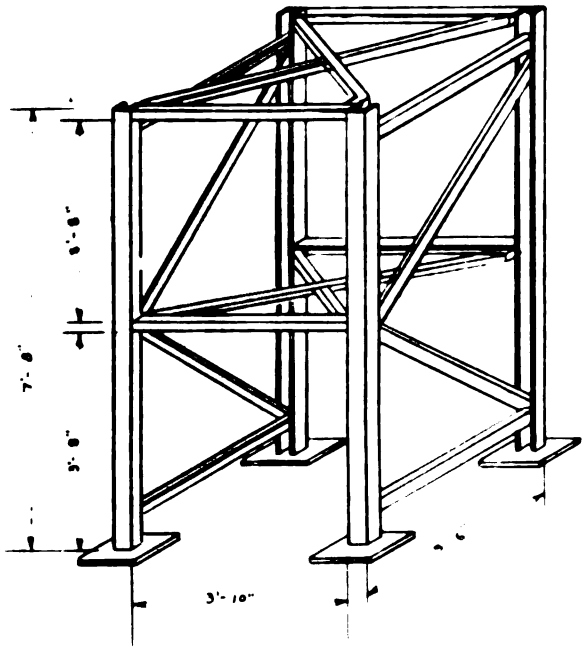
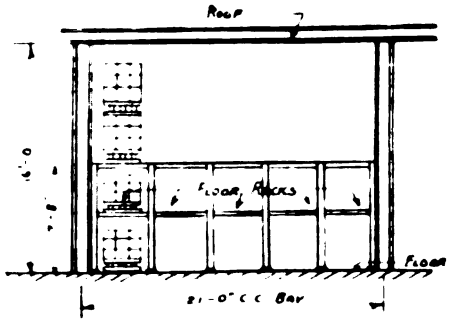


Fig. 5. Warehouse Layout After Alteration

is referred to as the "active stock". The modern selection line usually embodies the use of racks such as are pictured in Figure 6. This figure shows the construction of two different types of racks as used by the American Stores Company. These racks are constructed of metal and are sturdier than the wooden racks which are sometimes used. It will be noted that this system allows two pallet loads of merchandise to be stored directly above the selection line, thus greatly increasing this reserve space. Figure 7 shows a fork truck placing a pallet loaded with merchandise on top of the selection line rack. This particular load is being placed on reserve. Actual selection is only done from the merchandise on the bottom two pallets (one resting on the floor and the other on the rack at about waist level). This reserve merchandise is used to restock the assembly line as needed. Often the entire stock of an item can be carried on the selection line and in the reserve area directly above. There are many instances though where it is not possible to accomplish this. This fact leads to the use of a reserve storage area.

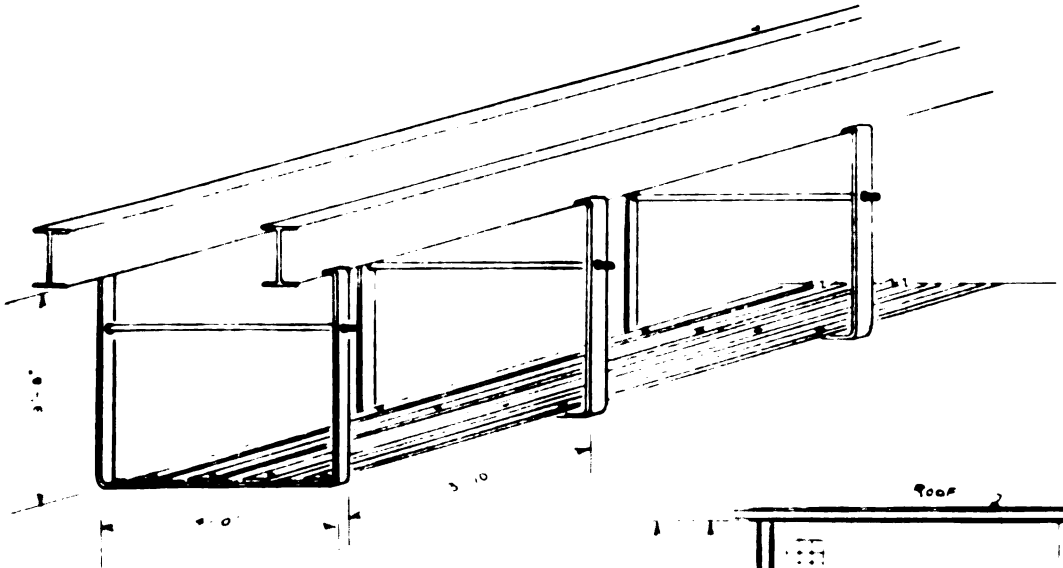
The reserve storage area is where goods are kept prior to being placed on the selection line or on the selection line reserve. Generally, orders are not filled from merchandise located in reserve. Exceptions are sometimes made to this rule in the case of extremely heavy moving items and bulk items such as flour and sugar. Racks are not used in the reserve storage space, but instead pallet loads of merchandise are merely stacked one on top of another. Figure 8 illustrates this. The reserve area is for the temporary storage of merchandise until it is needed on the selection line. The trend is to reduce this reserve space as much as possible since placing merchandise in this location involves extra handling.

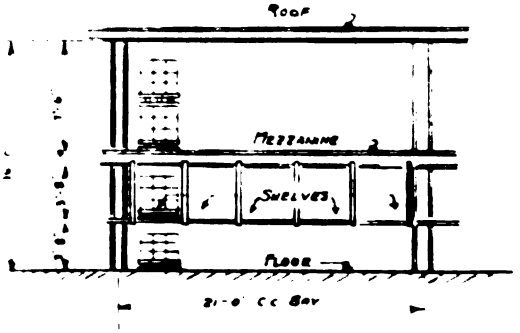




AMERICAN STORES CO
FLOOR RACKS - WAREHOUSE #5

JANUARY 1951 KDH





AMERICAN STORES CO
MEZZANINE & HANGING SHELVES

Fig. 6. Racks used by the American Stores Company JANUARY 1951 KDH

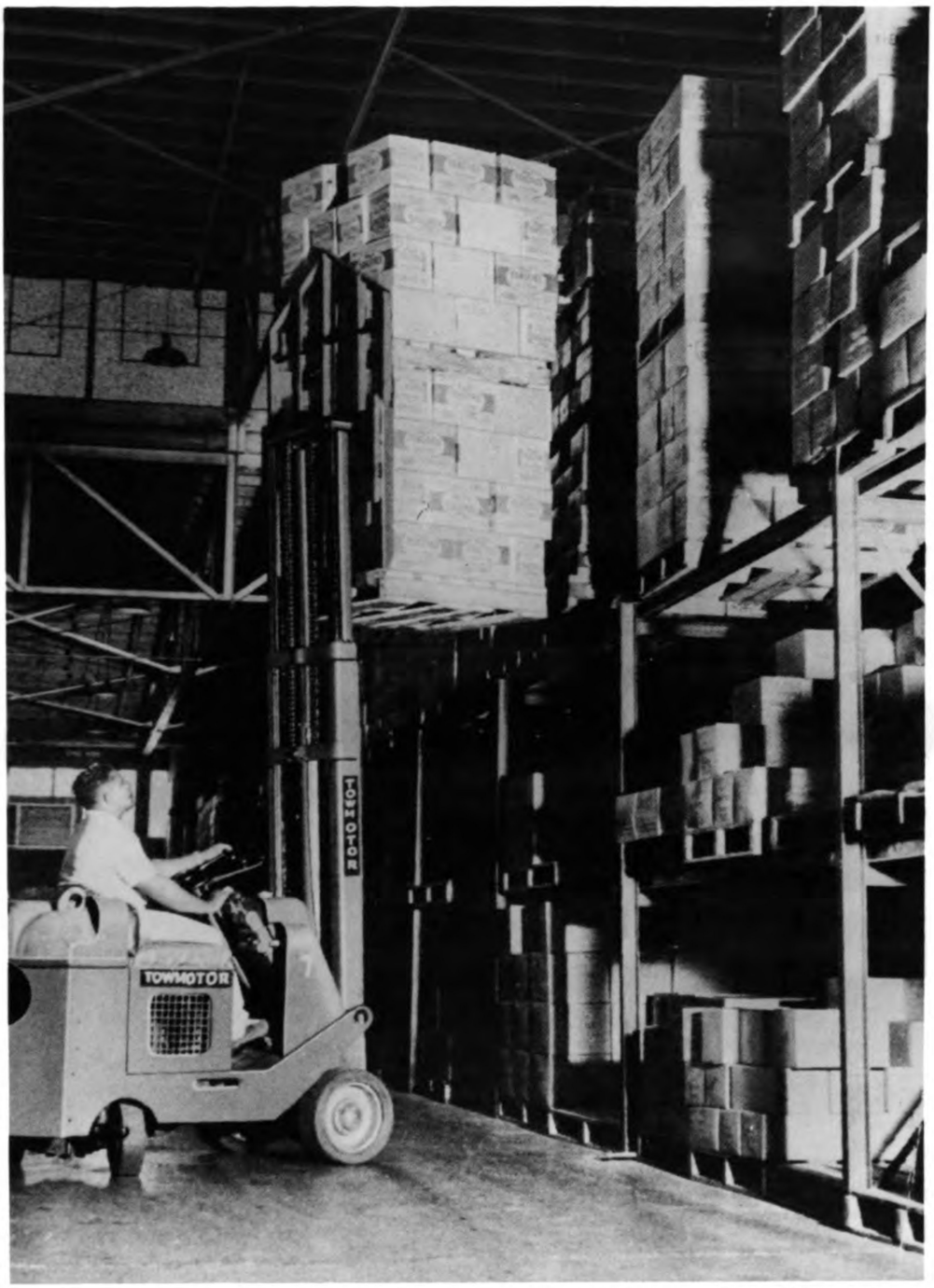


Fig. 7. Warehouse Scene

Fig. 8. Warehouse Reserve Storage Area

The shipping and receiving area refers to that space from which the store delivery trucks are loaded and unloaded. This also includes a space in which the orders may be checked (for errors in the selection process) after they have been brought from the assembly line.

The truck docks refer to that space in which the delivery trucks park while they are being loaded or unloaded.

The candy and drug room contains cigarettes, candy and drug items only. This room is usually kept separate from the rest of the warehouse for several reasons. The main reason is the small size of many of these items and their relatively high value. Most of these items are ordered in less than case lots by the stores and this means that the cases must be broken open to fill the orders. If this process of cutting the cases open were done on the selection line it would slow down the order picker's progress considerably. Also, it has been found that there tends to be considerable lost and damaged merchandise from open cases which are located on the selection line. For these reasons it is generally more economical to place these items in a separate room where they can be handled by one or two persons. The candy and drug room is generally arranged with its own selection line similar to that of the main selection area, the chief difference being that pallets are not used in the candy and drug room. The various items are stored on racks or sometimes in bins. The number of items carried in the candy and drug room depends on the extent of these operations as carried on in the retail stores served by the particular warehouse in question. The number of these items can vary from a few dozen to several thousand, although three to five hundred items might be considered an average amount today. At the present the western chains

seem to carry larger drug departments than do the eastern chains and thus they tend to stock many more drug items. The tendency in the East, though, has been toward greater efforts in the candy and drug fields, and one can probably expect to see this portion of the business grow in the future. Since the Fair Trade Laws have been declared illegal, the chains may be able to cut their prices enough to undersell the drug stores and thus obtain a larger portion of this business. The lower operating costs of the food chains will enable them to do this and still make a profit on the drug items. This means that the space devoted to the candy and drug room can be expected to increase in proportion to the total area of the warehouse.

Office space is that area devoted mainly to the clerical work involved in handling the orders as they are received from the stores. Today these orders are usually processed and inventory records kept by means of IBM or Remington Rand punch card systems.

The salvage area refers to that space which is used to collect and bundle the waste paper which has been returned from the stores. This salvage is then sold to a paper processing company.

A cooler is sometimes needed in the grocery warehouse to handle a few items that need to be kept at moderate temperatures. The cooler never needs to be very large in the grocery warehouse.

The shop and charger area is the maintenance room to take care of the fork lift trucks and the other equipment used in the warehouse. If battery operated trucks are used the batteries must be recharged daily. Adequate facilities must be made available for this purpose.

As can be seen from the table on page 35, the main changes brought about by the alteration in the layout of the warehouse being used as an

example were to increase the selection area, the candy and drug room and to greatly reduce the reserve storage space. Not only was the size of the selection area changed but also its shape was altered as can be noticed by a comparison of the two layout drawings. The new layout was developed on the basis of five week's supply of each item in order to allow for future increases in volume (although the present policy is to carry only two and one-half week's supply). The floor layout was designed with spaces allotted on the selection line as follows:

A. One full space: Items having a pallet output of greater than one pallet per week. (One full space means two pallets stocked vertically on the rack).

B. One-half space: Items having a pallet output of less than one pallet per week. (One-half space means one pallet occupying one-half of a rack).

The reserve spaces were allotted to items according to five week's output requirements in terms of pallet loads. The warehouse had the capacity to handle about nineteen hundred selection line items at its present tonnage output (at the time of the layout alteration) and still maintain a five week's supply of a balanced stock.

The main features of the new floor layout are as follows:

1. The heaviest moving stock is located closest to the reserve storage area.

2. The reserve storage area is located as close as possible to the receiving dock.

3. The selection line "families" are located for best accessibility to railroad or truck docks according to the current shipping medium.

4. Reserve for 75 percent of the items on the selection line can be placed on top of the racks.

5. All items are palletized and are on the selection line.

6. The length of the selection line was not increased over that existing under the old layout (the length of the line being slightly under 2,500 feet).

7. The storage capacity of the warehouse has been raised. The old layout allowed space for the following:

	Pallets	Tons
Reserve	5,131	3,850
Selection line	1,824	912
	6,955	4,762

With the new layout the storage capacity is as follows:

Main reserve	2,856	2,140
Top rack reserve	2,090	1,570
Total reserve	4,946	3,710
Selection line	2,132	1,066
	7,078	4,776

The capacity of the selection line has been increased by some 308 pallets, while the total capacity of the warehouse has been raised an additional 123 pallets by the change in the layout. It was estimated that five week's supply of the items carried would require a total of 5,727 pallets (including selection line and reserve pallets). This would leave a "cushion" of 1,351 pallets, 241 being on the selection line and 1,110 being the reserve area. "Cushion" storage space refers to that space available in excess of normal requirements. It is the area available to stow new merchandise added to the normal supply and not previously handled, excessive supplies of items being offered on promotion sales, merchandise on hand due to reasonable human error in ordering or guaging warehouse output, or other reasonable overstocks.

8. Increase selection efficiency by having all items palletized under proper code number and placed on the selection line. It is expected that the selector's piece count will be raised from 140 to 190 pieces per hour, or a gain of 36 percent.

9. Increase candy and drug room selector's piece count from 150 to 250 pieces per hour by relieving congested conditions in the candy and drug room and setting up a selection line. This represents an increase of 67 percent in selection efficiency.

It is expected that the overall efficiency of the warehouse will be increased from 1.7 tons per man hour to 2.5 tons per man hour, or a gain of 47 percent by the change in layout. The only new equipment that has been added is the racks on the selection line; lift trucks, pallets and other handling equipment having already been employed with the previous layout. Thus, this example presents a clear picture of the way in which layout affects the operating efficiency of a warehouse.

Reference has previously been made to "families" or groups of commodities. Before the analysis was made of the output of each item, the order sheet was regrouped so as to include all related items together in families. There are 22 families in all. The families, with the number of individual items in each family, are given in the table below.

	Family	Number of Items in Family
1.	Coffee, tea, coffee substitutes, hot beverages	81
2.	Flour, prepared flour, pie mix, baking supplies	125
3.	Soaps, soap powder, detergents, hand soaps, cleansers, bleach, laundry supplies	138
4.	Milk	17
5.	Juices	74
6.	Fruits, fruit cocktail, fruits for salad, et cetera	157
7.	Vegetables	155
8.	Prepared foods	142
9.	Sea food	57
10.	Pickles, relish, sauces, olives, vinegar, condiments	112
11.	Preserves, honey, vegetable and fruit butters, syrups	38
12.	Shortening, cocking oil, salad oil, lard	29
13.	Desserts (gelatine and puddings)	64
14.	Pet foods	34
15.	Household items, polishes, insecticides, motor oil, magazines	138
16.	Cereals	73
17.	Paper wares	58
18.	Bulk (sugar and feed)	22
19.	Cookies and cakes	18
20.	Canned meat	29

Family	Number of Items in Family
21. Baby food	139
22. Line candy	64
Total	1,764

Items were grouped on the selection line in families, and the order sheet was rearranged so that the sequence of items on the order sheet would be the same as the sequence of items on the selection line. The space that each item was alloted was determined on the basis of the average output of that item.

The family of line candy refers to certain candy items that are to be carried on the selection line instead of in the candy and drug room. About three hundred candy items were analyzed and of these it was found that 64 were shipped in carton lots. Since it was not necessary to break open the cases of these items, it was decided that they could be carried on the selection line along with the regular grocery products. It is only when these cases must be split open to fill an order that it is more advantageous to handle the items in a separate room. It might be noted in connection with this that as the volume of this phase of the business increases, more and more of these items can be ordered in case lots by the stores and, therefore, may be handled on the selection line rather than in a separate room. The extent of this depends largely on the size of the retail stores served by the particular warehouse. However this factor may counteract to some degree the tendency of the drug and candy rooms to become larger as the number of items carried in these departments increases.

In the discussion of the selection line area, one important device contributing to handling efficiency was not mentioned. This device is

known as the towline. The towline is a continuously moving endless chain usually mounted about eight feet above the floor level (to provide clearance for the fork lift trucks) and provided with loops or couplings onto which the four wheeled trucks used by the order pickers may be hooked. The purpose of such a device is to relieve the order picker of the necessity of hauling the loaded four wheel trucks to the warehouse loading dock. This allows him to spend more time in actually filling the store orders and less time in merely hauling merchandise from one part of the warehouse to another. Some towlines are mounted beneath the floor level but their purpose and operation is the same as the overhead towline. Today the towline usually follows the perimeter of the selection area. When the towline was first introduced, it was thought that it should follow the selection line. This meant that the towline would loop up and down every aisle and would go past every item on the selection line. The hand truck would be hooked onto the towline at all times and the order picker would merely remove merchandise from the pallets and place it on the truck as it was called for in the order sheet. It was soon found that the difficulty with this arrangement was that the towline was moving either too fast or too slow for the order pickers. The chain would be going too slow for a light order with only a few items, while at the same time it would be going too fast for a heavy order with many items and cases per item. While the speed of the towline can be adjusted, it cannot be adjusted to suit all conditions at the same time. Thus, present day thought on the subject has evolved that the towline only should be used to haul loaded trucks to the shipping dock and to bring empty trucks from the shipping platform back to the various aisles in the selection area. Now it is used only to move loaded and empty

trucks while the order picker is allowed to proceed at his job at his own pace (within limits). With selection lines as long as they are (the one in the example being almost 2,500 feet) the towline performs an important function in reducing as much as possible the distance that the selectors (order pickers) must travel.

Selection by code number or commodity description is a point that is greatly disputed in the grocery trade.[1] In the example given the decision has been to select by code number. At the present time a slight majority of the chain store companies reporting to the National Association of Food Chains select orders by means of commodity descriptions, but several of the chains indicated their intentions to switch over to selection by code number, so that in the near future the majority will favor selection by code number. Adherents of the code number method say that selection and checking are both faster and more accurate than by using the commodity description method. Whatever system is used though, the sequence of items on the selection line must be the same as that on the order sheet.

Another interesting change that warehouse layouts have undergone in recent years (besides the change in the towline route) is the fact that selection lines seem to be getting longer and the selection area greater in proportion to the storage space. In 1944 in an article in Chain Store Age[2] Mr. Ramlose, who has designed warehouses for many grocery chains and who was consultant for Chain Store Age, says that the selection area in

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1 National Association of Food Chains Bulletin, April 14, 1951, Vol. 18, No. 15. p. 8.

2 F. E. Landau, "Designing Your New Warehouse", Chain Store Age, November, 1944.

the grocery warehouse fills about one-half of the working grocery space, and that storage takes the other half. In other words the selection and the storage areas are about equal in size. Mr. Ramlose also goes on to state that "this ratio of half and half for selection and storage is low for storage". This ratio meant that a substantial portion of the selecting was done from open stock in storage. Of course, before the introduction of the selection line all selecting was done from open stock. Today the trend is towards getting all the items on the selection line, and having less and less reserve area. This can be illustrated by the example of the warehouse already given. Before this warehouse was remodeled the selection space comprised about 36 percent of the total area and the reserve storage about 39 percent of the total. In other words the storage space was slightly larger than the selection area. After the warehouse was remodeled this condition was reversed. The selection line then occupied 46.1 percent of the total area and the reserve storage space was 25.9 percent of the total. Thus the selection line was expanded and the reserve space was contracted so that now the selection area is almost twice the size of the reserve space. When merchandise can be brought from the unloading dock and placed on the selection line or directly above it instead of first being placed in reserve storage, both time and handling operations are reduced. The fact that the reserve for many items can be located directly above the selection line is due to the use of racks, pallets, and fork lift trucks which permit the high stacking of merchandise. The use of racks on the selection line also tends to keep the length of the line as short as possible. When the lines get up to 2,500 feet and more, this becomes an important factor. This is especially true when large and small

orders are filled in the same warehouse. When a selector is filling a large order he is busy along the entire length of the line, but when a small order is being filled the selector must often walk many feet between items. Clearly, a man who walks 2,500 feet and selects only 50 cases of merchandise will not have the same output (in cases per man hour) as a man who travels the same distance and selects 500 cases, as a large percentage of the time is occupied in just walking the length of the line. Every effort is made to keep the selection line as short as possible while at the same time efforts are being made to store as much as possible the entire stock carried by the warehouse on or above the assembly line. While these aims are somewhat conflicting in themselves, they both lead to greater economies and efficiencies in handling.

The second principle of materials handling states that continuous materials movement is most economical. The economies that result from the application of this principle may be classed under two headings: (a) direct handling economies resulting from continuous materials movement and (b) economies from the savings in the use of money that would otherwise be tied up in idle equipment and merchandise. In connection with part (a) of this principle, Curtis H. Barker, Jr.[3] has this to say;

> There is obviously a greater challenge in trying to achieve the objectives of the "Flow of Materials" (continuous material movement) rule in the warehousing and jobbing types of industries than in those which lend themselves to conveyorizing.

The chain store grocery warehouses have risen to and met this challenge. A notable example is the use of the towline, which has been previously

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3 Curtis H. Barker, Jr., "Industrial Materials Handling", Cleveland: The Lincoln Extension Institute, p. 21.

described. Conveyors are also used by many warehouses to help speed the flow of goods. Conveyors may be of the gravity operated type or they may be mechanically powered by electric motors. They may be used as an aid in unloading incoming freight cars and trucks and also in loading outgoing trucks. Warehouses having palletized operations, though, do not usually use conveyors in this manner since it involves less handling to unload the merchandise directly onto the pallets. Conveyors find their greatest use in the warehouse in replacing the towline. They run along the edge of the selection area and are used to bring merchandise from the selection area to the loading platforms.[4] One chain store warehouse uses a floor level moving platform type of conveyor which runs along one side of the selection area. The order pickers use normal four wheel hand trucks to fill their orders. When a truck is filled it is pushed onto the moving belt which then carries it to the loading platform. This conveyor performs just about the same function as a towline except that it only carries trucks to the loading platform and does not bring empty trucks back into the selection area.

The trend toward putting goods directly on the selection line instead of first putting them in a reserve area and then moving them to the selection line is another step that has been taken in conformance with this principle. Placing merchandise directly on the line makes for less handling and promotes a more continuous flow of the merchandise.

One of the most recent innovations in grocery warehousing is the car-aisle method of handling merchandise. This system is used mainly for goods

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4 "Streamlined Wholesale Grocery Warehouses", Washington, D.C.: United States Department of Commerce, Series 18, p. 65

that are received in car load lots. An aisle is provided in the car-aisle section for each item to be handled in this manner. Each aisle is capable of handling a complete carlot (about 50 pallets or 2,000 cases) and consists of a series of roller conveyors (with guides to keep the pallets headed in the proper direction) on which the pallets are placed. As merchandise is received, it is placed on pallets and then the pallets are placed on the receiving end of the proper aisle. The conveyors are constructed on a slight grade so that the pallets will move along the aisle under the force of gravity. At the assembly line end of the aisle, there is a stop to prevent the pallets from rolling off the end of the aisle. The car-aisle system combines the storage and selection line areas into one unit. Goods are placed at one end of the aisle in storage; they move along the aisle under their own power until they arrive at the selection end of the aisle. Thus the handling operation involved in moving goods from storage to the selection line has been eliminated, and the merchandise is more nearly approaching the continuous movement ideal. The car-aisle system provides the following:[5]

1. Complete physical rotation of the goods (first in, first out)
2. Easy reloading from the rear
3. Easy forward movement of the carlot so as to keep the pallets always at the assembly line face of the row (This avoids deep walkins as the goods are depleted in order picking.)
4. A single and short distance handling of the goods in the receiving and line-loading phases of operation combined

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5 Ibid, p. 84

While the car-aisle system reduces the handling of the merchandise and keeps it moving steadily on its way towards the selection line, its use brings up some problems. All items are not handled in sufficient quantities to recommend the use of a car-aisle. Those items that are placed on the car-aisle will disrupt the normal families of items and will require a rearrangement of the order sheet. Also for a given number of items, this system makes a longer selection line than does the normal line with two levels of pallets. The car-aisle system is being used experimentally in a few warehouses at the present time and its future adoption or rejection by the industry will depend to a large extent on the results of these experimental applications.

The other phase of the continuous movement principle applies to the turnover of merchandise in the warehouse. Turnover has been described as one of the four chief elements in the modern wholesale grocery warehouse operation.[6] Turnover is more than just a materials handling problem as it is connected with the whole philosophy of the operation of the business. A business can be conducted to make its profits through astute buying, speculating on future price changes and charging what the market will bear. The other view (and the view which is generally accepted by the retail chain store organizations) is that the concern should make its profit through merchandising - through large sales volume, low profit per sales, rapid turnover operations. Emphasis is on a merchandising profit and not a speculative one. This attitude makes the warehouse a distribution center and not a storage depot. If the warehouse is set up to handle

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6 Ibid, p. 1.

a certain weekly tonnage with a given inventory (say a two and one-half week's average supply) ratio, large deviations from this in the form of excessive inventories will cause the operating efficiency of the warehouse to drop. Operations can soon become severely hampered when the warehouse gets too full.

Excessive inventories and slow turnover can also tie up large sums of money which could usually be employed profitably elsewhere. One example can be given of a warehouse which followed the policy of carrying a two and one-half week's averaged balanced inventory. At one time a study was made to see if this policy was actually being carried out. It was found that, at the time of the study, the actual balanced inventory was 3.19 week's supply, or 28 percent over the two and one-half week's inventory goal. However, the actual cost value of the EXCESS stock was found to be slightly over $400,000, which is no small sum. At 6 percent the weekly interest charges on this would amount to about $470. Add to this the extra cost incurred in the warehouse in handling this merchandise at lower than normal operating efficiencies and it soon becomes clear that non-adherence to the turnover principle costs money. Of course, there are many valid reasons why the turnover principle cannot be strictly adhered to in all cases. However, it is not within the scope of this work to present a discussion of the relative merits of the two philosophies (previously mentioned) of conducting a retail business. What is within the realm of this work is to point out how the adherence or non-adherence to the method of operation that has been adopted can affect the materials handling operating efficiency of the warehouse units.

The third basic principle states that standardization of methods, types and sizes of equipment, is desirable for good materials handling efficiency. Much has been done in the warehousing field in this direction but much more remains to be done.

The advantages of standardization on types of equipment such as fork lift trucks, four wheel hand trucks and the other types of trucks that must be used are that maintenance is simplified and training of operators is simplified. If one make of fork truck is used, instead of two or three, maintenance and operating problems are obviously simplified since fewer parts must be stocked. An operator trained on one machine knows how to operate all the machines.

Much has been done toward trying to get a standardized pallet accepted by everyone in the industry. In 1947 the National Bureau of Standards issued its Simplified Practice Reccomendation R228-47 in which it recommended the following two pallet sizes to be adopted as standrd by the industry:[7]

1. 32" x 40" 2 or 4 way entry pallet for loads of 2,000 lbs. or less
2. 40" x 48" 4 way entry pallet for loads up to 3,500 lbs.

A two way entry pallet means that the pallet can be picked up by a fork lift truck from either end. A four way pallet means that the pallet can be picked up at either end and also at either side. Eight way pallets are also made which means that the pallet can be picked up from either end, either side and from all four corners. At the present there are about ten sizes of skids and pallets commonly used in grocery warehouses.[8] These

7 W. E. Braithwaite, "Standardization for Palletization", Modern Packaging, August, 1950, Vol. 23, No. 12, pp. 86-89.

8 "Streamlined Wholesale Grocery Warehouses", Op. Cit., p. 68

range in size from 28" x 32" to 48" x 72". The most common size is probably the 48" x 48" pallet with the 40" x 48" pallet ranking second. Shapes of pallets and skids vary also, some being square and some rectangular. There are also single faced pallets, glued pallets, expendable pallets and so on. They seem to come in an almost endless variety of sizes, shapes and types of construction. Pallet weights vary from three and one-half to about 96 pounds, depending on the construction. Such a variety is not always conducive to good handling efficiency. Many of these pallets have been developed for specialized industrial operations and are not suitable for the grocery warehouse. However, there is still a variety of sizes and types that could be used by the grocery warehouse. When a warehouse uses two or three types of pallets, several problems arise. Maintenance problems are increased just as in the case of several types of fork lift trucks. If pallets of different sizes are used, there is bound to be wasted space. If the racks on the selection line are designed to accommodate the smaller pallet, the larger pallet will probably not fit into the rack. If the rack is designed for the larger pallet, it will be unnecessarily large for the smaller one. In the reserve storage area, aisles designed to accommodate a pallet of one size may not take a different size.

In conjunction with the need to standardize on pallet sizes, there is also a great need to simplify and standardize merchandise container sizes (not the retail unit, but the shipping unit as handled by the warehouse). Containers seem to come in as many varieties as pallets. This variety of of sizes, shapes and weights does not lend itself readily to efficient handling methods. Some effort toward standardization has been made in this

area but much yet remains to be done. In March, 1950, the Commodity Standards Division of the National Bureau of Standards issued a report which contained the following six points that a manufacturer should consider in packaging his product:[9]

1. For ease in handling, no case or container should exceed approximately 50 pounds in weight.

2. The case or container height should be less than either the length or width dimensions. The height of the case should not exceed 14 inches. For example, cereal cases which are 21 inches high are poorly designed because they produce pallet loads which become unstable.

3. Cases or containers for heavy merchandise such as canned or bottled goods should not be larger than one cubic foot. Cases for lighter merchandise, such as cereals, or paper products, should not be larger than approximately four cubic feet.

4. Cases significantly smaller than one cubic foot for merchandise such as baby foods, spices, and extracts, may be taped, interlocked or fastened together in multiple units not to exceed maximum weights and dimensions herein recommended.

5. Consideration should be given to the elimination of any void or open space when merchandise is stacked on standardized pallets.

6. The case or container corrugations should be perpendicular to the bottom to provide maximum protection and supporting strength.

In relation to the last point it should be noted that the report also stated that the maximum height of a single pallet load should not exceed 72 inches, but may, of course, be less. Furthermore, the cases or containers should be strong enough to support the load when piled to a height of 16 feet without crushing or collapsing.

The purpose of this report is to get manufacturers to package their products in cases that will be of such sizes, shapes and weights that they can be easily and most efficiently handled in the grocery warehouse. But

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9 Dr. J. R. Whitaker, "Your Package - From Shipping Room to Retail Shelf", Modern Packaging, May, 1951, Vol. 24, No. 9, p. 122.

before the manufacturers can be expected to change or standardize their package dimensions, the warehouses themselves must adopt a few standard pieces of equipment. The most important piece of equipment that should be standardized is the pallet. Point five (above) makes this fact clear. It can probably be safely said that the 40" x 48" pallet will become standard in the grocery warehouse field. While the 48" x 48" pallet has been the most commonly used pallet (in all fields) up until recently (the Navy Department Bureau of Supplies and Accounts having adopted a 48" x 48" standard hardwood pallet),[10] the 40" x 48" pallet will probably become more widely used in the future, especially if the practice of shipping unit loads by rail and highway develops. The 40" x 48" pallet provides the best size for shipping by these two carriers. The 48" dimension is the best for railroad boxcars (whose inside widths are usually 110") and the 40" dimension is best for highway trucks (which usually have a net inside width of 88"). Thus for the warehouse, whose business is receiving and shipping merchandise, the 40" x 48" pallet is the most suitable size. While palletized shipments have not become too common in this field as yet, there is great opportunity here for increased materials handling efficiencies and economies. Once the 40" x 48" pallet is generally accepted, manufacturers can begin to do something about designing their cases so that they will best fit on the pallet without any wasted space. There are at least a dozen "standard" patterns of arranging merchandise on pallets.[11]

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10 Curtis H. Barker, Jr., "Industrial Materials Handling", Cleveland: The Lincoln Extension Institute, p. 192.

11 "The Addison-Semmes Expendable Pallet", The Robert Gair Co., New York City, New York, p. 9.

The best arrangement is the one which completely covers the pallet (does not leave any open spaces at the center of the load) and one in which the individual cases are so arranged as to form an interlocking, stable pile. Six of the standard pallet loading patterns leave open spaces in the load and thus do not effectively utilize the whole pallet area. Cases which form cubes should be avoided as they provide no effective means for interlocking the units of the load, and thus make for a load which is unstable and apt to fall apart. The length and width of all cases should vary by at least two inches. An ideal container would be one in which the length ranged up to twice the width of the container. The containers should be designed so that they will form an interlocking load with no open spaces on a 40" x 48" pallet. Overhang of cartons over the edges of the pallet should not exceed one and one-half inches on the 40 inch side of the pallet and two inches on the 48 inch side of the pallet. Thus, the overall dimensions of the load (on a 40" x 48" pallet) should not exceed 43" x 52". To get all manufacturers to produce cartons with dimensions such as to form interlocking loads with overall dimensions lying in the range between 40" x 48" and 43" x 52" is no easy task. However, the more products that are packaged to fit these requirements, the easier and more efficient will be the handling job at the grocery warehouse. A start has been made in this area of equipment and container size standardization but much work remains to be done.

The fourth principle states that storage space is best measured in terms of cubic content. This has already been discussed (somewhat indirectly) under the description of warehouse layout. However, a few more words here

will be appropriate. "Tiering Pallet-loads With Fork Trucks Doubles Food Warehouse Storage Space" is the title of an article which contains the following remarks:[12]

> Adoption of palletized loads and efficient tiering have utilized overhead space to the greatest possible advantage. The additional capacity provided has assured adequate storage space for the increased volume. . . Not only has the cost of additional floors been avoided, but a more efficient handling system has resulted than would have been possible if additional space had been secured through construction.

These remarks are typical of those made in all articles concerning the adoption of the fork lift truck-pallet materials handling system. Storage capacity has literally been doubled in many cases. Before the advent of fork lift trucks, merchandise had to be stacked by hand. Handling costs rose quite rapidly as the merchandise was piled higher and higher. Thus, merchandise was usually not piled very high and much potential storage space was not utilized. This has been radically changed since the introduction of fork lift trucks. Now merchandise can be stacked quite high and at practically no increase in handling costs or time. One furniture warehouse in Chicago found it could store 50 percent more merchandise per square foot of floor area by using lift trucks.[13] A tea company had similar results in one of its warehouses.[14] With the use of racks on the selection line, the capacity of the selection line has been doubled and even tripled over lines which only used skids. This increase in capacity

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12 "How the Food Industry Uses Storage Battery-Powered Trucks", The Electric Industrial Truck Association, Philadelphia 40, Pennsylvania, p. 9.

13 "Handbook of Material Handling with Industrial Trucks", The Electric Industrial Truck Association, Philadelphia 40, Pennsylvania, p. 30.

14 Loc. cit.

has allowed shorter selection lines, more storage space above the selection line, less separate reserve area, easier and quicker replenishment of stock on the selection line and quicker selection by the order pickers. Also the general trend toward the use of pallets instead of skids on the line has helped to increase the amount of space available for merchandise since pallets have less overall thickness than skids.

With the use of fork lift trucks, merchandise can now often be stacked 15 to 20 feet high, whereas before the use of such equipment seven to ten feet was often the practical limit. Today the capacity of a warehouse must be measured not in terms of the square feet of floor space available, but in terms of the volume of space available. Greater use of the cubic space reduces the size of the warehouse and reduces the distances that must be traveled through the warehouse. Handling a greater amount of merchandise in a smaller building means that the overhead costs (expense of upkeep on the building, et cetera) are reduced (per unit handled and stored). Warehouses must be constructed with the thought in mind that the entire volume of space is to be utilized. This means that many former overhead obstructions such as pipes, sprinkler systems, air heaters and such must be located flush with the ceiling or in such a manner so that they will not obstruct the high tiering of the merchandise. The use of modern mechanized equipment has replaced the concept of area as the measurement of storage space with the much more efficient concept of volume.

The fifth principle states that materials handling economy is directly proportional to the size of the load handled. This is one of the most important and basic principles of materials handling and is the one

from which many of the benefits of mechanized handling stems. It is a simple and rather obvious principle and yet at the same time a most important one. Reference has been made continuously to the use of pallets and fork lift trucks as a means of handling merchandise in the grocery warehouse but complete reasons were not given for the advantages obtained by the use of such equipment. The most obvious advantage is that the machine can handle more merchandise per trip than can the unaided man and that the machine can travel at higher average speeds than does the man. The use of the pallet enables the lift truck to pick up many cases of merchandise in one movement, to transport them and to put them down in another single movement. If the lift truck had to be loaded by hand every time it moved some merchandise, the advantage of its greater carrying capacity would be greatly reduced. It is the ability of the machine to handle many cases of merchandise in a single motion with the ease than an individual picks up and carries one case that gives the machine its great advantage over the unaided individual. The larger the load a machine can handle in a given trip, the more labor power it is replacing and, generally speaking, the greater will be the efficiency of that handling operation. The ability to handle many small individual units grouped together in a single large unit is generally referred to as the "unit load" method. A unit load has been defined as "a quantity of material assembled and sufficiently secured together to permit handling and stacking by means of power equipment, for loading, shipping and unloading as a unit. Unit loads may be formed on trailers, skids, pallets or by any unitizing method that makes materials accessible in large units for mechanized handling."[15] The type of merchandise handled by the

15 "Handbook of Material Handling with Industrial Trucks", Ibid, p. 15.

grocery warehouse lends itself admirably to the formation of unit loads. Rectangular cartons can readily be stacked into a load which has sufficient stability and cohesion to permit it to be handled by means of power equipment. The unit load is usually built upon some base such as a pallet or skid to permit easy handling. Unit loads often need to be bound together by external means such as wire strapping or rope, and sometimes the load must be glued together in order to permit handling as a unit load. Fortunately for the grocery warehouse, such measures are generally not necessary. Where the shape of the containers is such that interlocking loads can be constructed, the friction between the containers themselves is sufficient to hold the load together in a single unit.

The larger the unit load the greater the savings that will result. One thousand pounds is just about the maximum hand trucking load under ideal manual handling conditions, and one hundred feet per minute is close to the maximum speed that can be maintained. Electric industrial trucks can handle up to eighty thousand pounds in a single load (not in the grocery warehouse) and travel 300 to 500 feet per minute. Clearly then, industrial trucks employing the unit load method can do the work of many individuals much more efficiently than can be done by hand. Unit loads have many advantages other than savings in direct handling costs. Some of these are as follows:[16]

1. Faster movement of goods
2. Reduced time for loading and unloading carriers
3. Reduced packaging costs

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16 "Handbook of Material Handling with Industrial Trucks", Ibid, p. 17.

4. Maximum utilization of storage space (cubic content)
5. Reduced pilferage in transit and fewer stray shipments
6. Reduction in product damage in transit
7. Greater work safety for employees
8. Reduced worker fatigue
9. Reduced time and cost of taking physical inventories

The grocery warehouse has extensively adopted the unit load method in its operations in an effort to reduce handling costs. Many warehouses now handle all bulk commodities on a palletized basis. Shipments are received either by truck or rail and are unloaded directly onto pallets. Merchandise is then handled only in pallet load units until it is finally placed on the selection line. While this use of pallets and lift trucks has greatly increased the operating efficiency of the warehouse, there are still areas where this system could be applied with benefit. The palletized shipment of grocery items (at the wholesale level) has not yet become common practice. Merchandise is still loaded case by case into the railroad car and then unloaded by the same means at the car's destination (the grocery warehouse, in this case). Shipping by means of palletized unit loads would greatly reduce the handling costs at both ends of this operation. The biggest deterrent to this at the present time seems to be the problem of returning the pallets. It is to be hoped that a system will someday be worked out whereby this difficulty can be overcome. In the meantime, there is not much that can be done within the warehouse itself about this. The best that can be done is to unload the merchandise directly onto pallets and carry on from there. However, with respect to shipping the merchandise from the warehouse to the retail stores, a somewhat different

problem exists. Very few companies seem to use palletized shipments of store orders on their delivery trucks. The typical handling process at the present goes somewhat as follows: The order picker moves along the selection line pulling a four wheel hand truck behind him. He selects items case by case and places them on his truck. When the truck is loaded, it is hooked to the tow line which moves it to the loading platform of the warehouse. At the loading platform the truck is removed from the tow line and the order is checked for accuracy of selection by a "checker". The order is then placed on the delivery truck by a piece by piece hand operation. At the retail store the order is unloaded by the same piece by piece hand method. Thus, in spite of the great use of pallets and unit loads in the warehouse, there are still three operations (just described) where the unit load method is neglected and the transfer of merchandise is accomplished through hand labor moving one case at a time. It is true that the selection of individual store orders from bulk merchandise must, of necessity, be a hand operation, but it does not follow that these orders must be loaded onto and unloaded from the delivery trucks by the same hand process. To be sure, there are difficulties involved in the formulation of a unit load system to be applied to the delivery of store orders but these difficulties are not insurmountable. At the store end, one of the main problems is that each store must be equipped with a fork truck to handle the unit load. However, even if the delivery trucks were only loaded by mechanized handling methods and unloaded by the usual hand methods, one of the hand loading operations would have been eliminated and an advance would have been made. One of the difficulties of applying a unit load system is that each store order is a different size and thus there would often be either wasted space

on the delivery truck or else hand repacking would be necessary. Whether the savings that would be gained through the mechanized loading of the trucks would outweigh the loss of partially filled trucks is a question that cannot be answered here but is one that would require experimental investigation. Several unit load systems have been proposed which reduce handling operations, but none of them adequately solve the problem which has just been posed.[17] In one such scheme, a standard delivery box would be used. The delivery box would be hauled around the selection line and would be accompanied by the selector and the checker who would work together as a team. As the order was selected, it would be checked and packed in the delivery box in one operation. At the end of the selection line, the box would be loaded on the delivery truck without further individual handling of the merchandise. At the store the box would be unloaded from the truck by means of a small hoist which would be part of the truck's equipment. Thus, there would be no rehandling of the merchandise from the time it was selected until it was unloaded from the box in the store. Such a scheme as this would certainly increase the materials handling efficiency of the warehouse. This system was in experimental use by one wholesaler in 1945. The eventual adoption of such a system on a wide scale is dependent upon the extent to which such problems as the avoidance of waste space and checking the load can be overcome. The job of loading and unloading the delivery trucks is one phase of the grocery warehouse operation that has remained basically unmechanized and is an area in which further progress can be expected.

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17 "Streamlined Wholesale Grocery Warehouses", Washington, D.C.: United States Department of Commerce, pp. 87-92.

The size of the pallet that is used in the warehouse has an effect on the materials handling efficiency. A 40" x 48" pallet can carry a 50 percent larger load than a 32" x 40" pallet. A 48" x 48" pallet can carry a 20 percent larger load than a 40" x 48" pallet. The larger the pallet that is used the larger the unit load that can be handled in one trip. The more merchandise that can be handled at one time the greater will be the efficiency of the operation. While this would indicate that one should use as large a pallet as could be obtained, there are other considerations affecting the size of the unit load that cannot be neglected. The grocery warehouse is beginning to adopt the 40" x 48" pallet for several reasons. As has been pointed out before, this is the size pallet which is best suited for shipment both by rail and truck carriers. Output of many items in the warehouse is not sufficient to warrant the use of a larger pallet. If a larger pallet were used, turnover of the merchandise would fall below the limits desired by the management of the company. Also, 40 inches is about as far as a man can comfortably reach on the selection line and pick up a case of merchandise. Larger pallets would either increase the length of the selection line or would cause the selector to reach longer distances (to reach cases at the rear of the pallet), either of which would have the effect of reducing his efficiency. For these reasons, the pallet that is generally adopted, while it is not as large as it could be from the unit load viewpoint alone, is of the most advantageous size when all factors have been considered.

One final point that needs to be mentioned in connection with this principle (economy is proportional to the size of the load handled) is the

matter of handling less than case quantities on the selection line. The sales of some items are of such a limited nature that the stores are allowed to order one-half a case (a case being the unit in which the manufacturer ships the item). It has been found that handling half cases (or split cases as they are sometimes called) is quite slow and expensive. If the selector must cut open a case on the assembly line, he is naturally slowed down in his selecting process. Also when there are open cases on the line, there is greater opportunity for damaged and spoiled merchandise. It is desirable not to handle any split cases on the selection line, if at all possible. It is not within the realm of the warehousing department to make the final decision on what to do with these items, but the warehousing department can work with the buying department to determine whether or not the item should be dropped from stock or to see if the manufacturer could not possibly pack the item in smaller cases.

The sixth principle states that equipment built for motion should be kept in motion, and that idle equipment should be kept as inexpensive as possible. This principle is generally well followed in the grocery warehouse. An example is the use of pallets to store merchandise. The fork lift truck and other wheeled equipment are used to move the merchandise, but not to hold it in storage. Cheaper pallets and racks (on the selection line) are used to hold the merchandise in storage. An excellent example of equipment built for motion, being kept in motion, is the tow line, which is usually kept running continuously while the selectors are at work. The less expensive hand trucks that the selectors use are generally kept in motion, but not always. The exception is when the hand trucks are on the

loading platform waiting for the orders to be checked and loaded on the delivery trucks. This equipment is built for motion, but it often remains idle for extended periods at this point. Perhaps one solution would be to place pallets on the hand trucks and select the orders onto the pallets. When the trucks reached the loading dock, the pallets could be quickly removed from the truck and the truck allowed to be used again without delay. The reasoning behind this principle is that wheeled equipment is more expensive than non-wheeled equipment and the least expensive equipment that will do the job should be used. A comparison might be drawn with a railroad locomotive and a train of freight cars. The locomotive, being the most expensive piece of equipment in the train, is not allowed to stand idle while the various freight cars are being unloaded. Instead the locomotive is uncoupled and put to work hauling other freight cars, that have already been loaded or unloaded. The more expensive the equipment, the more it must be kept at work in order to pay for itself. Equipment that is to stand idle most of the time should be as inexpensive as possible.

The seventh principle says that the value of equipment is directly proportional to its flexibility. Perhaps this is the reason why the fork lift truck has become the most popular single piece of equipment in the materials handling field. The fork lift truck is the most versatile piece of handling equipment available. This truck cannot only move merchandise horizontally, but it can move merchandise vertically and stack it to considerable heights as well. The fork lift truck can handle pallets, and, if necessary, it can handle skids. It is for these reasons that this truck is a most popular and valuable piece of equipment in the grocery warehouse. The grocery warehouse uses other types of equipment, but none of these has

the versatility and hence the general usefulness, that the fork lift truck does. Low and high lift platform trucks are sometimes used. These trucks are for use with skids only and are unable to handle pallets. Consequently, their usefulness is quite limited. The low lift platform truck is used only to transport skids horizontally and cannot lift the skids high enough to stack vertically. Motorized hand pallet trucks (of both the low and high lift types) are often used in limited circumstances. The motorized hand pallet truck is a small fork lift truck that is directed by an operator who is on foot (instead of riding on the truck). These trucks are used, instead of the larger lift trucks, where the loads are fairly light and where the distances to be traveled are quite small. The travel speed of this type truck is limited by that of its operator. The four wheel non-powered hand truck is probably the least flexible type of equipment in use in the grocery warehouse (closely rivaled by the pallet in this respect). This truck is used in the order picking process and can only transport merchandise horizontally at a speed no greater than that of the tow chain or of its operator who is on foot. The fork lift truck has sufficient versatility to perform the task of almost any other piece of equipment in use in the grocery warehouse. Thus, this truck has considerable value in that its usefulness is greatly extended by its versatility. However, the fact that the fork lift truck can perform almost any task in the warehouse does not mean that it should be used to do all jobs. The smaller, less versatile, less expensive types of equipment have been designed for use in specific circumstances. If properly used, they should prove to be more economical in that particular capacity than the more versatile fork lift truck. Such specialized equipment, though, has a definite, but limited

range of usefulness. In an emergency the fork lift truck can perform the duties of any of the other pieces of equipment, but none of the less versatile equipment can perform the duties of the fork truck. Thus, the most versatile piece of equipment tends to become the most valuable.

The eighth principle states that the use of mechanized equipment instead of manpower generally increases efficiency and economy in handling. A discussion of the types and uses of mechanized equipment and its effects on efficiency and economy has generally been covered in the preceding points. The increase in economy and efficiency due to the introduction of mechanized lift trucks, pallets, tow lines, and so on, is undeniable. However, it is often impossible to distinguish just how much of this increased efficiency is due to the use of mechanized equipment and how much is due to other factors such as better layouts, working conditions and control of operations. This difficulty, though, should not deter one from adopting mechanized equipment wherever the overall results will prove it to be economically feasible. Mechanized equipment permits a larger volume of work output per operator than if the work were performed by hand. The use of such equipment usually must be justified on the basis of savings in labor costs. Mechanized handling equipment ought to be able to pay for itself within a year, or at most, two years.[18] Much equipment can pay for itself on the basis of labor savings in a good deal less than a year. An example of this is a mechanical floor sweeper which was recently purchased by a chain grocery company for use in one of its warehouses. While not a piece of direct materials handling equipment, this item nevertheless contributes

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18 Curtis H. Barker, Jr., "Industrial Materials Handling", Cleveland: The Lincoln Extension Institute, p. 32.

to the efficiency of the warehouse operation. The mechanical floor sweeper cost about $1,200. With this sweeper the entire warehouse could be swept in less than one day. Sweeping by hand was a full time job for one person. If the sweeper were paid $40 per week (and he probably got more), his annual wages would be $2,080. With the mechanical sweeper this work could be performed in less than a day so the weekly labor charges would be eight dollars, and the annual labor bill $416. Thus, the annual savings in labor costs would be $1,664, and the sweeper would pay for itself in less than nine months. This is but one example of how the use of mechanized equipment will increase the efficiency and economy of the operation. The only change that is involved is a change from doing the job by hand to doing it by machine. In most cases the introduction of mechanized equipment involves changes in methods or procedures or in the scope of the job so that the determination of the savings directly attributable to the new machine is almost impossible.

While the use of mechanized equipment generally increases efficiency and economy, there is also such a thing as over-mechanization. The savings to be had from the use of new equipment should always be measured as accurately as possible. It will sometimes be found that the savings will not justify the proposed investment. Examples of this are more apt to occur in areas where wage rates are relatively low and where the new machine is going to be used to replace an existing machine instead of hand labor. While mechanization is generally advantageous, it must be shown to be so on some sound basis. It might be pointed out that the grocery warehouse has not reached mechanical saturation at the present time, as just about every new machine introduced thus far has proved to be a good investment.

The ninth principle is one for which not too much can be said in the field of grocery warehousing. This principle says that the ratio of dead weight to pay load must be kept to a minimum. It can be applied to every piece of equipment in the warehouse. It means that the handling equipment itself should be as light as possible so that for a given total weight the load of merchandise carried will be as great as possible. If the upper limit of a hand operated load is about one thousand pounds, then the lighter the four wheel trucks used on the selection line are, the greater is the amount of merchandise that can be loaded on each truck. The same thing applies to lift trucks and other mechanized pieces of handling equipment. It must be remembered that power is required to move not only the merchandise load but also to move the carrier of that load. If a lighter piece of equipment can do the same job and will stand up as well as its heavier counterpart, it should be chosen in favor of the heavier machine. In an effort to achieve lightness though, one should be careful not to give up in other qualities what is achieved in lightness. A good example of this might be the use of hardwood or softwood pallets. A 40" x 48" hardwood pallet weighs just under one hundred pounds, but a softwood pallet of the same dimensions weighs about 50 pounds. Here a great saving could be made in weight but it would be at the loss of other qualities. Many grocery warehouse operations have found that for what the hardwood pallet gives up in weight it more than gains through longer life and less maintenance. In this case the weight factor would be overridden by the other factors that enter into the choice between the two pallets. The same reasoning applies to the choosing of lift trucks and all other handling equipment.

Not within the warehouse operation itself but directly connected with it is the problem of reducing the weight of the delivery trucks and their bodies. Maximum loads are usually restricted by state law. While the law does not care what proportion of the total weight is merchandise and what proportion is the truck itself, the company operating the truck does. It is of vital importance in all materials handling operations that the ratio of "pay load" to total weight is as high as possible, provided other factors are not sacrificed.

The tenth and last principle states that productivity increases as working conditions become safer. As in the case of the eighth principle, it is often difficult to measure the results of this principle directly or to attribute increases in productivity directly to it. However, some facts are fairly certain. One is that good lighting generally promotes an increase in efficiency. This has been fairly well proven in many industrial examples and it holds for the grocery warehouse as well. Good lighting aids both the selectors and the checkers in doing their jobs faster and more efficiently. Good lighting also aids the other members of the warehouse crew in performing their jobs. Good lighting has another effect in that it tends to promote cleanliness and cleanliness makes for safer working conditions. If the aisles are neat and clean, all pallets are in the proper position on the selection line and in the reserve storage area and the handling equipment is clean and well painted, there is a definite psychological effect on the workers to do a better job and to be more careful while doing it. A worker will be less apt to mistreat brightly painted, clean equipment than if the equipment were battered and dirty. A good coat of paint often seems to promote safer working conditions and higher produc-

tivity. Cleanliness should be applied not only to the movable equipment but to the building, floors, walls, pipes, windows, et cetera. Waste material, loose merchandise, broken cases, pallets jutting out into the aisles all present serious hazards to safe working conditions and are likely to promote accidents. Aisles should be kept clean and free from obstructions. The limits of the aisles should be well defined by clearly painted lines.

The grocery warehouse has done much along these lines to promote safer working conditions. The manufacturers of the mechanical handling equipment have done much to make their equipment as safe as possible. Automatic shutoffs, guards and backrests on the fork lift trucks are but a few of the many safety devices that have been built in this equipment.

Proper maintenance of equipment also makes for safer working conditions and better productivity. A good system of preventive maintenance will go a long way toward eliminating unexpected breakdowns which can cause both serious injury and serious interruptions to the work of the warehouse. Along with preventive maintenance goes proper training of personnel to operate the equipment. Personnel should be well schooled in the operation of the equipment and should also know the general traffic and safety rules and regulations in force in the warehouse. There are many good books and other publications on the subject of training industrial truck operators and on safety rules and practices. These publications, while written for industrial or manufacturing operations, have equal value for the grocery warehousing field and such material need not be repeated here.

CHAPTER V

MEASURING THE EFFICIENCY OF THE WAREHOUSE OPERATION

A materials handling system is not all machines and layout. Human beings still run the machines and without this human guidance the machines would all be worthless. With a given machine, different operators will produce widely varying results in the grocery warehouse. To determine whether or not the equipment is being used properly and in the most productive manner, it is imperative that some sort of measuring device be established to determine the relative operating efficiency of the warehouse. In this field there is no such thing as an absolute standard of efficiency. Instead, the results of one warehouse must be compared with those of another on some basis that is applicable to both.

There are several measures of warehouse efficiency currently in use. The most popular of these is "tons per man hour" (usually written TPMH). Tons per man hour may be computed for the whole warehouse, or they may be computed for different operations within the warehouse, such as car unloading, selecting or car loading. Tons per man hour for the overall warehouse operation is computed by adding together the tons of merchandise received into the warehouse and the tons of merchandise shipped out of the warehouse (during a given period) and dividing this sum by the total direct labor hours. The total direct labor hours as defined by the National Association of Food Chains in its Food Chain Grocery Warehouse Operating Efficiency Reports includes only "labor hours spent in receiving, stowing, selecting, transporting to shipping platform and loading freight for shipment." It excludes "janitor, maintenance, strictly clerical or supervision time

unless actually engaged in receiving, stowing, selecting or shipping freight."[1] This gives a measure of the operating efficiency of the warehouse. The more merchandise that is moved by a given amount of labor the better will be the tons per man hour. It will be noted that the tonnage includes only the tons received and the tons shipped. No allowance is made for merchandise that is handled within the warehouse, while the time spent in handling this merchandise within the warehouse is included in the labor hours. Since the chief purpose of the warehouse is to act as a distribution center, it is productive only in that it receives and ships merchandise. Handling of merchandise within the warehouse is useful only as it allows merchandise to be received and shipped. If an allowance were made in the TPMH for the tonnage handled within the warehouse, then the result would be reduced to what would be essentially a measure of the average load carried. As it is used, any handling within the warehouse will be reflected in increased labor hours which will reduce the TPMH. The TPMH measurement is the best general index of operating efficiency that is available. Some companies prefer to use a slight variation of this in making comparisons. This variation is computed in the same manner as the one just described except that the total direct labor hours does not include time spent in loading the merchandise for shipment on the delivery trucks. This is sometimes referred to as "TPMH less loading". The reason for this is that some companies operate their own trucks while others do not. Companies with several warehouses often use both systems to deliver their merchandise. Usually when a contract carrier is used to deliver to

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1 National Association of Food Chains weekly Bulletin, April 21, 1951, Vol. 18, No. 16, pp. 10-11.

the stores, the trucker loads his truck and this work is not performed by the warehouse crew. Thus, the TPMH less loading is sometimes better for comparison purposes when the warehouses use different delivery systems. The TPMH will naturally give a slightly lower value than the TPMH less loading for the same warehouse.

As well as being used to measure the overall results, the TPMH can be used to measure the operating efficiency of the different classes of work within the warehouse. TPMH is often computed for car unloading (rail only since the highway carriers unload their own trucks), selecting, loading and sometimes checking. In each of these cases, the data will be computed by dividing the tons of merchandise actually handled by the direct labor hours involved in handling the merchandise.

Another measure of warehouse handling efficiency is found by measuring the cases or pieces handled per hour in the different classifications of work. The efficiency of the selectors and the checkers is most commonly measured on a pieces per hour basis. The car unloading and loading jobs are occasionally measured on this basis but they are more often measured on a TPMH or a pounds per hour basis. The difficulty of using either system alone lies in the fact that the case weights of different commodities varies considerably. Unit weights of different items may range anywhere from a few pounds up to one hundred pounds. There is a degree of correlation between the unit weight of the cases being handled and the TPMH obtained for the operation. As the case weight rises, the TPMH output rises also - up to a point. Above 50 pounds per case the fatigue factor seems to become dominant and further increase in unit case weights does not bring about a comparable increase in worker output. Below 50 pounds per

case the TPMH output tends to rise or fall with a rising or falling unit case weight. At the present time no study has been made in this particular area and there is not enough information available to present more specific data on this relationship. However, the information that is available does seem to indicate that there is a small range of unit case weights that can be handled most efficiently by hand labor (in a case by case operation). This is one area then in which further study might result in increased handling efficiency.

In measuring its results, business is generally faced with a dual set of standards. One of these standards measures results in terms of output, production, et cetera, using physical units as the measuring yardstick. This type of measurement as applied to the grocery warehouse (weight and time) has already been discussed. The other type of measurement is a measure in terms of dollars. The balance sheet and the profit and loss statement are the final measurers in dollars of the operations of the business. While the results of a business are being continually measured in terms of dollars, the yardstick is also continually changing in value. It is difficult to compare this year's dollar results with those of ten years ago without correcting in some manner for the changing value of the dollar. This difficulty does not exist with respect to physical measurements such as time, length and weight. Both types of measurements must be used as neither presents a complete picture of the operations of the business. Thus, the operating efficiency of the warehouse is also measured in terms of dollars. The chief dollar figure used in measuring warehouse operations is one presenting the warehouse expense (which includes labor costs and other operating expenses). In order that different warehouses

may be compared, this is expressed as a percentage of the cost value of the merchandise delivered by the warehouse during a period. Expressing the measurement this way may seem to eliminate the variability of changing dollar values. This is done to some extent but not completely, because prices and wages may, and usually do not, move together at the same time and by the same amounts. This percentage should be used in making comparisons of different operations during the same time period, but care should be exercised when making comparisons over an extended period of time during which prices or wage rates have changed to any degree.

Sometimes a hybrid measuring device is used which contains both dollar and physical units. With respect to the grocery warehouse two such measures are commonly used. The first measures warehouse expense in dollars per ton of merchandise handled (total of the merchandise received plus the merchandise delivered). This gives a dollars per ton figure which measures the efficiency of the warehouse in that it shows the present dollar cost of handling a ton of merchandise. The other measurement is really nothing more than a variation of this one. This gives warehouse labor cost per ton of merchandise handled. It presents a direct picture of the labor charges involved in handling each ton of merchandise.

To sum up then, the following data have been presented as a means of measuring the efficiency of the warehouse operation:

1. Physical
    a. Cases per man hour
        (1) Unloading
        (2) Selecting
        (3) Checking
        (4) Loading

b. Tons per man hour

(1) Unloading
(2) Selecting
(3) Checking
(4) Loading
(5) Total warehouse (National Association of Food Chains definition)
(6) Total warehouse less loading

2. Dollar

a. Warehouse expense as a percent of the cost value of the deliveries

3. Mixed

a. Warehouse expense per ton of merchandise handled
b. Warehouse labor cost per ton of merchandise handled

No discussion of measurements of the efficiency of a particular operation would be complete without some mention of work standards or efficiency standards. There is no point in keeping records and computing such a series of data if it is not going to be put to use. These measurements should be used as a guide to determine whether or not operations are up to par and to point out any serious deviations from normal. Their use usually results in the setting of some work or performance standards by management. These standards may be flexible or they may be very rigid. They may be published for all to see or they may not even be printed but just in the heads of a few men. The generally accepted view today is that a performance standard should be a reasonably attainable goal and not a goal that can be reached only occasionally by the very best workers under optimum conditions. A performance standard can be set only after one has a thorough knowledge of the job, the equipment and the conditions under which the job is to be performed. Performance standards are used for several reasons. The main reason is to find out what can reasonably be expected from a workman on a

particular job with a given set of working conditions. Setting a performance standard implies that records will be kept of the performance of every individual who comes under the standard. The standard then provides management with a guide by which it can measure the efficiency of its operations. A performance standard is also used to acquaint the labor force with management's idea of what is expected from each job. In devising a performance standard, Mr. B. L. Thomas of the warehousing division of the Winn and Lovett Grocery Company[2] lists the following seven elements of a successful standard:

1. It must have the confidence of the workers.
2. It must be fair to both worker and employer.
3. It must be set so that it can be reached with a reasonable expenditure of effort.
4. Meeting the standard should carry some form of reward - something to create desire in the minds of the workers.
5. The standard must be simple and easily understood.
6. Paper work should be kept to a minimum; use existing records if possible.
7. A standard requires continuous attention - promotion, publicity and revision as necessary.

Performance standards in the chain store grocery warehousing field have not been codified to the point where one can say, "this is it". Conditions vary so widely that it is impossible to set a standard that can be applied to all warehouses. An example of the variation in efficiencies can be seen in the Food Chain Grocery Warehouse Operating Efficiency Report for November, 1950. The least efficient warehouse operated at 0.73 TPMH while

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2 Summary Report on Warehousing and Delivery Clinic, January 15-17, 1951, National Association of Food Chains.

the most efficient warehouse operated at 2.49 TPMH. It would probably be quite impossible to set one standard that could be applied to both these operations. Perhaps the best that can be done at the present time is to point out some of the results that have been obtained by various warehouses. This will show what has been obtained, but these results should be regarded more as a guide than a standard.

Judging from the November, 1950 Warehouse Operating Efficiency Report 2.00 TPMH would have been a very good operation as only three warehouses out of the 40 reporting companies had an efficiency greater than this, and the highest was 2.49 TPMH. However, in the February, 1951 Report, ten warehouses had efficiencies greater than 2.00 TPMH and the most efficient operation was 2.79 TPMH. Two tons per man hour is still good but it is being achieved by more warehouses and so may have to be revised upward in the future.

The Winn and Lovett Grocery Company of Jacksonville, Florida has worked out some standards which they use in their operation. In receiving merchandise, they can unload 360 cases per man hour stacking the cases on pallets. On the selection line they average 150 cases per man hour. No mention was made of checking the merchandise. Perhaps, like some companies, they did not check the orders leaving the warehouse at all. On the loading operation they claim 500 pieces per man hour. In the overall operation they figure 141 cases per man hour. If an average of 35 pounds per case is used (and this is fairly representative), these standards would work out to the following on a tonnage basis. The unloading operation would give 6.3 TPMH. On the selection line 2.6 TPMH could be maintained. The loading operation works out to 8.75 TPMH. The overall warehouse operation

is 2.46 TPMH. These measurements are fairly high, but they represent what would be considered a good performance today. On checking the orders, other companies have reported that five hundred pieces per man hour can be reached without too much difficulty (on a 35 pound per case basis, this is equivalent to 8.75 TPMH). If the average wage rate prevailing in the grocery warehouse is taken as $1.80 per hour, the Winn and Lovett Grocery Company data can be used to compute the warehouse labor cost per ton of merchandise handled. This computation comes out to $0.73 per ton. If the further assumptions are made (and these are only approximate) that the warehouse labor charges represent 75 percent of the total warehouse expense, that the average cost of a ton of groceries is $300, and that the warehouse ships one-half of the total tonnage handled during the period, the Winn and Lovett Grocery Company data can be extended to compute the warehouse expense per ton of merchandise handled and as a percent of the cost value of the deliveries. The results of these computations are as follows: The warehouse expense is $0.97 per ton of merchandise handled. The warehouse expense is 0.65 percent of the cost value of the deliveries.

Other companies give different figures for the performances that they are obtaining. Mr. R. L. Buchanan, Vice President in charge of Store Operations of the Lucky Stores, Incorporated, San Leandra, California, states that they are operating their grocery selection line at the rate of 175 cases per man hour or 2.75 tons per man hour (this gives an average of 31.4 pounds per case). Their overall grocery warehouse operates at the rate of 1.75 tons per man hour. The warehouse labor cost for the grocery section is less than 0.75 percent of the cost value of the merchandise delivered. This labor cost is about 2.50 percent of the cost of the

merchandise delivered for the drug section and on a combined basis is less than 1.00 percent of the cost value of the merchandise delivered. Another company estimated 2.00 tons per man hour on grocery selection, which is lower than most estimates on this job. The Jewel Tea Company, Chicago, Illinois, claims 1.6 to 1.8 tons per man hour in its single floor warehouse handling approximately fifteen hundred dry grocery staple items. Mr. Milo Geiger, of the warehousing and transportation department of the Krambo Food Stores, Appleton, Wisconsin, gives the following data taken on a check run on their grocery selection line. These measurements are interesting because they show the variation in the selection rate within the selection line itself.

Line 1.	98 items - tissue, sugar, flour, cereals	148 cases per hour
Line 2.	386 items - spices, extracts, gum, candy, cigarettes and tobacco, cheese and drugs	142 cases per hour
Line 3.	210 items - olives, pickles, preserves and jellies, sauce, salt, coffee, tea, mustard, and vinegars	203 cases per hour
Line 4.	198 items - canned fruits and juices, canned peas, corn, beans, tomatoes	263 cases per hour
Line 5.	182 items - canned beets, asparagus, spinach, kraut, potatoes, mushrooms, chinese foods, beans, spaghetti, milk, soups, and fish	214 cases per hour
Line 6.	199 items - canned meats, dog food, macaroni products, nuts, baking powder, baking flours, syrups, shortening, and salad dressings	170 cases per hour
Line 7.	287 items - desserts, chocolate, cookies, dried fruit and vegetables, canning supplies and baby foods	185 cases per hour
Line 8.	362 items - bleaches, cleansers, soaps and powders, household items, grocery and meat supplies	157 cases per hour

The average for the entire selection line works out to 187 units per man hour or 3.7 tons per man hour (which is 39.5 pounds per case).

To summarize, then, the following are presented as being representative of what can be obtained in a good warehouse materials handling operation. The assumption is made that the average weight per case is 35 pounds.

	Cases per man hour	Tons per man hour
Unloading	360	6.30
Selecting	175	3.06
Checking	500	8.75
Loading	500	8.75
Total warehouse	128	2.25
Total warehouse (less loading)	134	2.35

Warehouse expense as a percent of the cost value of the deliveries . . . . . 0.75 percent

Warehouse expense per ton of merchandise handled $1.00

Warehouse labor cost per ton of merchandise handled . . . $0.75

These measurements are not to be taken as a standard, but are rather to be viewed as goals obtainable under (usually) rather favorable circumstances. They represent what can be done in a very good (but not necessarily the best) operation. Also, what is good for today may not be good for tomorrow. Warehouse efficiencies have been steadily increasing in the post-war period since they have been measured and reported on by the National Association of Food Chains. In 1947 the average warehouse efficiency was 0.91 TPMH, and in 1950 it was 1.42 TPMH.[3] If this increase in efficiency were projected to a warehouse handling 10,000 tons per month the average yearly savings due to the increase in efficiency (from 0.91 to 1.42) would be 47,364 man hours of labor. The very fact that efficiencies are being

3 Ibid, p. 33.

measured and compared with one another tends to provide a stimulus to raise them, and higher operating efficiencies are the whole aim of materials handling.

CHAPTER VI

SUMMARY AND CONCLUSIONS

The importance of the warehousing function in the operation of a grocery chain store business cannot be denied. The purpose of the warehouse is to distribute various grocery items to the stores as they are ordered by the stores in the most efficient manner possible. The grocery warehouse generally serves as a distribution center (rather than a storage center) since the food chain store business operates on the principle of a large volume of sales combined with a low average markup on each of those sales. In order that the capital and inventory requirements to sustain this large sales volume do not become excessive, there must be a large turnover of merchandise. A large turnover means that stocks of merchandise on hand are kept at as low levels as are consistent with the policies of the individual company and with the availability of the merchandise, price levels, et cetera. Rapid turnover means a continuous flow of merchandise through the warehouse to the stores. Any interruption or delay in this flow of merchandise means lost sales at the stores. While the warehouse does not stand in the "front line", so to speak, nevertheless, its importance should not be minimized.

It is imperative that the warehouse be operated in the most efficient manner possible. It must not be forgotten, though, that the warehouse is a service operation. The decision as to where to draw the line between strict warehouse operating efficiency and service to other departments of the company is one that cannot be decided by the warehouse division alone but requires the cooperation of all the departments concerned. The decision

reached should be guided by the ultimate aims and goals of the company. Warehouse operating costs today average approximately 2.00 percent of the cost value of the merchandise shipped from the warehouse. Expressed in another manner, warehouse operating costs take about one-tenth of the gross profit obtained on the sale of the merchandise that the warehouse handles. If this expense ratio can be reduced through more efficient methods and the warehouse still provide the same service, the results will be noticed in a rising net profit. With the long run trend of margins being downward, continual improvement in areas of the company's operations, such as the warehousing function, must be obtained if profits are not to disappear altogether.

The grocery warehousing process is mainly a matter of materials handling and it has been through better handling methods that the warehouse has improved its performance. The use of mechanized equipment before the advent of World War II was quite limited. It was during and after World War II that industry in general, and the grocery warehouse along with it, adopted and made extensive use of mechanized devices which greatly improved materials handling efficiency.

Out of the knowledge that has grown up about various handling methods over the years, there have evolved certain principles which can be used as a guide in establishing a materials handling system or in evaluating or improving one already in existence. These principles cover all phases of materials handling and can be applied to any situation. In different situations, different principles may receive the emphasis and become the most important. There are ten of these principles of materials handling and they have been listed and explained in Chapter III of this work. To sum

them up briefly they cover the following points: Layout, continuous material movement, standardization, storage space, size of load handled, use of motorized and wheeled equipment, flexibility of equipment, mechanized equipment versus manpower, ratio of dead weight to pay load and safe working conditions. Each of these principles has been applied to the grocery warehouse to a greater or lesser extent over the years. The result of this application has been substantial and continued improvement in the operating efficiency. How these principles have been applied has been pointed out in detail in this work. With respect to the layout of the warehouse certain trends are apparent. The chief among these is the use of larger selection and smaller storage areas. Greater use of racks is being made on the selection line in order that the capacity of the line may be increased and more merchandise stored above the line. As many articles as possible are handled on the line instead of being selected from the reserve storage. These changes all increase the selectors' efficiency and reduce the handling required. Also, in locating items within the warehouse, more attention is paid to the average tonnage output of each item. Heavy tonnage products are given positions in the warehouse adjacent to the receiving and shipping docks in order that the merchandise will be transported a minimum distance.

Since turnover is being emphasized more and more in the grocery warehouse, it becomes increasingly important as the tonnage handled by a given warehouse expands over the years. This increased emphasis on turnover also reflects a greater sense of cooperation between the warehouse and the buying departments. This cooperation is required to obtain the best overall results and will become increasingly evident in future years. Cooperation

is not limited to the warehouse and the buying departments, but extends to other departments of the organization as well. In the future it can be expected that the warehouse department will work more closely with the store planning, location and layout group (chiefly with respect to back room lay-out, unloading facilities, and distance from the warehouse). There will also be greater cooperation with the store managers and supervision with respect to ordering (the warehouse can work most efficiently when the daily orders are approximately even in tonnage) and time of deliveries. Getting back to turnover of merchandise within the warehouse, it was shown in Chapter IV, page 18 how non-adherence to the company's policies on this point can result in large sums of money being tied up in merchandise and also in decreased operating efficiency for the warehouse due to congested conditions. The decision to speculate on price movements does not rest with the warehousing department. Any such decision should take into account not only the monetary risks involved but also the intermediate difficulties that the warehouse will face in getting merchandise out to the stores when it is in an overstocked condition.

In keeping goods flowing through the warehouse, the car-aisle is an innovation that will bear watching in the future. While this system reduces the required handling of merchandise, its use brings up several problems which have as yet to be satisfactorily solved. Problems generally have been overcome in the past, though, and if the system has sufficient merit, its adoption should become more widespread in the future.

In the area of standardization much future progress can be expected. First, the 40" x 48" four way entry pallet will probably become standard in the grocery warehouse field. This size is most suitable for train and

truck shipments and has already been recommended as the standard pallet size. It represents the best compromise between the various factors that must be considered in choosing a pallet size. Second, more cartons in the future will be designed with handling requirements in mind. Sizes will be adjusted so that cases can be stacked on a pallet with no waste space and in such a manner as to form stable interlocking loads. Third, other types of equipment will become more standardized but this is in the more distant future. New and special types of equipment are still being introduced at such a rate that not too much progress has been made in standardization as yet.

The unit load principle has been adopted in the receiving and stocking portion of the warehouse operation but there is much opportunity to apply this principle to the selection and delivery side of the operation. Experimental work is being done by several companies with palletized shipments to the stores and other means to reduce the handling operations in selecting the merchandise and getting it out to the stores.

The day also may come when the warehouse will receive all its merchandise on pallets. This will greatly reduce the time required to unload the merchandise as compared with the present tedious hand methods.

Greater cooperation will be forthcoming from the buying department with respect to slow moving items. Slow moving items should be obtained from the manufacturer in smaller case units so that cases will not have to be split open in the warehouse.

Skids will probably be used less in the future in the grocery warehouse. Skids are not as versatile as pallets (since they cannot be piled on top of merchandise) and hence their value is not as great. Along with

skids will go platform lift trucks. The fork lift truck will gain in use and value in the grocery warehouse.

With the advent of heavier loads and greater speeds of movement of these loads, greater stress is being placed on safety. Lift trucks are being made easier and more foolproof to operate; operators are trained more thoroughly; plant safety rules are established and enforced; preventive maintenance is employed to eliminate breakdowns and accidents; and the plant itself is arranged with aisles of the proper width; aisles are well defined and are kept clear from merchandise, pallets and trash; and better lighting is employed.

Various data have been established and applied to the warehouse to measure the efficiency of its operation. More extensive use will be made of these data in the future as more operators realize the advantages to be gained thereby. These measure the overall output of the warehouse both in physical (TPMH) units and in terms of dollars (operating cost expressed as a percentage of the cost value of the goods shipped). Individual records can also be kept for each man in the warehouse who is engaged in receiving, selecting, checking or loading. The productivity of each man is known and this provides a useful tool in union negotiations and is sometimes used to establish incentive pay plans.

The use of these measurements is the only means whereby management can actually tell on an exact basis what the results of the application of various materials handling methods are. They remove the guesswork from measuring the efficiency of different methods of operation that are employed in the warehouse. Certain data have been presented that represent

what are very good operations today, but they are not achieved by all companies and should not be construed as setting a standard. Also they will doubtless become outdated as operating efficiencies improve, and as new methods and equipment are employed.

Grocery warehouses have undergone extensive changes and improvements in the materials handling methods employed over the last ten years. Modern mechanized equipment has been introduced and scientific analysis applied in determining the best layout of the warehouse. These changes have brought about a rise in efficiency and increased productivity. In spite of rising labor and other operating costs, the expense ratio of the warehouse (as a percent of sales) has remained approximately constant. While the warehouses have made great strides in the past, there are still many opportunities for further improvement which can be expected to be forthcoming in the future.

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