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An evaluation of materials handling equipment in general merchandise warehouses Richmond, Va.

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AN EVALUATION OF
MATERIALS HANDLING EQUIPMENT
IN
GENERAL MERCHANDISE WAREHOUSES
RICHMOND, VIRGINIA

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CHAPTER I

INTRODUCTION

The Definition and Importance of Materials Handling

In order that the reader may understand the positive need for materials handling equipment, he must be fully aware of the value to modern society of the function of materials handling as an integral part of physical distribution. The dynamics of modern marketing places an increasing importance on the physical distribution functions. The population explosion, the resulting increase in numbers of buying units, and the outward thrust of these groups from the central parts of the cities into the burgeoning suburbs, has strained the ingenuity and ability of the distributive agencies to keep pace. Production has demonstrated its power to spew forth an infinite variety of consumer and industrial goods in an ever-increasing stream, a stream which has been met by demand backed by apparently limitless bank accounts, stimulated by consumer oriented marketing managers aided by motivational research specialists. The problem of meeting the demands of America's consumers has become one of physical distribution and physical distribution is an integral part of marketing. In the words of one authority, "You can't really separate a company's physical distribution system from its marketing system, except to

talk about it. The policies, goals, and strategies are inter-related. The marketing department and the distribution departments ... work together and exchange information to maximize profits."[1] The management of physical distribution has received a larger and larger share of attention from marketing men as competition has emphasized the need for creating additional time and place utility.

The writer has chosen to concentrate on the specialized area of materials handling equipment which bears the major burden of the storage function of physical distribution. "Traditionally, product storage has been an important part of economic activity. Originally performed by consumers for personal needs -- later this function was transferred to retailers, wholesalers, and manufacturers."[2] Another source comments, "The primary purpose of storage is to adjust supply and demand through the creation of time utility. Through storage, goods are made available at the time needed and in the proper condition."[3]

[1]Kramer, Walter, "Physical Distribution and Marketing" Handling and Shipping, vol. 13, Feb. 1964, Cleveland, Ohio; The Industrial Publishing Corp., pp. 32-33.

[2]Smykay, Edward W., Bowersox, Donald J., and Mossman, Frank H., Physical Distribution Management, New York; The McMillan Co., 1961, p. 202.

[3]Philips, Charles F., and Duncan, Delbert J., 5th ed., Marketing, Principles and Methods, Homewood, Illinois; Richard D. Irwin, Inc., 1964, p. 667.

Another authority states, "All materials handling is transportation and all transportation is materials handling, but the latter refers usually to movement within a plant, mine, warehouse and so forth."[1] Another emphasis is given to the problems of physical distribution by the statement, "An area that represents the greatest drain on profits for United States industry ... the handling and distribution of goods in warehouse, factory and mine."[2] Still another source is quoted, "It has been said today that the greatestopportunity for the reduction of industry costs ... lies in the more economical handling and transporting of materials. The continuous flow of goods is important."[3] The fact that the writer is concerned here with the equipment to be used in the handling of materials, makes an understanding of the concept of materials handling important to the reader. John R. Immer comments as follows: "Materials handling is the means by which the goal of greater efficiency may be attained not only in industry but wherever materials must be moved."[4]

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[1] Stocker, Harry E., Materials Handling, New York; Prentice-Hall, 1943, p. 1.

[2] Thomas, Dana L., "Good for the Long Haul", Barron's, vol. 43, Sept. 9, 1963, New York; Dow Jones Co., Inc., p. 3.

[3] Bethel, Lawrence L., Atwater, Franklin P., Smith, George, H.E. and Stackman, Harvey A., Jr., Industrial Organization and Management, New York; McGraw-Hill, 3rd ed., 1956, p. 304.

[4] Immer, John R., Materials Handling, New York; McGraw-Hill, 1953, p. 3.

Immer defines materials handling as, "The preparation, placing and positioning of materials to facilitate their movement or storage."[1] It should be realized by the reader now that the storage function can be efficient only if the handling of goods within the storage area is efficient and that planning for the handling in advance of storage eases the problem of movement in and out of storage. The value to the industry of efficient materials handling may be more fully sensed from another statement, "From the standpoint of labor, improved methods of materials handling offer the greatest prospects for higher wages and better working conditions."[2] And again, "The warehouse industry is based almost entirely on handling and storage of materials. A change of 10% in handling costs ... to the warehouse, may be a matter of life or death. Materials handling now requires specialized knowledge and there emerges the materials handling engineer."[3] (The writer points out that a change in costs is reflected in Gross Profit and therefore in Net Profit.)

Now that the reader is aware of the important place which materials handling occupies in present day physical distribution, the next step is to outline the historical growth and development of materials handling methods and equipment in the succeeding section.

[1] Ibid, p. 3
[2] Ibid, p. 5
[3] Ibid, p. 8

A Brief History of Materials Handling

One of the most interesting facts to be uncovered by the student of materials handling is the early appearance in history of equipment and methods to replace manpower, and the relatively rapid tempo of development during the past fifty years.

The development of materials handling equipment may be divided into three periods of time. The first period begins with the earliest records found in ancient Britain, Greece, Rome, and Peru and ends at 1900 A. D. During these many centuries, materials were moved by manpower with the assistance of crude cranes, hoists and other lifting devices. These mechanical means, however, were generally used only when the objects were too heavy for manpower alone.

The second period covers the years 1900 A. D. - 1940 A. D. during which we find movement of materials being carried out by mechanical means wherever possible in preference to manpower. There is no absolute delineation between these periods for there is an over-lapping due to the evolution of mechanical devices.

The third period includes the years since 1940 because of the rapid development of materials handling equipment as the result of the need for speed in handling during World War II and the carry-over into the post war years.

Period Prior to 1900 A. D.

The examples still to be seen of ancient materials handling capacity must include the Great Pyramids of Egypt, the obelisks of both Egypt and Rome, and the Stonehenge in England, where blocks of stone weighing eight to twelve tons and standing fifteen feet high are thought to have been moved over water by raft then over land by sled. In the building of a pre-Inca temple near Cuzco, Peru, individual stones of twenty tons were raised 2,000 feet from the valley floor, probably, it is thought, by a series of canal locks.

The late President Herbert C. Hoover and his wife, Lou H. Hoover are responsible for the translation from the Latin first edition, dating from 1546 or 1556, of a work titled De Re Metallica, written by Georgius Agricola. This translation was made and published privately in 1912. Although this translation has not been available to the writer, excerpts from this are found in later writings. Reprints of some of Agricola's drawings, found in the work of John R. Immer[1], show a hand windlass with a flywheel for stability. This curious equipment was occasionally geared, using manpower by means of a treadmill. Another device shows water being raised from a mine by means of a chain carrying metal dippers with both the chain links and dippers removable for replacement, -- the whole operated by manpower.

[1] Ibid, Chap. 2

Still another, reveals a suction pump and various types of force pumps, one being described as a series of balls of horsehair with a sewn leather covering, fastened to a chain at six foot intervals, drawn through a vertical pipe. The chain was then run over a 24 foot wheel powered by either man or horse on a treadmill, generating enough energy to pull water from a depth of 210 feet. Other drawings show a four wheeled wooden cart running on wooden rails, a wheel-barrow and a jib crane. Immer states that De Re Metallica was used as a standard text on metallurgy for 200 years.[1] In 1770, Josiah Wedgewood is reported to have experimented in England with a factory layout to improve materials handling. In 1785, Thomas Jefferson reported from France that muskets were being produced with inter-changeable parts. Pictures reveal that in 1796 an English foundry used a swing-ing crane. Eli Whitney, in 1800, was mass producing muskets by means of a bench assembly line, the partially completed firearms being passed from hand to hand.

Lewis Mumford[2] refers to early German drawings reproduced by courtesy of the "Deutsches Museum Munchen," revealing a mine interior utilizing a wooden ore cart bound with iron straps and a rudimentary version of an automatic revolving screw coal stoker.

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[1] Ibid

[2] Mumford, Lewis, Technics of Civilization, New York; Harcourt, Brace & Co., 1934, p. 143.

Period 1900 - 1940

Beginning about the turn of the century, manpower was being replaced by equipment, with production based on the use of conveyorized machine or assembly line. Described by Lewis C. Ord[1] is the manufacture of wooden flat cars in 1890, each car made by a single gang of workmen, then the use of separate gangs of workmen for each section of the car, bringing higher output with reduced costs of production although accompanied by increased costs of materials handling. At this time, nine hours constituted one work shift, seven hours were required to complete one car and eleven cars could be produced each day on six separate tracks.
Ralph C. Davis quotes T. B. Copley as stating, "Bethlehem Steel, at the turn of the century moved pig iron by hand. Investigation showed that workmen handling 92 lbs. of pig iron can be under load only 43% of the time. Today, pig iron is moved by modern conveyors."[2]

Further reference to the use of manpower instead of mechanical devices is commented on by Edward W. Smykay, "The reported internal operation of early warehouses illustrates the general neglect of efficiency concepts. These warehouses received merchandise ... which was manually moved to the storage area, ... then hand piled on the floor.

[1]Ord, Lewis C., Secrets of Industry, London; George Allen & Unwin, Ltd., 1944, p. 18.

[2]Copley, T. B., Fred W. Taylor, vol. ii, p. 41, quoted in Davis, Ralph C., Industrial Organization and Management, New York; Harper & Bros., 1940, pp. 186-87.

Because of cheap labor rates, manpower was freely utilized with little consideration of efficiency in space utilization, work methods, or materials handling."[1]

Finally, the point was reached, where, in May 1913, Henry Ford used a continuous assembly line with the men remaining in one place while the materials flowed past. The Ford Motor Company established the first progressive assembly line which was followed by numbers of other conveyor lines. During World War I, this method was widely used, with fixed path equipment, and this remained the main production technique until World War II. During the 1920s there was a conversion to conveyors and to parts kits, both of which were used in several automobile plants in the United States. In the 1930s these systems were adopted by Standard Automobile Company in England.

Period Post - 1940

The advent of World War II necessitated increased production without regard for cost. Many plants invested in materials handling equipment and the economics of production resulting continued this development into the post war period. One form of materials handling equipment which had evolved from the Henry Ford assembly line was the conveyor in a wide variety of types and forms. As a partial

[1]Smykay, op. cit., p. 203.

explanation of the problems faced by materials handling manufacturers in the post World War II period, the writer refers to a recent article by Dana L. Thomas which offers the following significant statement, "In the years before World War II, materials handling came to be taken for granted but management was more interested in high speed production. Materials handling as such added nothing tangible to the value of goods sold ... so we found it increasingly difficult to induce businessmen to put money into improving their conveyors, reminisced a sales executive. This situation has changed. Soaring labor costs and narrowing profit margins have forced business to take another look at conveyors. The critical sale of materials handling has been intensified by giant advances in automation. Now, computers are linked to storage and automatic conveyors."[1] Further in the same article, Mr. Thomas comments, "However, push button warehouses are unlikely to mushroom until several difficulties are overcome. They are costly, and once installed, hard to alter. They must repay investment early, for they may become obsolete within ten years. Moreover, selling the idea to labor unions is very difficult. Some experts forecast that, over the next decade, the installation of automated systems could cause the loss of 50,000 unskilled jobs while creating positions for 2,000 skilled analysts."[2]

[1]Thomas, op. cit., p. 3.
[2]Ibid, p. 5.

In 1956, the rapid trend to automatic equipment was noted in a remark by Lawrence L. Bethel, who stated, "Certainly, the most significant trend in materials handling today is that directed toward operatorless handling equipment and systems."[1] Today, in 1965, the materials handling engineer finds that there is almost no limit to his opportunity to improve materials handling methods in the average warehouse. One recent development currently offered by a manufacturer of industrial equipment is metal flooring for warehouses, trucks and rail cars within which air is circulated, forced upward through vents on contact with objects pushed across its surface, the air supporting heavy loads which can be pushed by a man instead of being placed on wheeled vehicles. The same company offers pallets (platforms), on which loads are piled, the pallets having their own contained cushions of air forced downward against the floor.

One materials handling equipment salesman remarked that most warehouses are inefficient because they have either outgrown their space and have not concentrated their efforts on handling large enough unit loads or they have thought they could solve their problems by increasing space without increasing their utilization of space. Another made the startling comment that if warehousemen really tried to solve their problems effectively, the materials handling salesman would

[1]Bethel, et al, op. cit., P. 312.

be out of business because direct shipments from manufacturers to users would eliminate the need for a great deal of warehousing.

Having given the reader a brief history of the growth and development of materials handling methods and equipment, in the following section the writer will suggest a set of sound principles to guide those who are responsible for the solving of materials handling problems.

Principles of Materials Handling

It is important to establish principles governing the solving of materials handling problems in order to think clearly about the different areas of problems and to concentrate attention on each one separately. As one authority states, "These principles provide a convenient framework for the mass of information, examples, techniques and methods, also serve as a test of the values of these examples."[1] The principles seem to fall naturally into four major classifications, the first three of which will be discussed here. These classifications are,

Principles of Planning

Principles of Operating

Principles of Equipment

Principles of Costing

[1]Immer, op. cit., Chap. 3.

The last of these principles, Costing, will not be discussed in this paper because it involves so many variables which are unrelated to the actual application of equipment to a specific materials handling problem. For example, the purchase of equipment will be partly governed by the amount of money available even though the cost of the best equipment for the purpose may exceed the budget. Since information of this kind could not be made available the question of cost of equipment was omitted from this paper.

Principles of Planning

Outlined below are some acceptable principles concerning the planning of materials handling functions.

1. It is important to plan for the over-all economy of handling materials. Maximum economy in handling materials is obtained by reducing the terminal time (waiting time) of equipment to the minimum. Waiting time is lost time. "Greater economy is obtained as the ratio of equipment investment to units of materials handled is reduced."[1] For this reason, power units should be separate from load carrying units in order that one may be moving while the other is being loaded or unloaded. If the power has to wait for the loading, time and money are lost.

[1]Stocker, op. cit., p. 7.

2. It is important to sell to the staff the philosophy of materials handling. Everyone must be made aware that not only is waiting time lost time, as stated in the preceding paragraph, but that every unnecessary movement adds to the cost of production. Carefully planned motion should be the objective.

3. Warehouse layout should be studied continuously in order to reduce handling.

4. Responsibility for materials handling should be delegated to one person so that the problems of production or storage will not interfere with the objective analysis of the problems of materials handling.

5. In the storage of materials it is important to utilize fully all three dimensions in space, namely, depth, width, and height. For example, the full utilization of vertical space may eliminate the obstruction of one row of material by a second row, reducing the need for lateral space and lateral movement thereby reducing the time required for movement.

6. Live storage must be utilized. By this is meant having goods in motion on equipment which is filling a necessary movement function to facilitate handling. For example, the amount of goods in motion on conveyors or assembly lines reduces the amount of handling time needed and increases storage space available.

Principles of Operating

The following paragraphs set forth eleven principles governing the operation of materials handling functions.

1. Productivity is increased as working conditions provide safeguards for the health of the workmen.

2. Efficient handling is safe handling. Accidents through carelessness reduce production and increase costs.

3. Productivity of men is increased as fatigue is reduced by the use of mechanical equipment and other aids to the reduction of fatigue.

4. Work should be planned to avoid re-handling. This requires an analysis of the flow of materials into storage, time in storage, and removal from storage, starting with the receiving platform and ending with the delivery platform.

5. Economy is obtained as the size of the load unit handled is increased with the use of mechanical equipment. This is true whether the package handled is prepared by the shipper or made up by the warehouse. Thus, the unitized load becomes important.

6. Make use of gravity wherever possible in the movement of materials.

7. Where gravity is not sufficient, use mechanical means for moving materials.

8. Productivity of equipment is increased if repairs and replacements are anticipated and schedules and procedures are established for the maintenance of equipment.

9. The unit expense of materials handling increases as the quantity to be transported exceeds the capacity of the plant.

10. Economy in handling materials is obtained if they are moved in a straight line.

11. The determination of the best practice under particular conditions is necessary to maximum economy.

Principles of Equipment

In the succeeding paragraphs, the writer has stated a number of principles to govern the selection and use of materials handling equipment.

1. Economy in materials handling is obtained by the use of mechanical equipment for handling heavy units of materials. Thus, the use of air or vertical space becomes a way of utilizing heavy equipment to conserve space while handling larger unit loads, reducing movement of materials, increasing the speed of handling and reducing the use of manpower.

2. Select the proper equipment for a particular job. Each piece of equipment has both specific uses and general uses but none is suited to all jobs. It is necessary to know the advantages and the limitations of each piece of equipment, the materials it can handle and its operating characteristics and abilities. Equipment not suited to the job in hand may be eliminated in the beginning.

3. It is important to select equipment and to use methods which are flexible in use and application because to do so is economical. Thus, as examples to illustrate, a swing boom may be preferable to a rigid boom because it can cover a wider area thereby solving more than one problem, or a fork lift truck with a pallet (platform) may be superior to a hand lift with a skid because it will lift more pounds of materials to greater heights in a shorter time.

4. It is important to integrate equipment into the materials handling system of the plant.

5. As the dead weight of equipment is reduced in relation to the load carried, unit costs of equipment and maintenance are reduced.

6. It is important to coordinate the operation of materials handling equipment, to synchronize men and equipment.

7. Reduce the terminal time of power units, -- plan their use to keep them working.

Summary

In this chapter the importance of the place which materials handling occupies in the area of physical distribution has been explained. This has been followed by a brief historical sketch of the development and growth of materials handling methods and equipment together with a set of principles to guide the planning, operation, and use of equipment necessary in carrying out the materials handling functions.

In Chapter II, which follows, an attempt is made to enlarge the understanding of the reader by discussing the factors which enter into the selection of materials handling equipment.

CHAPTER II

FACTORS IN SELECTION OF MATERIALS HANDLING EQUIPMENT

Analysis of Materials Movement

The first step in the selection of equipment is to analyze the requirements of the business in order to form an ideal pattern for the movement of materials from the point of receiving to the point of shipping. This analysis should include the following three factors:

1. The path the materials will follow and the areas of the warehouse involved.

2. The methods to be employed in handling the materials and the preparations necessary for handling.

3. The equipment to be used.

Path Materials Will Follow

With respect to the first factor, one source has stated, "In planning a materials handling operation, the objective is to determine how to transport in the shortest possible time with the least expenditure of money and energy so as to obtain the maximum productive efficiency."[1]

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[1]Stocker, Harry E., Materials Handling, New York; Prentice-Hall, Inc., 1943, p. 1.

It is appropriate to refer here to one of the Principles of Operating, stated on page 16, "Economy in handling materials is obtained if they are moved in a straight line." The modern and efficient warehouse manager or materials handling engineer will design his layout so that each unit of material will be moved only once into storage and once out of storage. One of the Principles of Planning to be found on page 14, states, "Warehouse layout should be studied continuously in order to reduce handling." To do this would probably require a series of flow charts. If materials are to be divided and distributed at once, they may be moved directly to a distribution area as close as possible to the shipping platform without being placed into storage. Re-handling of materials adds time and labor to the costs. Again, refer to one of the Principles of Operating on page 15, "Work should be planned to avoid re-handling."

Warehouse areas are generally classified into three or more divisions based on the time that the materials are expected to be in storage. For convenience, speed, and economy of handling, fast moving goods will be assigned one area, slower moving goods a second area, and so forth. Goods expected to be in storage without movement for more than a brief time are separated from the others. The fastest moving goods generally will be placed nearest to the shipping

department and the distance of the others from the shipping department will be proportionate to their decreasing rate of shipment, considering, however, factors of load unit, weight and size. The reason for this is that the fastest load carrying equipment is severely limited in load capacity, therefore, it may be utilized most economically when speed of movement due to frequency of movement, is more important than size or weight of load.

Slow moving equipment with large capacity may be utilized most fully when speed is not the first issue. Since movement into storage generally occurs with less frequency but in larger volume of car load lots than removal from storage of case loads, the storage placement factor calls for careful study.

Methods to be Employed

The second factor to be considered is that of methods to be employed in the movement of materials. It is fitting to refer to one of the Principles of Operating and quote from page 15, "Productivity of men is increased as fatigue is reduced by the use of mechanical equipment and other aids to the reduction of fatigue." And a second principle, "make use of gravity wherever possible in the movement of materials."

In keeping with these principles quoted mechanical means of moving goods will be used wherever possible with gravity

receiving first consideration, and as few men as possible will be utilized. It will be necessary to plan and prepare the receiving platform to provide space for the quantities of goods to be anticipated and to select the methods which will result in the handling of large unit loads in the shortest possible time with the least effort. Each area of the warehouse will be planned with the following objectives in mind: prepare to handle the largest possible quantities in the smallest possible space, moving materials the shortest possible distance with the smallest possible expenditure of manpower.

Equipment to be Used

The third factor to be considered is that of equipment to be used. On page 15 is stated the following Principle of Operating: "Economy is obtained as the size of the load unit handled is increased with the use of mechanical equipment. This is true whether the package handled is prepared by the shipper or made up by the warehouse. Thus, the unitized load becomes important."

Plans should be made for equipment which can handle large unit loads, to move goods without power but by gravity wherever possible, to utilize vertical space for storage and equipment which can lift heavy loads to great heights. Based on the Principle of Equipment found on page 17, "It is important to select equipment and to use methods which are flexible in use and application because to do so

is economical", the decision should be made to select that which has a wide range of uses. Thus, the decision might be made to use a fork lift truck with a high load capacity, with a telescoping mast to reach 18 feet in the air and a variety of attachments so that it could handle boxes, bales, bags, rolls of paper or carpet as well as a multitude of other materials, moving in and out of rail cars or trucks and placing in or removing from storage.

Having analyzed briefly, in this section, the basic problems involved in the movement of materials, the succeeding section discusses the factors to be considered in the choosing of specific types of equipment.

Determination of Choice Specific Types of Equipment

Material to be Moved

One of the first considerations must be the general characteristics of the material to be moved. Materials may be divided into bulk goods and packaged goods for the purpose of the discussion. Bulk materials such as coal, lumber, furniture, liquids and soft substances, including grains, which would be handled in car load lots, may be classified or divided by the amount or quantity to be moved, the size of the object or unit load, and the flow-ability of the material.

Packaged goods, including crates, cases, cartons, boxes, barrels, bags and rolls, may be classified by weight, size, shape and the strength of the container.

A second consideration will be the physical state of the material. By this is meant the fragility or durability of the material. With respect to the bulk goods, the shape and hardness of the particles and possibility of damage to the shape should be considered. Considered also should be the possible effect of atmospheric conditions, such as dust, temperature, moisture and the need for protection from those elements.

Other considerations may be, possible chemical action, such as corrosion of metal, damage to painted or polished surfaces, fire hazards from spontaneous combustion of coal or grain. Here also, must be protection from changes in temperature and moisture conditions. Perishable goods will require special protection from many of these hazards.

Specialized equipment will be needed to handle quantities of small containers, small or large crated or cased goods, cylindrical objects, perhaps light but cumbersome or heavy and compact, irregular shaped objects, round, square or flat objects.

Having discussed the problems of the nature of the materials themselves, problems revolving around the materials flow are discussed in the succeeding section.

Nature of the Operation

There are six factors worthy of consideration, all of them concerned with the movement or flow of materials, which are discussed in the succeeding paragraphs. The six factors are:

1. The relative permanency of the operating problem to be solved.
2. The sequence of the operations.
3. The volume of production to be handled.
4. The continuous or intermittent flow of the materials.
5. The nature and extent of the movement of the materials.
6. The distance the materials are to be moved.

Relative Permanence of Problem

The first factor is the relative permanency of the operating problem to be solved. If a materials movement path is a permanent one, fixed path equipment may be installed. Under this classification are included, elevators, hoists, and fixed conveyors of all types. A temporary or changing problem, however, does not justify the expense of permanent equipment but calls instead for flexible use and perhaps portable equipment which may be set up and moved quickly.

Sequence of the Operations

The second factor concerns the sequence of the operations. Where the flow of work involves a pre-determined series of movements, the materials will flow in a fixed path. The choice of equipment to support the flow of materials will be determined by the plant layout, which may have to be preceded by a methods and flow study handled by competent materials handling engineers.

Volume of Production to be Handled

The third factor is the volume of production to be handled. Heavy, bulky, or awkwardly shaped materials resulting in a slow movement, will call for a different type of equipment from that needed for small, easily handled goods. The concerns here are with the weight, size, and capacity of the equipment.

Continuous or Intermittent Flow

The fourth factor is whether the flow of materials is continuous or intermittent. A constant flow will require a different type of equipment from a varying or intermittent flow. This difference is partly the result of the rate or speed of flow as well as the sequence of operations but needs to be considered separately. A continuous flow is more likely to use fixed path equipment although non-fixed equipment may be set up if properly scheduled to suit the flow of materials. Equipment may be operated continuously or intermittently to adapt to production requirements. The normal requirements of general merchandise warehouses present intermittent flow problems for the most part.

Nature and Extent of Materials Movement

The fifth factor concerns the nature and extent of the movement of materials. The first consideration here, must be how the goods are to be moved, whether by manual or mechanical means, whether by gravity or power equipment. The next step is to consider in what direction the materials are to

be moved. The final step is to determine whether the materials are to be moved horizontally, vertically, or by a combination of these movements. It will be found that strict vertical movement has a higher cost factor on account of technical complexity and cost of equipment and load factors. In addition, most vertical movement is needed only intermittently which increases the cost per unit of materials handled. It is well to point out here that some equipment normally used for horizontal movement may be easily adapted to situations where inclined movement will eliminate the need for and expense of vertical movement.

Distance Materials are to be Moved

The sixth factor is the distance that materials are to be moved. Here it should be kept in mind that time is money and that the objectives of sound practice should be to move the largest possible loads the shortest possible distance in the shortest possible time. It will be made clear in a later section of this paper that some types of power equipment are better suited to the transport of large quantities of goods over longer distances than other types. The 'down' time of expensive power equipment, meaning the time during which it is not in motion to move a load, is wasted time. For this reason, the use of powered but also load carrying equipment must be limited to relatively short runs in order to reduce to a minimum its non-productive time. For this

reason, it is important to operate powered, load carrying equipment with full capacity loads within relatively short distances and replace this equipment with other types for longer distances.

The next step in this discussion is to consider the problems of plant facilities.

Plant Facilities

Structural Problems

The selection of equipment is frequently restricted by the inefficiencies presented by the building in which materials are to be handled. The obsolescence factor is one of the most common, for such rapid changes have taken place in the development of materials handling that building construction has fallen far behind. Harry E. Stocker remarks, "Some industrial structures have actually been obsolete in certain operating particulars the day they were completed, owing to lack of thoroughness in studying requirements for the most economical handling of materials."[1] Another major problem is the age-old one of attempting to adapt a structure built for one purpose to another purpose. Modifications of old structures may be made, often, however, at great expense. Factors such as the location, load capacity, speed, and number of elevators and hoists in a multi-floored building furnish one example of a serious problem due to the expense of changing.

[1]Stocker, op. cit., p. 211.

Floors and Ceilings

Construction characteristics offer a problem with respect to the load bearing capacity of floors. For example, a warehouse might be prevented from using its vertical space for raising its storage level by an insufficient floor load capacity. Akin to the problem of floor load is that of ceiling load. Overhead conveyors, suspended from the ceiling, require inherent strength in the ceiling supports. General merchandise warehouses normally use only light weight overhead conveyors so that this is not often a problem for this group. The floor and ceiling load problems are combined into one for a multi-floored warehouse.

Lack of sufficient ceiling height may be a problem by limiting the warehouse ability to utilize vertical space for additional storage even when the floor supports allow the added weight. One warehouse, seen by the writer in Richmond, solved the problem of floor load by suspending a mezzanine from the ceiling. The problem of lifting loads to mezzanine height was solved by the use of a portable powered hoist set in a fixed position.

Columns supporting the ceiling of a warehouse may be found to be spaced awkwardly for the desired width of aisles, walls may interfere with space planning, doors may be too narrow or their height may be too low for load carrying equipment.

Another often seen failure of planning even in new buildings is to find the level of the floor of the receiving and delivery platforms too low or too high for the floor of the average truck. Equipment is available to meet this situation in the form of ramps, called dock boards or dock plates, both fixed and portable as well as manual or power operated. Added equipment means added expense which good planning could have lessened, if not eliminated. Those businesses which have found it advisable or necessary to continue the occupancy of old buildings as well as to spread with growth into adjoining old buildings, usually find that each building has its own floor level. The different floor levels create a problem for load carrying trucks, which problem may be partially solved by ramp construction.

A problem of considerable consequence is the texture of the floor surface. A rough surface is hard on trucks. Conversely, soft floors may be injured by the trucks. To solve these problems, truck tires may be made of metal, wood, solid rubber or pneumatic air-filled to suit the floor surface, existing or planned.

Number of Levels

Possibly the source of the greatest number of plant facility problems arises from the square foot size of the warehouse and whether it is a single or multi-level warehouse. A warehouse on one level will reduce the need for high vertical

lifting. Many warehouses, however, are located in congested areas where sufficient lateral space is very expensive and possibly unavailable at any price. Each situation presents its own problems. The large, one-floor facility faces the question of how to reduce the travel time of power equipment and the multi-level warehouse, how to overcome the bottleneck and offset the expense of vertical intermittent flow. One of Richmond's largest soft goods warehouses is planning a building program to double its space this year in a five story downtown building, sacrificing operating ease to convenience of location.

Platforms

One final note about plant facilities must be added, namely, the importance of sufficient platform space for unloading and loading of trucks and rail cars. Off street facilities for trucks should be provided wherever possible, with platform space to allow simultaneous handling of as many vehicles as are normally planned for at any one time. To do so this usually calls for a long platform set at truck floor level. Ideally, the platform should be enclosed to protect goods from weather conditions, preserve heat in the warehouse and provide comfort for the warehouse personnel. A warehouse built to the street line may cut into its storage space on a diagonal to provide platform area and to conserve space. A warehouse with extremely limited space is faced with a difficult truck scheduling problem to avoid

traffic congestion. Provision for a rail siding may be necessary with the same platform problem as with trucks, to allow for easy and rapid access to more than one car at a time within the building in order to reduce handling charges and to offer protection.

Equipment, then, must be selected which will not be too large for restricted space in aisles, on elevators and of door openings nor too heavy for weak floors or ceilings or elevators but still be able to handle the required volume of production with the least expenditure of manpower and time without damage to goods or property.

James M. Moore sets forth the objective of plant layout by stating, "The objectives are to reduce costs by decreasing inventory costs, utilizing space, and increasing productivity; to reduce waste by eliminating danger to material during handling and by being flexible to meet specific handling requirements; to increase productive capacity by increasing productivity per man hour, increasing machine productivity through reduction of 'down' time, smoothing out the work flow and improving production control; finally, to improve distribution by decreasing damage to the product, by improving routing, location of storage and increasing the efficiency of receiving and shipping."[1]

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[1]Moore, James M., Plant Layout and Design, New York; The MacMillan Company, 1962, pp. 305-25.

From the problems revolving around plant facilities, this discussion moves on to the questions of equipment use.

Use Factors

"The materials handling engineer must mechanize a movement of goods operation with the objectives of,

(1) minimizing handling thereby providing increased protection for the material,
(2) developing speed in the movement of goods by obtaining maximum unit loads, also by keeping equipment working constantly at maximum potential, and by
(3) obtaining the maximum use of warehouse space and transportation equipment as well as selecting the most suitable materials handling equipment for the job."[1]

The quotation above covers a broad field of problems from which may be selected certain ones for emphasis to which may be added others of equal importance.

Protection of Material

Protection of the material to be moved by handling as little as possible requires the selection of equipment which will handle large unit loads with care for the nature of the material and type of container. Selection could profitably be preceded by a flow study to insure that materials are moved directly to their objectives as pointed out in a previous section of this paper.

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[1]Colton, Richard C. and Ward, Edmund S. of Traffic Service Corp., Practical Handbook of Industrial Traffic Management, rev.,Baltimore, Md.; Lord Baltimore Press, 1959, p. 128.

Speed in Movement

Speed in the movement of goods, meaning the correct speed for the type of materials and the demands of production, will require equipment capable of handling large quantities of goods on schedules of constant flow. It is fitting to refer here to a Principle of Operating mentioned on page 15 to be reminded that, "Work should be planned to avoid re-handling," and to the Principle of Equipment on page 18, "Reduce the terminal time of power units, --- plan their use to keep them working."

Safety Factors

Safety is a factor which must be considered as equal in importance to the others. Speed without safety is of small value. Safety must be thought of as involving several aspects, first, safety to the materials handled, second safety to the operator of the equipment, and, third, safety to other persons who may come into contact with the equipment. Mechanized equipment is considered by the materials handling experts to be safer for personnel than manual equipment, although it is pointed out that any injuries resulting are apt to be of greater severity.

Noise Factors

The problem of noise from equipment must enter into any planning. In general merchandise warehouses, noise is a less significant factor than in manufacturing plants, but every piece of moving apparatus creates noise which produces fatigue among personnel. Much has been done by equipment

manufacturers to reduce the noise level by developing and installing ball bearing axles on wheeled trucks and on conveyors of all types and rubber tires on mobile equipment. Motor noise has been reduced by the use of electric motors in place of gasoline or diesel fueled motors. Anyone who has been in an enclosed space with belt conveyors has been conscious of the rumble from the friction of the belt on the power or guiding rollers. The modern electric powered fork lift truck of 5,000 lb. capacity, however, moves with only a swish to indicate its presence.

Fume Factors

The problem of fumes from industrial equipment has furnished the industrial engineer with a challenge. Gasoline and diesel powered trucks may be used without concern in outdoor handling areas but in enclosed areas, electric motors have replaced them almost exclusively. Obviously, the elimination of noise and fumes has, however, added the maintenance problem of battery re-charging which needs to be done daily in an active warehouse. Liquid propane gas fuel is currently used in some warehouses as a compromise between the noise and fumes of gasoline and diesel and the need for re-charging batteries.

Flexibility in Use

Flexibility in use of equipment furnishes an opportunity to save operating expense. Among the Principles of Equipment

on page 17, is stated, "It is important to select equipment and to use methods which are flexible in use and application, because to do so is economical." Actually, gasoline powered equipment is more flexible than the electric because it can be used in a greater variety of places although a problem indoors. The fork lift truck is more flexible than the simple lift truck because there are so many attachments available which allow it to handle a great variety of materials. A crane with a swing boom is more flexible than one with a fixed boom. Another example is a tractor equipped with a roller in front to push heavy reels of wire. To achieve maximum flexibility, it is advisable to provide equipment with capacity to handle loads ranging from the average minimum to average maximum.

Reliability Factor

Finally, the factor of reliability must be considered. Reliability is dependent upon proper maintenance but also on durability to minimize the amount of maintenance necessary thereby keeping the equipment in use for longer periods of time. According to a survey made by the magazine Industry and Power in 1940, reliability governs the selection of equipment in 66% of all plants.[1]

[1]Immer, John R., Materials Handling, New York; McGraw-Hill Book Company, Inc., 1953, Chap. 7.

Before leaving the consideration of equipment selection factors, it is fitting to examine briefly the problems of equipment costs.

Cost Considerations

Although the writer has not undertaken to discuss in detail the cost factors of equipment selection, it is fitting to point out the areas which might be included in such a study.

1. First, there is the decision regarding initial cost since there are generally several types of equipment available for any purpose. Included in the initial cost will be that of the equipment and installation, allowance for time lost during installation and the probable lower production until workmen become accustomed to the new equipment.

2. Second, is the rate of depreciation and obsolescence. In the case of pallets, for example, purchasers have a choice between wood and steel, balancing initial cost against cost of maintenance and depreciation.

3. Third, is the factor of operating costs related to use and production, such as fuel and labor, maintenance, repairs, replacements, and cost or savings due to damage.

4. Fourth, is the factor of equipment unit load

carrying power, speed in relation to load and the saving of manpower.

5. Some other cost considerations must include taxes as well as the financial position of the business together with the competitive pressures of its position in the industry and business community.

6. All cost determinations should be based on the concept of present values of the investment covering the life expectancy of the equipment.

Any statement regarding the consideration of equipment costs should include a reminder to the reader that the acquisition costs of equipment constitute fixed costs which will show a reduction per unit load of materials handled as production increases. The variable costs incidental to the use of equipment will, in turn, increase per unit load handled. Thus, the determination of a break even point for any piece of equipment would aid in determining its economy in a particular materials handling situation.

In the final analysis, the establishment of a continued strong materials handling improvement program is a basic responsibility of management.

Summary

In this second chapter, some important factors to be given consideration in the selection of materials handling equipment have been reviewed and discussed. Following a brief

analysis of the directions of materials movement, the reader has been introduced to the problems based on the differences between types of materials, next, the six factors of, the permanence, the sequence, the volume, the continuity, and the method and distance of materials movement. From that point, the chapter presented some of the problems involved in the physical facilities of the warehouse, a discussion of the problems surrounding the use of the equipment itself, and, finally, some reminders with respect to the factors of costs.

The succeeding chapter presents the major classifications of fixed path equipment together with the use applications of specific types of equipment falling into these classifications.

CHAPTER III

CLASSIFICATION AND APPLICATION

FIXED PATH EQUIPMENT

Introduction

Authors differ in their methods of classifying materials handling equipment so that this writer has chosen to combine the ideas of four sources[1] in the way he feels will be most expressive of the functions of the equipment.

Equipment may be divided generally into the three following distinct classifications:

1. Fixed Path Equipment
2. Mobile or Non-Fixed Path Equipment
3. Miscellaneous Warehouse Equipment

This chapter will be confined to the presentation of the first classification and the succeeding chapter will present the second and third classifications. Fixed path equipment is a term applied to materials handling equipment which is set into position in order to accomplish a specific job.

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[1]General Service Administration, Federal Supply Service, Warehouse Operator's Handbook, Washington, D. C.; U. S. Government Printing Office, 1958.

Immer, John R., Materials Handling, New York; McGraw-Hill Book Company, Inc., 1953, Chaps. 8-12.

Moore, James M., Plant Layout and Design, New York; The McMillan Co., Inc., 1962, Chap. 14.

Reed, Ruddell, Jr., Plant Layout, Homewood, Ill.; Richard D. Irwin, 1961, Chaps. 8, 9, 10.

The position may be a permanent one or it may be a temporary position filled by a portable unit of equipment.

The path followed in the movement of materials may be horizontal, vertical or a combination of both. The route taken in the movement may be underground, on the surface or overhead or combinations of these. The movement itself may be continuous, intermittent, regular or irregular. The equipment may be classified as covering a wide area or a limited area.

Each of these sub-divisions of equipment will be presented in this chapter with a description and explanation of the specific types of equipment included.

Horizontal Movement

Conveyors

Conveyors furnish one of the most flexible and valuable methods of moving materials because of the great variety of types of equipment available and the application of this method to so many different kinds of materials. Technically, a conveyor is an unattended mechanical device used for transporting materials from one point to another, faster and more efficiently than men could do it. "Dollar for dollar, conveyors often show a higher return on capital investment than

other forms of stationary mechanization."[1]

There is a type of conveyor available for any material in any form to move it any direction and in almost any quantity. One great advantage of the conveyor is the large quantities of materials it will hold in temporary storage. This form of storage is often referred to as 'live' storage.

Conveyor equipment must be planned with great care and tailored to fit the precise need. The bibliography of this paper lists the names of some of the most important manufacturers of conveyor equipment from which the writer obtained valuable information. Since the writer has confined himself to equipment particularly suited to general merchandise warehouses, the discussion herein will be limited to this area of use.

Gravity Conveyors

One of the Principles of Operating on page 15, states, "Make use of gravity whenever possible in the movement of materials." It is obvious that the use of gravity eliminates the need for the use of power and is, therefore, economical.

Gravity conveyors are generally found in the three following forms:

1. Rollers
2. Skate wheels
3. Pipe rail

[1]Small Business Administration, Technical Aids for Small Manufacturers, No. 63, Washington, D. C.; U. S. Government Printing Office, 1958, p. 1.

The first form utilizes cyclindrical rollers which may be set between rigid frames on either horizontal or inclined planes. A second form utilizes skate wheels on roller bearings set within rigid frames. The third form of gravity conveyor is a simple iron pipe which may be suspended overhead from ceiling supports or supported by uprights from the floor.

Both the first and second forms of conveyors are often seen set into the tops of work tables, as in the Receiving Department where the packages are opened and checked. (see figure 1) Another common use for these forms of gravity roller is to move materials for long stretches between work locations with gravity sections of conveyors linked at intervals with powered units, to raise materials to a higher level at which point gravity again takes over. The rigidity of the material moved must be considered in using these types of conveyors, since the material rests on the surface of the rollers or wheels. For this reason, these will be seen used for all sizes and shapes of packaged goods.

Any material which can be suspended from a hook may be moved over a pipe conveyor (see figure 2). All the conveyors may be of different widths, with or without sides, depending upon the degree of guidance required to keep the material on the conveyor. These conveyors may be straight or curved.

Powered Conveyors

Powered conveyors open a much wider range of use than the gravity forms because they are not restricted to short distances or to form of material. The roller (see figure 3), and skate wheel types are often powered to achieve greater distances than gravity allows, with the power furnished by a belt in contact with their under surfaces. The powered conveyor offers the benefit of being able to stop it easily without friction thus creating less possibility of damage to the material being moved.

Solid surfaced belts are in common use with flat surfaces for packaged goods or V-shaped, forming a trough, for moving bulky, loose material. The belt is supported on the under side by rollers or wheels. The solid surface of the belt is ideal for moving small items or delicate items which would not move safely on rollers or wheel surfaces. A belt conveyor may be open, with or without sides, or enclosed, if the material is a type which would be injured by exposure or create dust. The belt may also be resting on springs when heavy material is being moved.

The solid belt conveyor has one advantage over some of the other types in that it is easy to divert packages from the conveyor by mechanical means. The belt is considered particularly good for large quantities of materials at speeds from 2 to 200 feet a minute. The belt may be one-way or two-way.

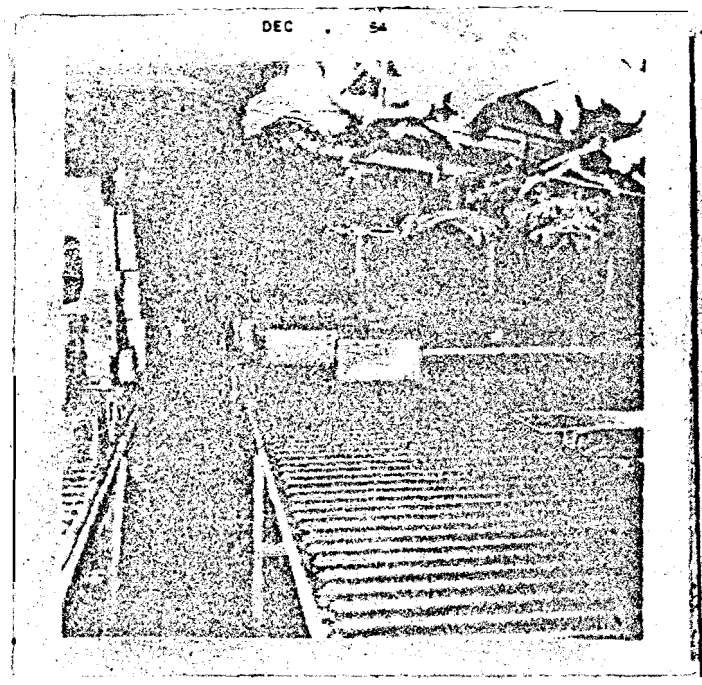


Figure 1
Gravity Roller Top Table

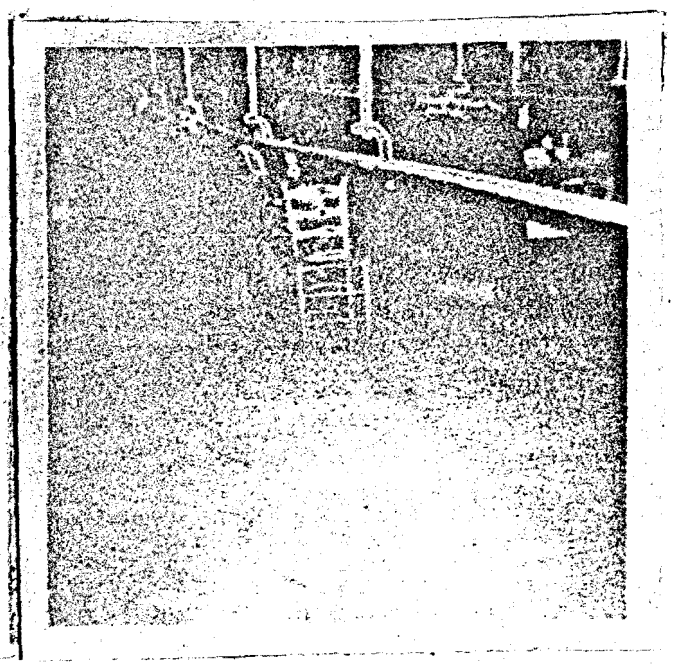
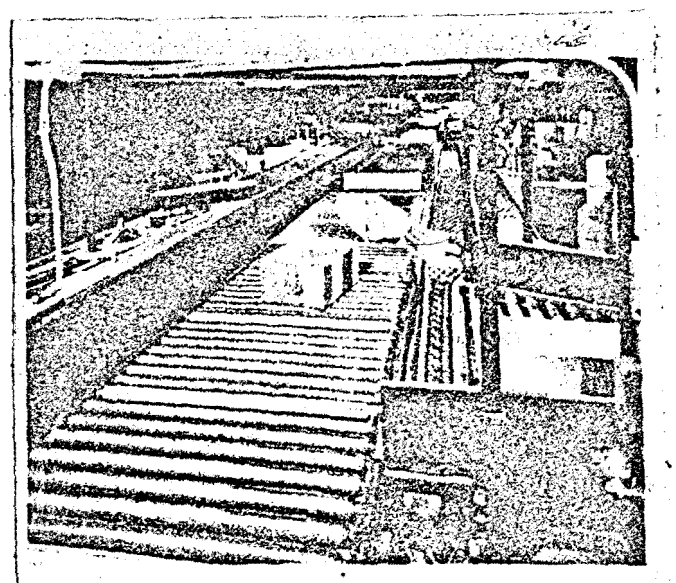


Figure 2
Overhead Pipe Conveypr



APC live roller conveyors are designed to convey heavy, bulky, difficult materials, including cans, drums, slatted crates, pallets, and many unpackaged materials. General duty and heavy-duty load capacities.

Figure 3
Powered Roller Conveyor

Another form of conveyor utilizes wooden slats fixed between parallel chains. This type is used particularly for moving heavy and bulky packaged goods. In the constant movement of packaged goods, the apron conveyor is often used. This conveyor is formed by a series of overlapping metal plates, valuable because it is flexible enough to move around curves either laterally or vertically. The apron conveyor is most useful in the handling of small items during the process of production and, therefore, less useful in general merchandise warehouses than in the specialty goods handling.

Power driven belts and roller conveyors are frequently used to move cartons from the receiving platform into the checking area of a general merchandise warehouse. The power may be directed and actuated from a central station to regulate the flow of materials.

An interesting form of continuous movement conveyor is the rotating cable. This is a spiral shaped cable rotating within a pipe, open at the top to expose the cable. On the cable garments are hung from clothes hangers which are caught and moved forward by the spirals in the cable. This type may be used over great distances and in any direction.

A variation of the rotating cable is the twin-screw conveyor. This consists of parallel, revolving, spiral flanged metal tubes, particularly suited to moving soft bagged materials on horizontal or inclined planes.

Conveyors

On Wheels and Powered

In this division the most significant piece of equipment is the trailer or cart which is a 4 or 5 wheeled metal framed vehicle roughly 30 by 60 inches, sometimes built with two platform shelves and sometimes as a high-sided metal cage. This equipment is seen in large warehouses where small packages are being moved out of storage to fill orders or in transportation terminals where small packages are being trans-shipped. (see figure 4)

The advantages of the use of carts are that they may be moved from place to place by hand, then, when loaded, connected with an overhead or underground powered chain or cable and moved automatically to a designated location. This cable or chain movement is known as a dragline. An entire dragline system may be 1500 or more feet in length, covering a wide area of warehouse space, with a multitude of spur tracks for temporary storage at designated locations, either on the way into storage or at the shipping platform, and may be directed by remote control from a central dispatcher's desk. Each cart, when set into the dragline, is directed to its destination by the manual setting of a dial or a rod on the side of the cart, which, in turn, trips a mechanical or a magnetic contact set into the warehouse floor at the correct switching point.

Pneumatic Tubes

The tube in a general merchandise warehouse is generally used for the transmission from the merchandise control office of purchase orders and receiving invoices to the receiving platform or of order filling instructions to that department. In addition, however, tubes may be adapted to bulk materials where dust control or exposure forma hazard. This situation, obviously, applies to the processing of goods rather than to the handling of packaged materials. The fact that tubes may be fitted to any space, direction of movement and size of material makes the tube a practical and flexible type of equipment. Even small tools may be sent through tubes with ease.

Chutes

The package chute was one of the earliest forms of gravity materials handling equipment because it can handle a volume of packaged goods quickly. The chute is usually found in a combination of horizontal and inclined movement. One disadvantage of the chute is that containers must be strong to stand collision at the turns or at the bottom. The obvious problem is to avoid sending delicate or fragile goods down the chute. One advantage of the chute is that the friction of movement slows material if the incline is not too steep. The chute may be open at the top or fully enclosed and in any size needed. A chute may be made of metal for hard surfaced goods or of canvas for soft materials.

Temporary Fixed Path Equipment

In this group are found conveyors, both gravity and powered, in all forms, developed into portable units. These units may be of any desired length as well as built with several telescoping sections to be adapted quickly to changing conditions. These portable conveyors are also made in folding sections. On a receiving platform or delivery platform, a roller or skate wheel conveyor may be inserted the length of a truck body so that cartons or cases may be pushed by hand in a continuous line to unload or load. Portable conveyor sections are stored generally on a movable rack to be pushed quickly to the point needed. (see figure 5)

Load-Glide Systems

A fascinating, new, and as yet unproven, materials handling method has been launched by the Industrial Truck Division of the Clark Equipment Company of Battle Creek, Michigan. One phase of this new method is called the Air-in-Floor System. This consists of the permanent installation of hollow metal flooring through which is circulated air under pressure. It is claimed by Clark Equipment that 1,000 pounds of material loaded on a pallet may be moved by five pounds of manual pressure because the load is supported by the air which is released upward from the floor by the downward pressure of the load on numerous protruding ball-shaped valves set into the floor surface. This flooring may be installed in trucks, rail cars and on the floors of all or part of a warehouse.

Figure 4a
Platform Cart
on dragline

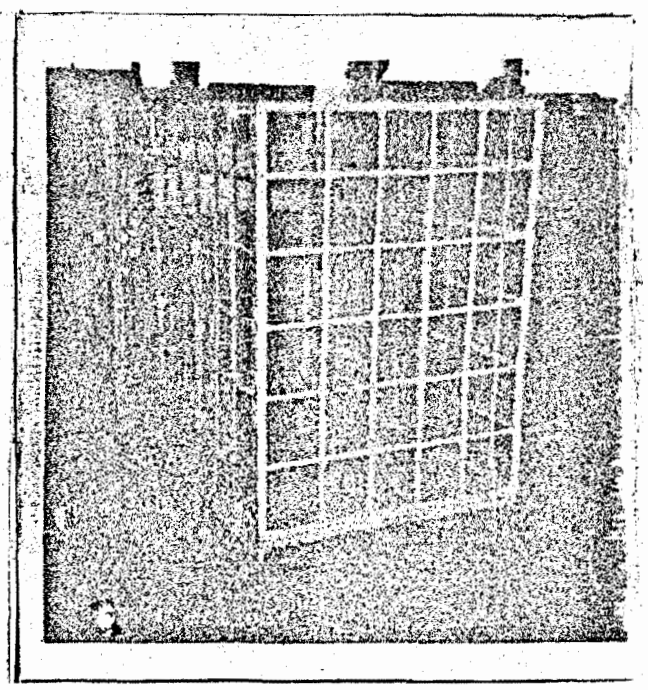


Figure 4b
Cage Cart

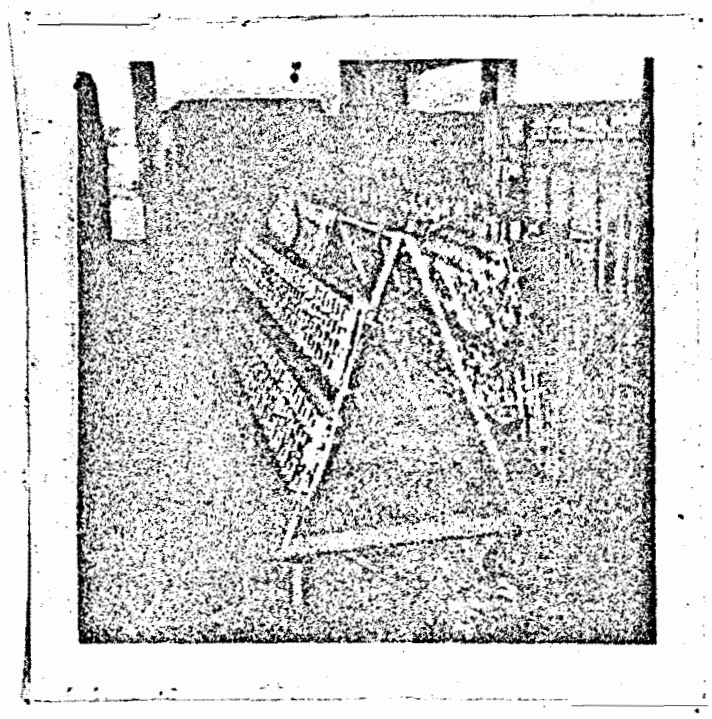


Figure 5
Portable Skate Wheel Conveyor
Sections on Rack

The use problem, according to statements made by local warehousemen, is that its successful operation requires the coordination of the trucker with the warehouse. Specifically, unless the truck were equipped with Air-in-Floor, the unloading would still have to be done by the present methods, and, since full pallet loads may be unloaded directly by fork lift trucks now, no time would be saved. Apparently, with full coordination, handling of quantities of materials for short distances not requiring powered load carrying equipment, would be considerably improved. (see figure 6)

The second phase of this system is the Air-in-Pallet. This consists of a metal platform (pallet), on which packaged goods are loaded but which contains its own independent air pressure unit releasing a downward draft against the floor thereby supporting the weight of the load and allowing it to be pushed by hand thus replacing power equipment. (see figure 6) Unfortunately, none of this equipment is yet in use so that the writer has been unable to see this in operation.

Roller Floor Systems

This system utilizes rollers set into frames in the floor, allowing heavy objects to be moved by slight hand pressure, from location to location. This system would be useful chiefly in a situation where objects were being processed while held in temporary storage. For example, large pieces of furniture or heavy appliances being inspected or refinished, could be handled easily in this manner.

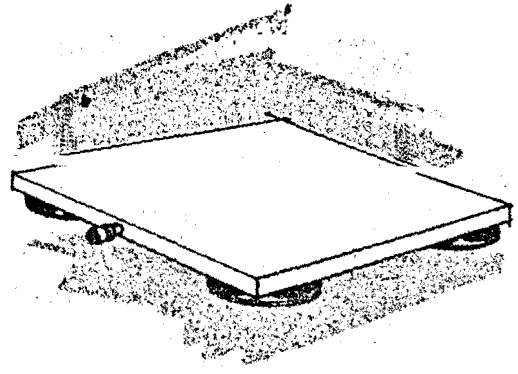
CLARK EQUIPMENT

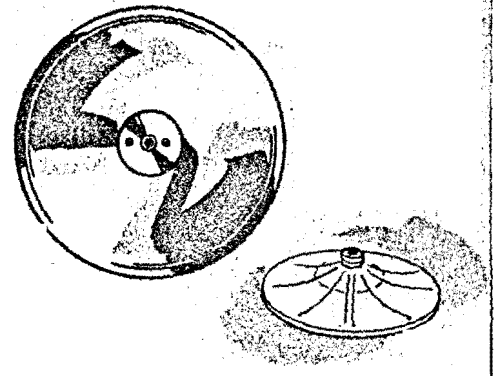
LOAD GLIDE SYSTEMS

AIR IN PALLET SYSTEMS

AIR PALLETS
Constructed of aluminum, steel or plywood, serves as the plenum chamber for air distribution to the air castors.

AIR CASTORS
Saucer-like pads with central nozzle which dispenses air film from the plenum chamber, forcing a thin film of air in between the resilient material base and the floor surface.

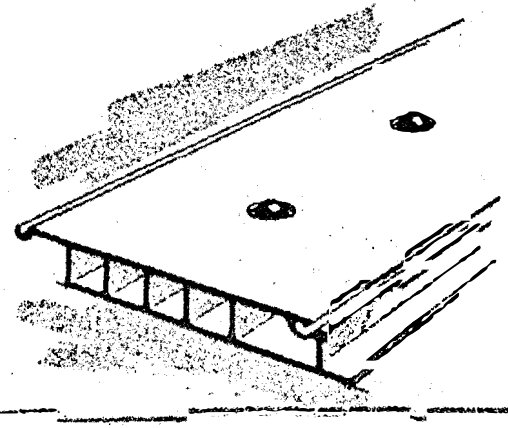




AIR IN FLOOR SYSTEMS

STD. AIR-IN-FLOOR MODULES
Plywood or aluminum sections installed over existing surfaces acts as plenum chamber for air-in-floor system.

BALL CHECK VALVES
Spring-loaded ball valves, mounted in air-in-floor modules, valves only emit air when air-in-floor pallet depresses ball and overcomes spring force.



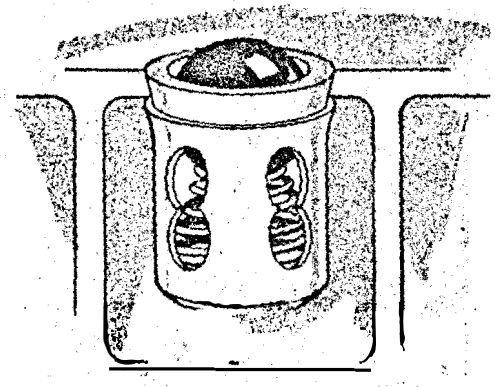


Figure 6

Overhead Movement

Limited Area Equipment

General merchandise warehouses have very little use for equipment in this classification, most of which consists of cranes or derricks, valuable for very heavy lifting. Occasionally, however, an overhead rail carrying a manually operated or powered hoist will be used for moving heavy household appliances.

Longer Distances - Continuous or Intermittent Movement

Trolley or Monorail

This is a very common type of installation in most general merchandise warehouses. Platform trucks for both small packaged goods and for hanging garments are suspended from wheeled trolleys running on an overhead rail. These are used in the work areas where merchandise is being checked into temporary storage for inspection, sorting, marking, and in order-picking sections prior to shipment. A system of this kind may fill a large area with a series of spur rails leading from the opening section to separate department locations. From the preparatory work areas, the rail system may lead directly to the shipping platform. (see figure 7)

One chief advantage of the overhead rail is its capacity for storage. As mentioned earlier with respect to conveyors, this form of storage is frequently referred to as 'live' storage. A second advantage is the ease with which large quantities of materials are moved by hand with little effort. A third advantage is the saving of floor space and the clearing of the floor for other equipment.

Pipe Rail

A variation of the monorail is the solid pipe over which garments may be moved in groups suspended from clothes hangers. Sometimes the hangers are hung directly over the pipe and sometimes from a wheeled trolley. (see figure 8)

Rotating Cable Conveyor

A third type is the rotating cable which was described in the section under Horizontal Powered Conveyors. This type may be extended for great distances. One in a Richmond warehouse carries hanging garments 165 feet between departments located in separate buildings. The M-H Standard Corp. of Hamilton, Ohio, manufactures this type of equipment under their trade name Monoflo.

Belt Conveyors

The belt method, using solid, roller or wheel surfaces, carries large quantities of all types of materials any required distance without obstructing the floor area.

Materials may be diverted by automatic gates or by remote control from a central point.

The fully automatic warehouse is successfully in operation in a number of case goods warehouses throughout the United States, although there is none in Richmond. This system would include materials flow in all directions. The Alvey-Ferguson Co. of Cincinnati, Ohio, has placed automatic installations in the distribution warehouses of at least 27 large manufacturers and processors. Another firm has developed what it calls the 'Memory' conveyor belt for automatic package sorting. This firm is Goodyear's Industrial Products Division. (see figure 9)

Chain Draglines

The overhead chain sometimes replaces the underground installation and is particularly useful when there is a need to keep the floor area unobstructed. In this variation of the dragline, the load-carrying carts are hooked onto the chain and may be switched automatically as in the underground method.

Vertical Movement

Irregular Movement

Freight Elevator

This elementary form of equipment is found in every multi-floor building designed to carry large load-carrying

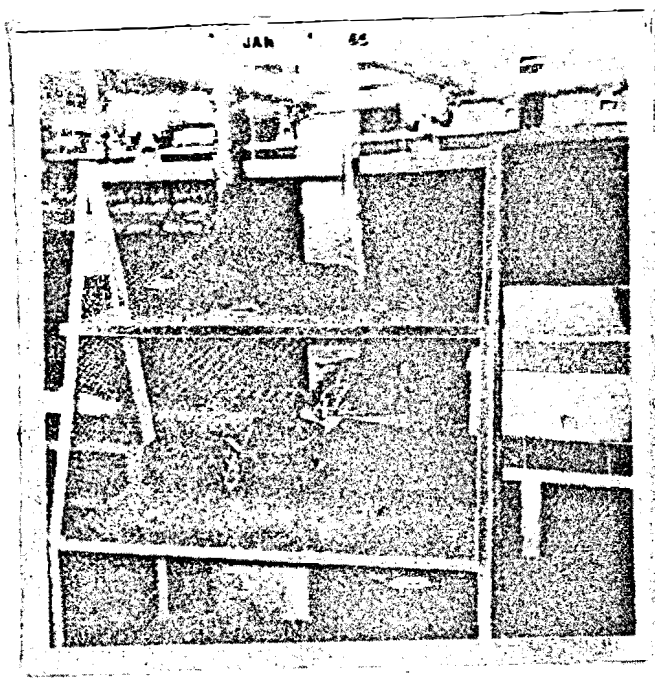
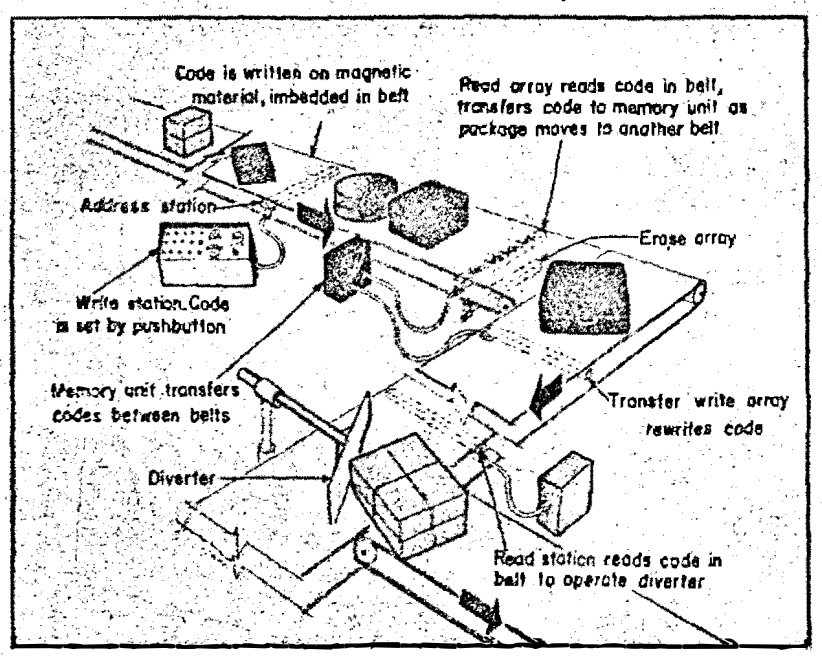


Figure 7
Trolley Platform Truck

Figure 8
Overhead Pipe Rail

Goodyear Introduces "Memory" Conveyor Belt



Goodyear's Industrial Products Division has developed a "memory belt," utilizing the basic principles of magnetic polarity to place an invisible destination code on packaged items or bulk materials being carried through a conveyor complex. The "memory section" can be incorporated into almost any type of conveyor belting. Initial cost and operating expense are said to be comparable to those of other coded dispatching methods.

The drawing above illustrates a typical application of the belt in an automatic package sorting and dispatching system of Maitrol Products Division of Magnetics, Inc. Ferro-magnetic materials embedded in the belt enable it to "listen" and then "remember" as it stores coded information and automatically escorts items to predetermined unloading points. **(Item 42).**

Figure 9
'Memory'
Conveyor

equipment with large quantities of materials. Its chief limitations are its lack of load capacity and the waiting time necessary between trips. For these reasons, it has been replaced by conveyors for constant flow movement.

Dumb Waiter

For small items, not needed in a continuous flow, this form of small lift serves as a convenient accessory in a multi-floor building.

Hydraulic Platform

This equipment is useful where a rise of only a few feet is needed. This takes the form of an independent platform unit which may be raised to the level of a truck floor and onto which the truck may be unloaded, after which the platform is lowered to the ground level or carried, in the case of a mobile unit, to a place of storage.

Self-Leveling or Adjustable Dock Board

A dock board serves as a bridge between the receiving or delivery platform and the level of a truck floor. The board is fitted into the lip or forward edge of the platform. When the truck backs to the platform, the self-adjusting type moves to keep above the tail gate of the truck, then settles down on top of the gate. The adjustable board is moved into place by hand actuated mechanism, with the power sometimes furnished by hydraulic system or by electricity. Still another very modern board is governed by counter-weights. (see figure 10)

Mobile Elevator

This is a portable vertical framework supporting upright rails on which moves a platform for lifting materials to an upper level above the reach of a fork lift truck. One Richmond warehouse utilizes this method to reach a mezzanine floor. (see figure 11) This equipment would be most useful where a permanent elevator could not be installed or where the need might be temporary. The lift could be expected to handle limited quantities of materials. Power is usually electric.

Regular Movement

Package Lift

This equipment forms part of a continuous movement, starting with a horizontal section, leading into a vertical shaft, with shelves or small platforms guided between parallel rails. Large quantities of small packaged goods may be handled by this lift which may also be moved by hand or powered by hydraulic or electric systems.

Continuous Vertical with Horizontal Movement

Rotating Cable

Again there is a need to mention this cable conveyor because of its flexibility of use. This may carry materials in both horizontal and vertical directions at both low and overhead levels. Refer to pages 46 and 54.

Figure 10
Adjustable Dock Board

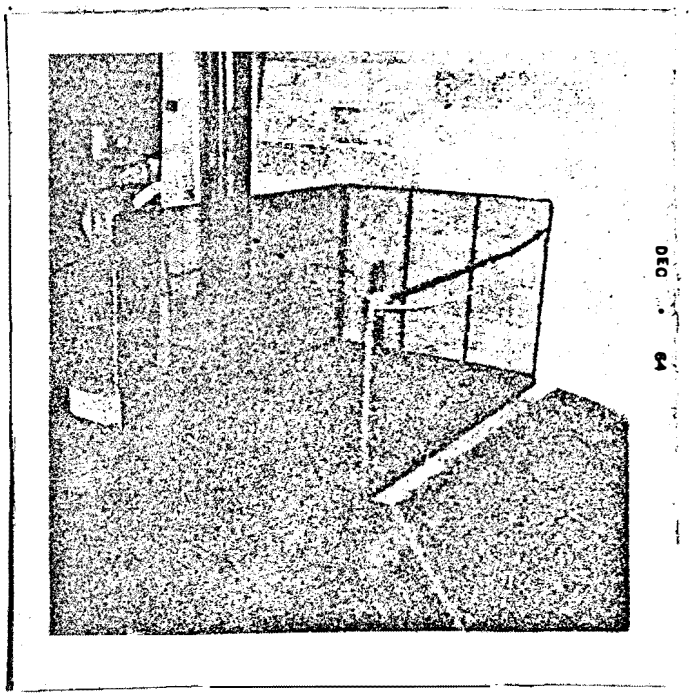


Figure 11
Mobile
Elevator

Automated Systems

This form of conveyor system offers continuous movement carrying large quantities of packaged materials. It may be directed to all points of flow, may be partly or fully automated and may use both gravity and power. This system is highly flexible to the size of container, offers unlimited 'live' (moving) storage facilities, saves time and eliminates manpower.

Chutes

Again attention is drawn to the widely used metal or canvas chutes. (refer to page 48) These may be straight, curved or spiral as well as fitted into any given space for any size of material. Packaged goods brought from storage to shipping department by overhead belt conveyor may be diverted onto a chute for quick assembly at a packing desk or delivery route sorting table.

Roller and Wheel Conveyor

Here also is a repeated reference to the common conveyor which may be combined in horizontal and vertical movements of large quantities of materials. The reader may refer to pages 42 and 46 for details.

Horizontal and Vertical Movement with Mobile Units

Portable Belt Conveyors

Belt conveyors have been described previously on page 44. Portable forms of this equipment are moved from truck to truck on a receiving or delivery platform by hand or power, although the movement of the belt is by power. This type of equipment is one of the most flexible and valuable for handling un-palleted packaged goods. (see figure 12)

Portable Elevating Platforms

This mobile powered unit is for use in an area without a delivery platform. It was described previously on page 57 as useful in unloading trucks under the name of Hydraulic Platform. Lifting power may be furnished by hydraulic or electric energy and propulsion by gas or electric energy.

Fork Lift and Skid Lift Trucks

These pieces of equipment have been developed in so many variations that space would not be available in this paper for all of them. A number of these will be described in greater detail in a later section under Mobile Equipment. Briefly, the fork lift truck is a mobile lifting and carrying unit, the propulsion furnished by gasoline, diesel oil, liquid propane gas or electricity, with the lifting power actuated by hydraulic power. Units range from 500 to

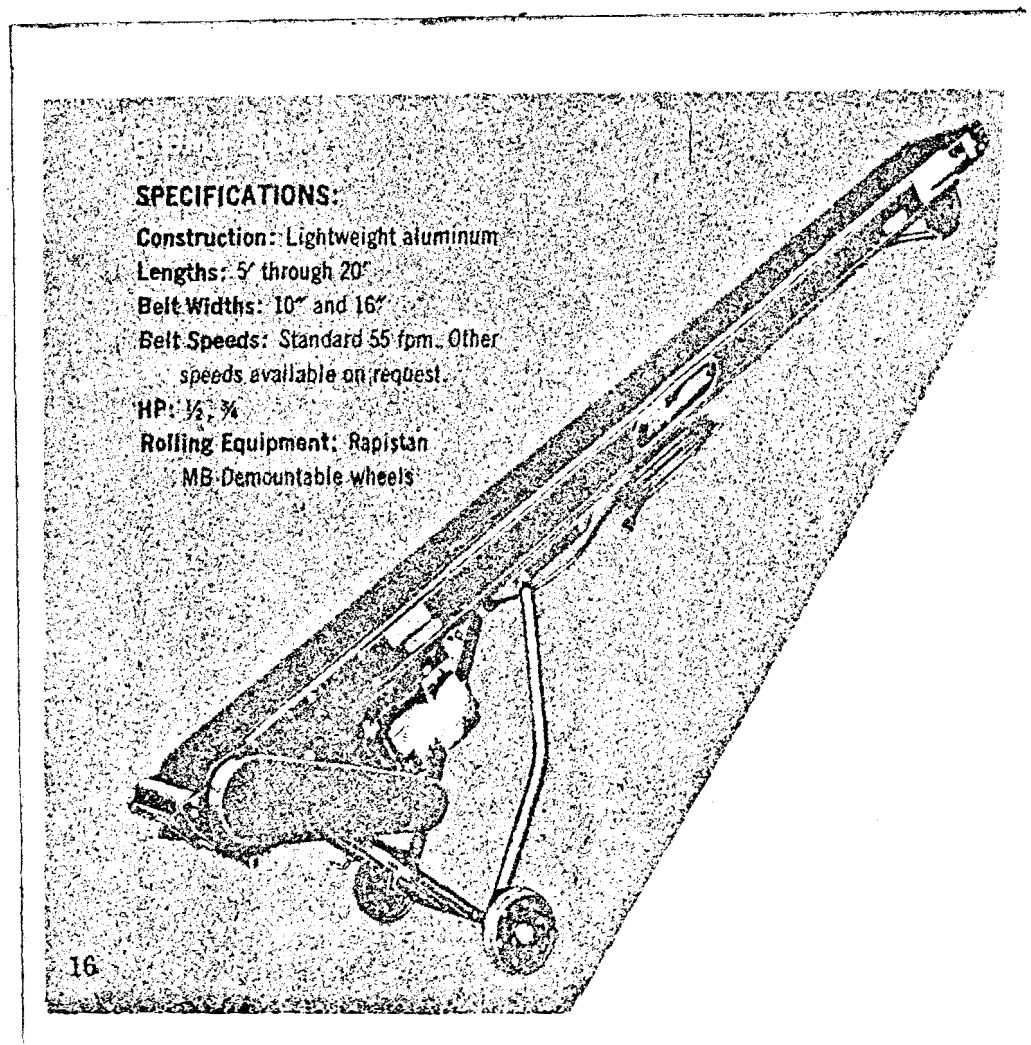


Figure 12
Portable Belt Conveyor

40,000 pounds in their lift capacity. Units may lift 3,000 pounds to a height of 19 feet to take advantage of vertical space for storage. In the words of one authority, "Compact, more maneuverable equipment is being employed to store higher in the air with narrower aisles. The fork lift has emerged as industry's number one work horse. The almost infinite variety of attachments now available ... makes it truly a universal handling machine."[1]

The fork lift is designed to lift all types, sizes and shapes of materials often to considerable heights loaded on a platform called a pallet, or with its attachments, all forms of materials. The skid lift, on the other hand, is designed only to handle materials placed on a low platform called a skid and only to a few feet above the floor. Every warehouse handling large quantities of materials will utilize a fork lift truck for unloading and loading of trucks, trailers and rail cars. Some fork lifts are built in a size which allows them to drive into a truck to pick up or deposit a load. There is a type designed for almost every purpose although their adaptability to different forms of materials gives each one a wide range of uses.

[1]Bethel, Lawrence L., Atwater, Franklin P., Smith, George H. E., Stackman, Harvey A., Jr., Industrial Organization and Management, 3rd. ed., New York; McGraw-Hill Book Co., Inc., 1956, p. 312.

In a large warehouse handling chiefly packaged goods, there might be seen a low mast fork lift used for servicing trucks and moving goods into nearby low stacked storage as well as a high mast lift picking up a load outside a truck, carrying it 300 feet and placing it in storage at the 19 foot level. Materials handling engineers generally place a distance limitation on the economical use of a fork lift because it is a powered load-carrying unit with limited carrying capacity. This distance is placed at about 300 feet because the unloaded return time or 'wasted' time is too great beyond that distance.

For greater distances, equipment authorities recommend the use of powered tractors which will haul a train of trailers with a carrying capacity far exceeding that of the fork lift. Tractor trailer systems are discussed in a later section of this paper under Mobile Equipment.

Summary

In this third chapter, the reader has been introduced to the first general classification of materials handling equipment, namely, fixed path equipment. The chapter has discussed the variations of direction of movement, the route followed, the regularity of movement and the materials to be handled. The succeeding Chapter IV will present specific types of mobile or non-fixed path equipment with their applications to materials handling problems.

CHAPTER IV

CLASSIFICATION AND APPLICATION
MOBILE OR NON-FIXED PATH EQUIPMENT
AND MISCELLANEOUS EQUIPMENT

Introduction

In this chapter are included the second and third general classifications of materials handling equipment with a description of the many types and their specific applications to problems. Mobile or non-fixed path equipment identifies those types which are not set in a permanent position but which, instead, are moved by hand or mechanical power from place to place in order to fulfill their assignments. Accordingly, all of this equipment may move or be moved horizontally, and may move or assist in moving materials, horizontally or vertically or in both directions, over either a wide area or a limited area. Miscellaneous equipment includes several types of accessories used to assist the mobile equipment to carry out its functions.

Horizontal Movement

Limited Area Equipment

Wheels

There are many types of small wheeled vehicles designed to fit an almost endless number of specific jobs and materials

handling problems. Some are powered, some without power. For purposes of distinction, these are divided first by the number of wheels on which they move.

One-Two-Three Wheels

Wheel Barrow

This is probably the oldest form of wheeled hand truck, the common garden variety of one-wheeled load-carrying vehicle. Due to the ease with which it handles fairly heavy loads of miscellaneous materials, the wheel barrow may be found in many warehouses filling the need for a quick, short movement of goods. It is limited in its application to small quantities of goods of small size.

Hand Trucks

Here is another basic type of equipment. A steel frame in H or inverted A form with two wheels in front and two handles in back, a metal blade extending forward from the wheels to be slid under a large case, box or barrel. The bed of the frame may be flat or rounded to fit different shapes of materials. This piece of equipment is often referred to as the 'stevedore's hand truck' and constitutes a very fast way of handling a single unit loading job.

Hand Operated Fork and Skid Lift

This is sometimes called a Jacklift and may be a hydraulic or mechanical lift powered unit. (see figure 1) This is essentially a three-wheeled vehicle with two arms or central narrow frame, each side supported on a wheel and a single

wheel unit in the front to be used for steering by means of a handle serving also as the means for manual propulsion. The arms of the fork lift are set very low so that they may be slid under an object resting on the floor or through a loaded pallet. The skid lift may have arms or a platform raised several inches from the floor, allowing it to be slid under a skid platform which rests on metal legs.

Four-Five-Six Wheels - No Power

Hand Trucks

This type of equipment offers the largest variety of forms of any of the small materials handling equipment available. Basically, the hand truck is a platform, generally on four wheels although a fifth or sixth wheel may be added to offer stability and strength for heavy loads.

The variations in the superstructure of the hand truck are numbered by one author at 56,[1] although the simple platform is greatly used. Commonly seen forms are the metal, wood or canvas box, with or without top, the platform with one or two sides, boxes with solid sides, slat sides or lattice work sides or merely upright stakes at each of the four corners. (see figure 2)

A second area of flexibility in the hand truck is the wheel arrangement. Wheels may be fixed or rotating in different

[1]Stocker, Harry E., Materials Handling, New York; Prentice-Hall, Inc., 1943, p. 182.

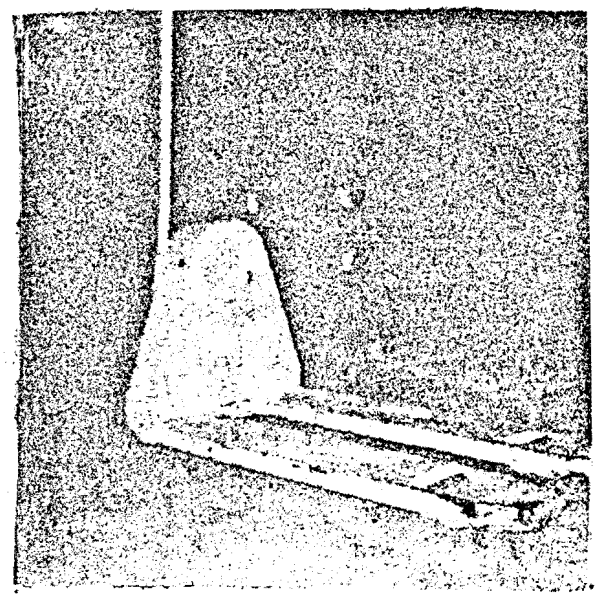


Figure 1
Hydraulic Hand Fork

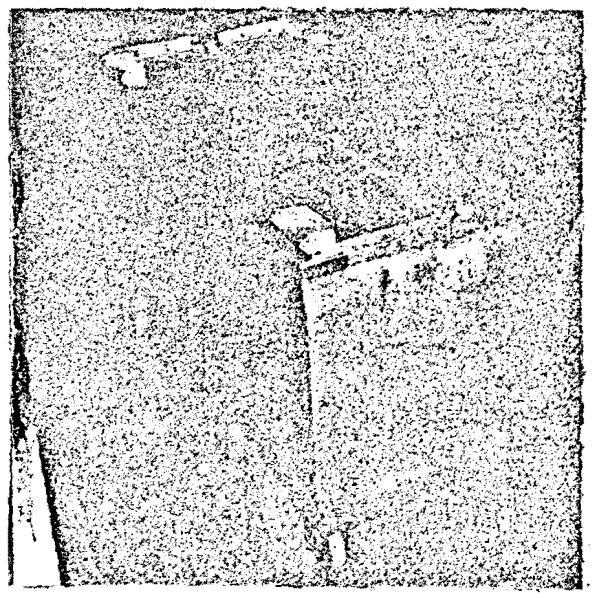


Figure 2
Covered Metal Box Truck

combinations to provide easy turning within a small radius. It is possible to replace the flat wheel by flanged wheels for use on rails or by cylindrical rollers for use with heavy materials.

Special Service Trucks

It is probably true that every warehouse operator eventually develops some special form of equipment to fill a particular need for which no equipment manufacturer has provided. Furniture and bedding warehousemen have developed several types of interesting specialty equipment. The first of these is the Bed Truck, which is a small 4-wheeled platform with a superstructure of pipe rods forming a shelf with a central dividing wall. The bed rails are placed on the platform, the head and foot boards resting on the shelf and leaning against the central wall. (see figure 3)

A second specialized type is the Mattress Truck. This is a two-wheeled hand truck of a size to fit a single mattress of any size with iron rails to support the mattress. This truck is used to move one mattress within the storage area when filling an order. (see figure 4)

A third type is a dolly or wheeled platform with a padded upper frame for moving a single chair. (see figure 4)

A fourth type is a dolly with a three-tiered structure to hold and move three sofas. (see figure 5)

A fifth type is a pallet or platform with an iron rail section at one end for supporting a mattress, the platform large enough to carry four or five mattresses standing on end. This pallet, when loaded, would be moved by a fork lift truck. (see figure 6)

A sixth type is a Lamp Truck designed to hold lamp bases and shades without movement to avoid damage.

A seventh type is a small metal-framed hand truck on a base with four castor wheels. The truck includes a low shelf above which is a box. Built on one end of the truck is a three-step ladder with separate supporting wheels and two large circular handles at the top of the ladder. This truck is used for filling orders of small packaged goods, the ladder allowing the order filler to reach high shelves. (see figure 7)

Wheeled Rack Truck

This is a variation of the hand truck used for moving hanging garments. A seven foot length of iron pipe is supported by uprights at each end. Sometimes this pipe rack moves on four small castor wheels fastened into a metal frame and sometimes the rack is constructed over a shallow wooden box fitted with wheels.

This form of equipment is essential in moving hanging goods within a limited work area and is often loaded on a truck to transport garments from warehouse to stores. As a point of

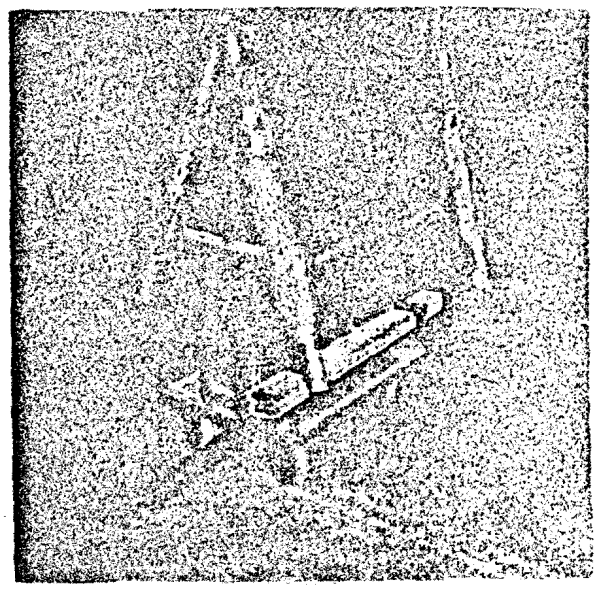


Figure 3
Bed Truck

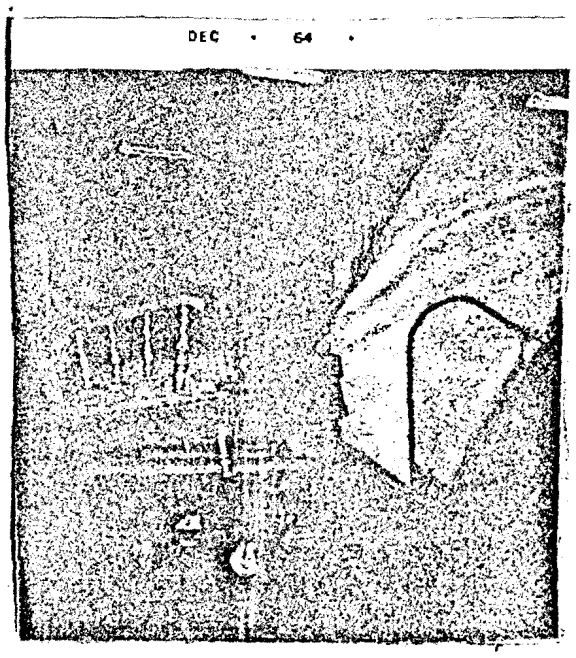


Figure 4
Chair Dolly
Single Mattress Truck

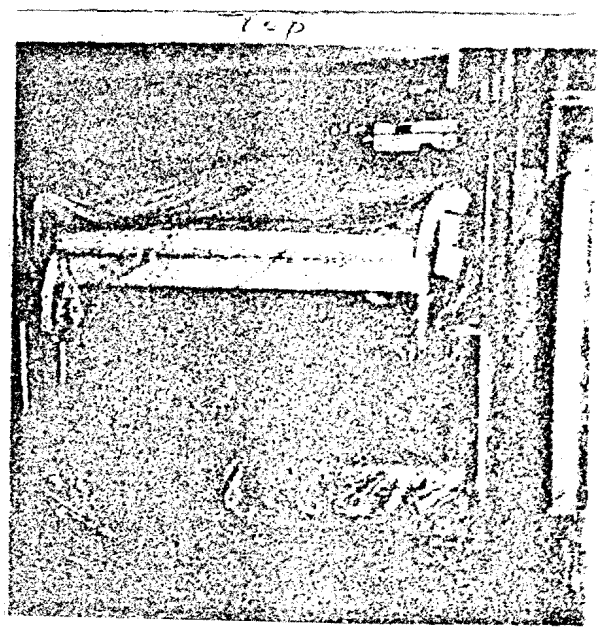


Figure 5
3 Tiered Sofa Dolly

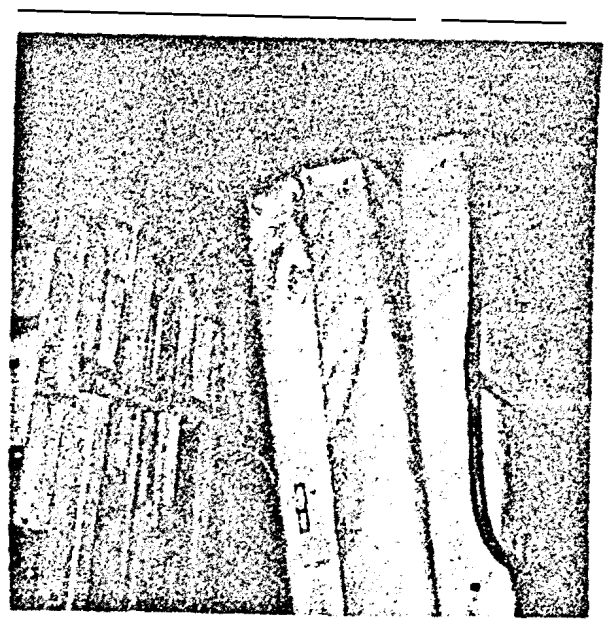


Figure 6
Platform Mattress Truck

interest, those readers who have visited the New York City Seventh Avenue garment district will recall having to dodge hundreds of these pipe racks, heavily loaded, being pushed along the sidewalks and in the streets.

When prepared for truck transport, the rack truck often is enclosed in a covering of canvas or comparable material to protect the garments from dust and possible damage.
(see figure 8)

Trailers

This equipment is a four wheel vehicle with body form varying from a simple platform to a box, cage, or series of shelves to fit the kind of material handled. The trailer may be hooked into a line or train of trailers to be hauled by a tractor or it may be set into an overhead or undergound dragline for automatic delivery to a pre-determined location.

Dollies

Here is another rudimentary form of materials handling equipment used for bulky, awkward or heavy goods. . The dolly consists of a small wooden or metal platform or sometimes only an open square or rectangular frame resting on four castor wheels which allows it to move freely in any direction by hand power. In a warehouse it would be used to move a heavy or bulky object for a short distance between work areas or to a point where a fork lift truck could take over.

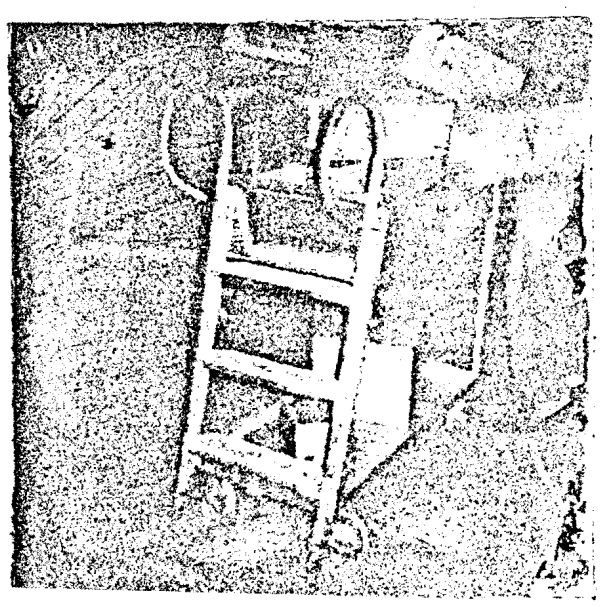


Figure 7
Package Hand Truck

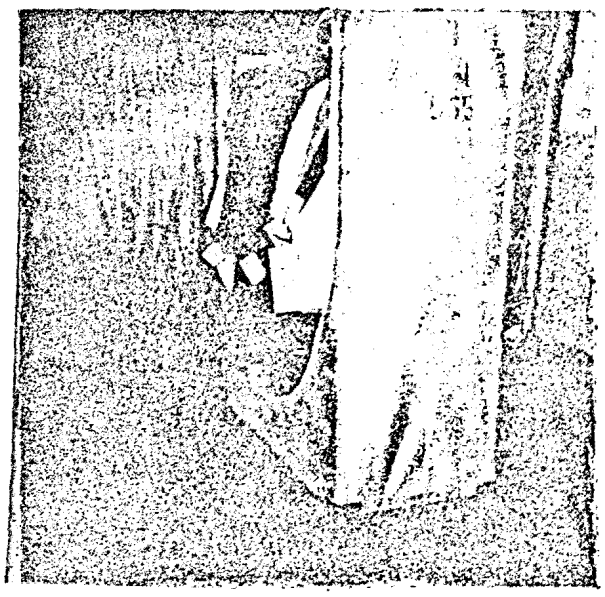


Figure 8
Canvas Covered
Rack Truck

Roller Tables

This is a table on wheels used in work areas for moving light goods from location to location. These will be seen used in marking areas and in upholstery workrooms of general merchandise warehouses.

Lift Trucks without Power

This type of equipment is used for moving quantities of packaged goods or large bulky goods for short distances by hand. It is basically like the lift truck described earlier in the 3-wheel section. This has four wheels, however, to give greater stability and to support more weight. It may be designed as a fork lift or as a skid lift. Some of these will lift only a few inches, others several feet. The lifting power is usually hydraulic.

Powered - Non-Lift

Platform Truck

The platform truck is commonly seen in transportation terminals carrying baggage of all kinds. These have long high platforms and are powered by diesel or electric motors. The truck may be designed to allow for the operator to walk or to ride.

Car-Mover

This is a small tractor designed to move a rail car in order to allow for unloading. This obviates the need for a railroad locomotive to shift cars and speeds the turn around of

cars thereby reducing the cost of demurrage.

Wide Area Equipment

Four Wheel Powered Lift Trucks

Fork Lift and Skid Lift

These basic lift trucks were described briefly in a preceding section on page 61. Here the more important variations will be enumerated. First, it is necessary to understand that a lift truck may be designed for the operator to walk behind it at a low speed or to ride on the truck at speeds up to six miles per hour. Models are designed to allow the operator to stand and some to sit on the vehicle.

A second basic difference involves the use of a counter-weighted and balanced body to offset the load weight. Weighting increases the size of the body thereby making it impossible to turn in narrow aisles but gives the truck the capacity to reach forward in order to pick up or deposit a greater load with its mast extended upward to full height. The so-called 'narrow aisle' or 'straddle arm' lift trucks have much smaller bodies, can lift as high as any piece of equipment but are limited in their ability to reach forward easily compared with the heavier bodied trucks. They are very useful space-savers. The 'straddle arm' truck is designed with two arms extending forward, supported by wheels in front to offset the lifted weight. (see figure 9)

Low Lift Platform and Pallet Trucks

The low lift trucks are like the non-powered trucks except for the addition of power propulsion. The flat platform is for lifting loaded skids, the forktruck for lifting pallets. The lifting height of these does not exceed four or five inches.

Low Mast Fork Lift

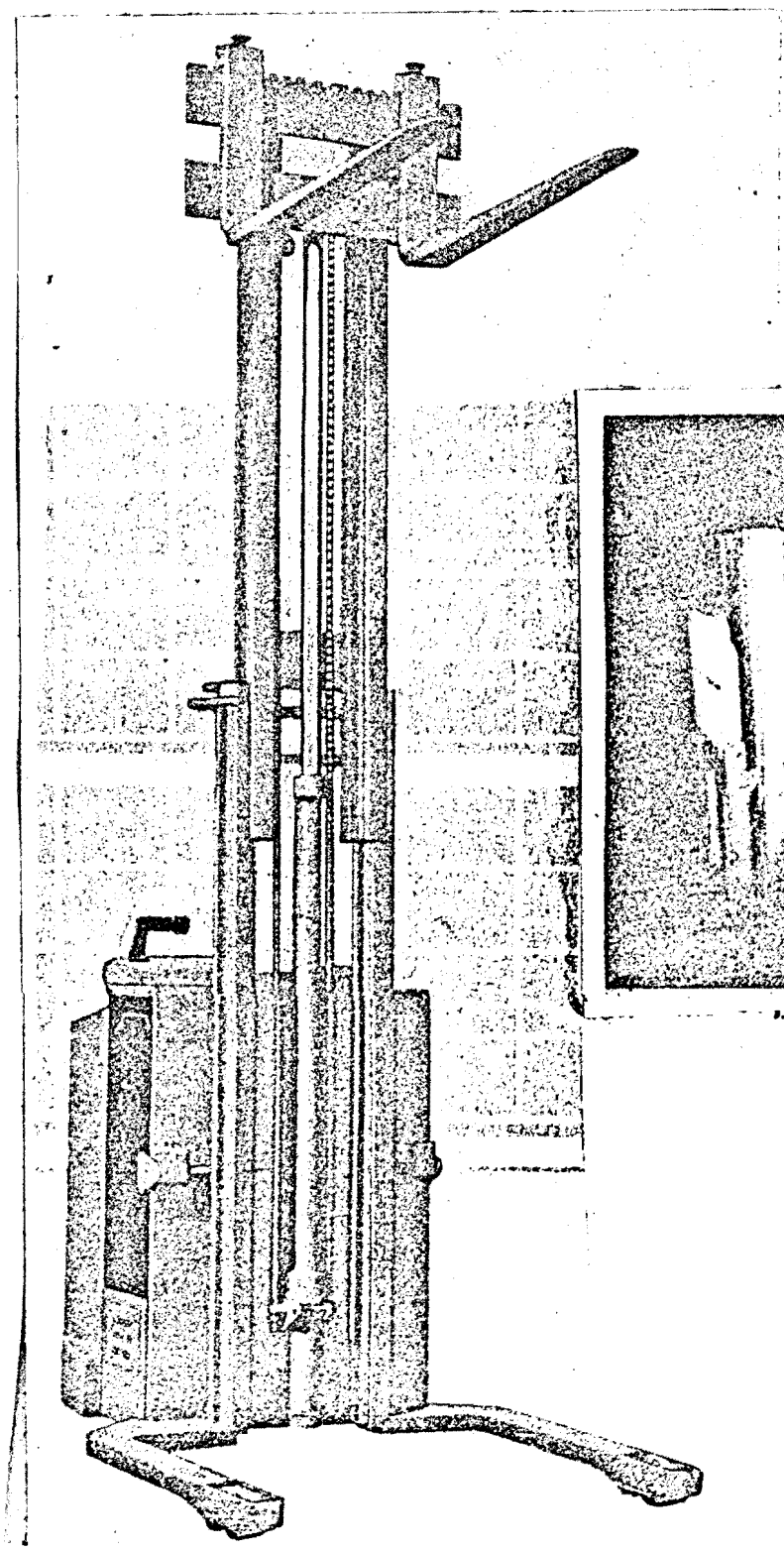
This lift is designed with a mast from 50 to 70 inches high which is low enough to allow it to be driven into a trailer or truck or under low doorways. (see figure 10)

High Mast Fork Lift

For use in high-tiered warehouses with maximum vertical stacking of goods, this lift truck has a mast with double or triple telescoping sections. When fully extended the load lift can be as high as 18-19 feet.

Tilt Mast Fork Lift

On these trucks the mast is designed to tilt 5 degrees forward or backward from the perpendicular. With the mast tilted back, the load center is pulled toward the body of the machine, allowing it to carry greater loads. When mast is tilted forward, the truck may reach to lift and deposit a load, but sacrifices load capacity.



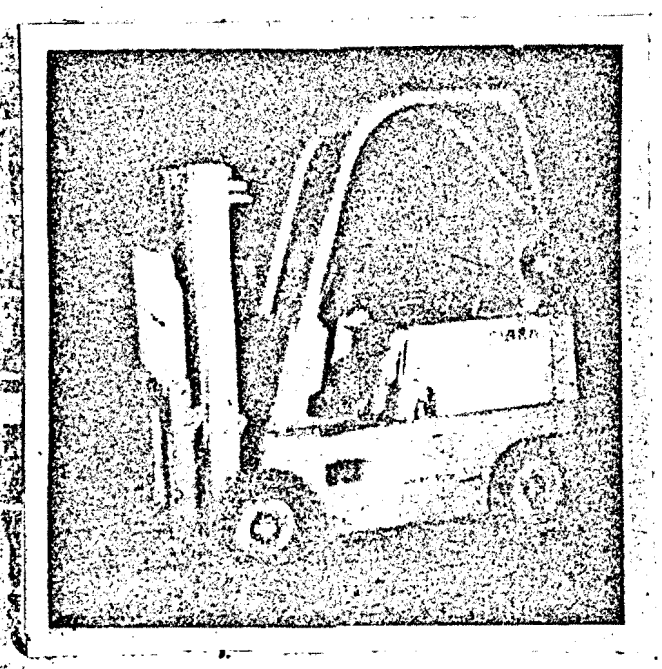


Figure 10
Low Mast
Fork Lift

Figure 9
Straddle Arm
Triplex Mast Fork Lift

Side Loading Lift

This is a large truck capable of great lifting capacity designed to pick up and carry on one side, long sections of materials such as metal beams or lumber. A specialty of this kind is not common in general merchandise warehouses, but available, if needed.

Straddle Lift

Here is another specialty type of truck which actually straddles its load, lifts it and carries it underneath the body. As is the sideloader, the straddler is good for long objects and is less useful in the general merchandise warehouse than in the construction field. The limitation of this truck is in respect to its height of lift.

Remote Control Jackstacker

For very high tiered stacks, this lift provides a high level platform for the operator which allows him to select objects more easily by means of an automatic control mechanism. This is a good machine to have in a warehouse where small orders are filled by hand.

Order Picker

Another variation is a telescoping mast fork lift which provides a platform, if wanted, on which the operator may lift himself to pick merchandise, by hand, from high shelves.

Attachments for Lift Trucks

The versatility of the fork lift truck is due not only to its lifting power but also to the number and variety of the attachments available for adapting to different materials. Types of forks in common use are:

1. the Saber - a thin knife edge blade to slide under unpalleted cases resting on the floor.
2. the Chisel - a heavy blade with sharp edge for sliding under slightly raised cases or boxes.
3. the Standard - for lifting pallets where openings are already available.
4. the Shovel - for handling loose bulk material.
5. the Clamp - a two-armed attachment which grips a large case, box or bale or any unitized materials from both sides. This saves the time of forking and may also save the time of loading on a pallet.
6. the Scoop - a double jawed attachment for gripping any large cylindrical object, such as an oil drum or roll of newsprint. These jaws can be rotated for greater ease in handling.

   the Ram - a straight, heavy, round steel bar which may be inserted into the center of any rolled material such as rugs, carpets or paper.

8. the Crane - a lifting arm for use with bulky, heavy objects.
9. Rotating Forks - these enable the lifting of objects resting on an angle.

10. Side Shifting Forks - these enable the truck operator to move the forks independently of the truck in order to get directly in front of the object to be lifted.
11. Scissor or Extension Forks - these enable the forks to be extended forward to reach an object.
12. the Pusher - enabling the truck to push a solid object without danger of injury to the material.

Power Sources for Fork Lifts

Gasoline and diesel fuel may be used in outdoor areas but their fumes make their use dangerous indoors. To offset the fume problem, liquid propane gas is used by some warehouses but the safest form of power is electricity. The disadvantage of electric motors is the need for daily re-charging of batteries and a second or replacement battery. This factor obviously creates an expense factor.

Tractor-Trailer Systems

For the movement of large quantities of materials for distances over 300 feet, the most efficient method is the use of four-wheeled trailer trucks of any type suited to the material. The trailer will be connected in a line with other trailers and pulled by a tractor. The tractor drops the train of trailers at a designated location and returns for a second train. Fork lift trucks may then lift the materials from the trailers to place them in storage.

This method follows one of the cardinal principles of materials handling which is to reduce to a minimum the traveling time of powered load carrying equipment and haul maximum quantities of materials with a minimum use of power. (see figure 11)

Personnel Carriers

For the movement of supervisory personnel or for transporting the work staff to and from distant work stations, small electric powered carriers are in common use. These are available in one, two, and four man sizes. (see figure 12)

Miscellaneous Equipment

Pallets

A pallet is a platform generally three or four feet square on which material is loaded into a compact mass so that it may be lifted and moved as a unit by a fork lift truck. The pallet itself may be constructed of wood, steel, or a combination of wood and heavy corrugated paper.

The economical method of handling materials in shipment is for the shipper to pre-load his merchandise on pallets so that it may be unloaded on arrival in maximum unit loads with a minimum of time and effort. More and more of this is being done through the efforts and cooperation of shippers and buyers. This method of preparation or packing is called

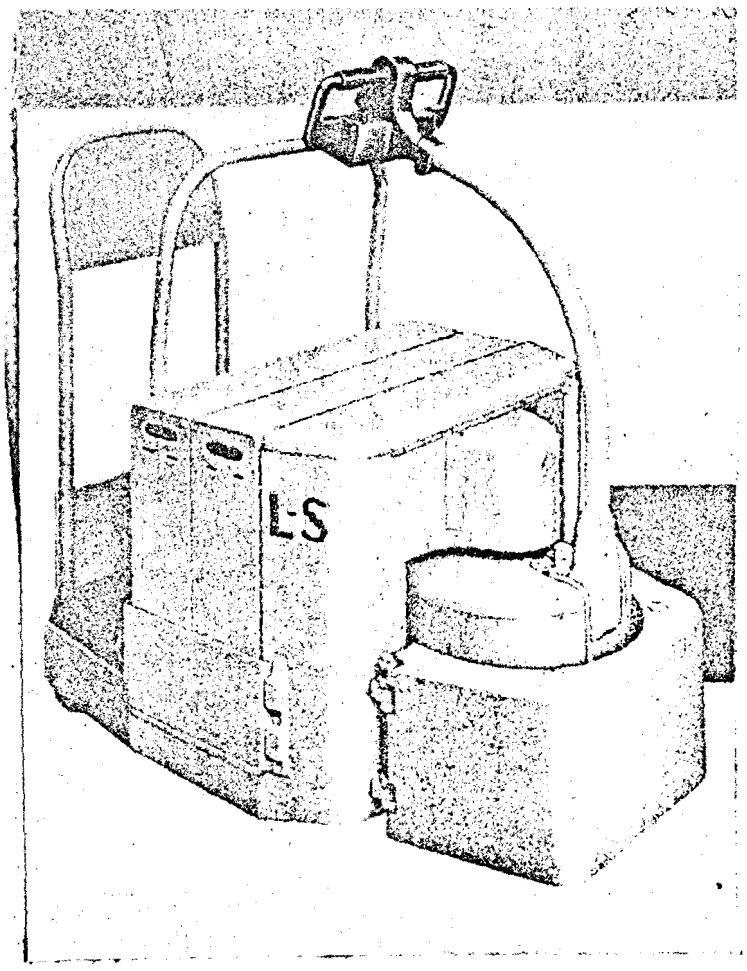


Figure 11
Electric Powered Tractor
by Lewis-Shepard

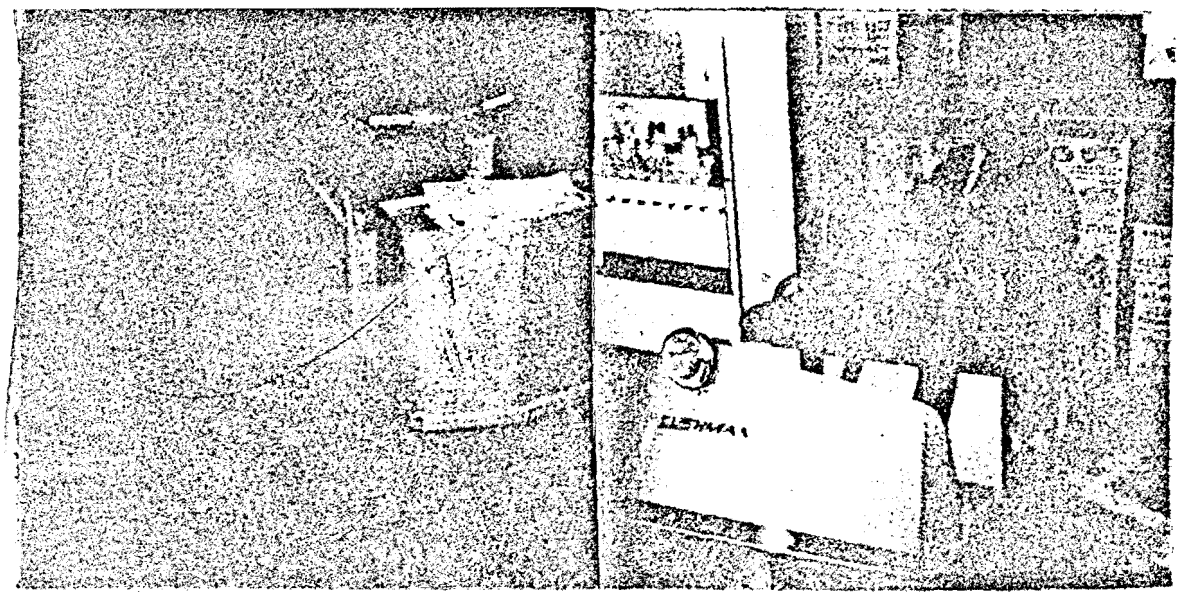


Figure 12
Personnel Carriers
1 Man 2 Man

'palletizing' or referred to as the 'unitized' method of shipment. If material reaches its destination unpalletized, it is carefully loaded by hand on pallets in prescribed ways referred to as the 'pattern' in order to insure its remaining in a single unit mass so that it may be handled by a fork lift truck. The writer has seen a shipment of bagged material glued together to form a palletized load.

Steel pallets will last longer than wooden pallets, but cost more. As an illustration of the probable expense problem, the reader may be interested to know that one Richmond warehouse now has approximately $75,000.00 invested in 26,000 wooden pallets. (see figure 13) Some shippers are using disposable pallets made of soft inexpensive wood cross bars enclosed in two sheets of corrugated paper, satisfied for them to last one trip.

The size and construction of pallets differs depending upon the weight of the material to be loaded, the method of shipping, manner of handling and the storage methods used. Size is partly governed by the space available in storage. In principle, the large pallet is better because it will carry a larger load and save handling time. For example, shipping done by truck and rail means reasonably careful handling including the use of forklift trucks, therefore is not hard on the pallet. Outside storage of pallets requires a sturdier product than would be required for inside storage.

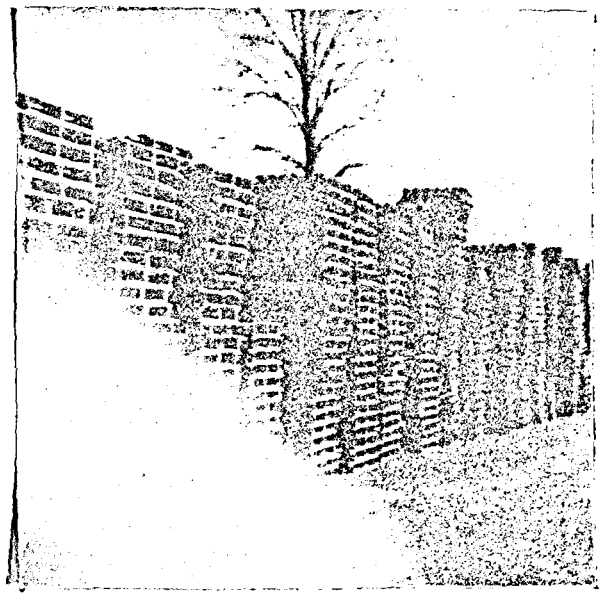


Figure 13
Wooden Pallets
Stored Outdoors

There are several important variations in the types of pallets commonly used. The 'single face' pallet has three parallel wooden bars roughly 3 by 5 inches, connected on only one side by 1 by 5 inch strips of hard wood. This is a light weight pallet. The 'double face' pallet has both sides covered or fastened together by wood strips which gives it greater strength. Both single and double face pallets may be lifted by a fork truck from only two directions since the forks must enter between the bars of wood. The '2-way' pallet is constructed of square wood blocks instead of bars to allow entrance of the forks from any one of the four sides of the pallet. The 'solid face' pallet has a top of plywood to provide greater strength and longer life plus less danger of injury to soft covered materials from splinters or rough wood edges.

Dock Boards and Ramps

As mentioned previously under Vertical Movement on page 57, a dock board serves as a bridge between a warehouse floor and the floor of a truck or rail car to provide passage for men and equipment.

A portable dock board is a one-piece metal ramp which is moved from place to place as needed. It is light enough to be moved by hand. This board is usually not adjustable in any way.

A fixed position dock board is set into the forward edge of the receiving or delivery platform and may be adjusted to

the level of the truck or car floor by mechanical means. The lifting of the board may be accomplished by hand control of hydraulic power, or of counter-weight movement or by push button control of electric power. The forward edge of the board is protected from injury by a truck through buffers fastened on the face of the platform to absorb the shock of any contact with the truck.

A ramp is an inclined platform used to offset the differences in floor levels between parts of a plant to provide a smooth path for wheeled vehicles.

Summary

In this chapter, the writer has endeavored to give the reader a concise but clear explanation of the most frequently used applications of non-fixed path equipment considered to be of major significance in the moving of general merchandise. The effort has been made here as well as in the preceding chapter to describe the action of the equipment in a way which would convey to the reader some of the impact received by an observer of the equipment at work. The writer recommends that any reader, intrigued by his descriptions, arrange for the opportunity to see these fascinating machines in action. In the following chapter, the writer will draw comparisons between the use of materials handling equipment as demonstrated in Richmond, Virginia warehouses.

CHAPTER V

A COMPARISON AND EVALUATION OF GENERAL MERCHANDISE WAREHOUSES RICHMOND, VIRGINIA

Purpose of the Study

The purpose of this study was to determine what materials handling methods and types of materials handling equipment were being used in general merchandise warehouses in Richmond, Virginia.

Objectives of the Study

The objectives of this study were as follows:

1. To determine what methods of materials handling were being used,
2. To determine what types of materials handling equipment were being used,
3. To compare both methods and equipment with acceptable standards set by authorities on the subjects, and,
4. To evaluate the present use of methods and equipment by means of the standards.

The Research Plan and Area Covered

In order to keep the research within attainable limits restricted by time and subject, the writer has concentrated on carefully selected general merchandise warehouses in Richmond, Virginia, which would be representative of the area. These limits were established with the realization that there might be warehouses outside of Richmond that were larger or more modern but with the expectation that the methods and equipment being used in Richmond could be compared with those generally accepted and available for use.

To obtain the necessary primary source data, the writer has visited six general merchandise warehouses, one public warehouse and one truck transportation terminal. Three of the general merchandise warehouses are operated by two major department stores, one by a wholesale dry goods company, one by a manufacturer of men's clothing and the last by a large retailer-owned wholesale food cooperative.

Public warehouses and transportation terminals were purposely excluded from the study in order to limit the scope of the research to operations involved as closely as possible in the same kinds of problems. Two new facilities, a public warehouse and a transportation terminal, owned by the same parent corporation, were visited by the writer, because he believed that these would enable him to observe methods and

equipment in use applying equally well to general merchandise warehouse operations. References to these two organizations will be made only for purposes of illustration.

Secondary source data has been accumulated by the reading of available published material in Richmond public or institutional libraries as well as private collections together with available articles published in periodicals during the past several years. In addition, the writer has obtained a considerable amount of valuable information through correspondence with equipment manufacturers.

Having explained why and how this study was carried out, the writer attempts, in the succeeding section, to prepare the reader to achieve a better understanding of the problems of materials handling and the differences to be found in the use of methods and equipment.

Problems of Materials Handling

Before engaging in a description and comparison of the actual use of methods and equipment, the writer believes that it will assist the reader to a better understanding of the problems involved by referring to comments made by several authorities on this subject. John R. Immer has commented as follows: "An understanding of the nature of the movement of materials is a pre-requisite to any use or consideration of specific types of equipment. Without this, the equipment may be technically adequate but not be

the specific type of equipment or method which should be applied."[1]

A second authority, Edward W. Smykay, states, "The fact must always be kept in mind that handling per se adds no value to the product. The objective in selecting a given materials handling system is to accomplish necessary product handling with a minimum of movement."[2] Further, Mr. Smykay, says, "Because of the vast amounts of equipment available and the different characteristics of each movement problem, the selection of a materials handling system must remain a tailored operation."[3]

Still a third well known authority writes, "Installation of mechanical equipment generally brings reductions in handling costs amounting to 20-90%, as well as equally large savings of time. For example, the Westinghouse Lamp Company, Trenton, N. J., reported that by increasing handling equipment 50%, production was doubled without any increase in floor space."[4]

[1]Immer, John R., Materials Handling, New York; McGraw-Hill Book Co., Inc., 1953, p. 9.

[2]Smykay, Edward W., Physical Distribution Management, New York; The McMillan Co., 1961, p. 244.

[3]Ibid, p. 245.

[4]Stocker, Harry E., Materials Handling, New York; Prentice-Hall, Inc., 1943, p. 1.

The National Retail Merchants Association has stated as a policy for receiving, freight handling and distribution, the following, "To receive and distribute merchandise with the greatest accuracy, least amount of time and cost and the best physical handling which will give the fullest support to merchandising and operating."[1]

From the foregoing quotations, the reader should be conscious of the possibility that while observed differences in the use of methods and equipment may not signify a difference in efficiency, mechanization is a constituent of efficiency in materials handling. In the following section, the writer will identify and describe briefly, the organizations and the warehouses included in this study.

[1]Traffic Group, National Retail Merchants Association, Receiving Department Operations Manual, New York; Traffic Group, National Retail Merchants Association, 1960, p. 55.

Identification of Organizations and Warehouses

Miller and Rhoads, Inc.

This organization is a department store with a published annual sales volume of approximately forty million dollars. The two Richmond warehouses serve the main downtown store and one branch store in Richmond in addition to six out of town stores. A buying staff, located in Richmond, buys merchandise for all eight stores, most of which is brought into and distributed to all stores from the two warehouses. One of the warehouses (Hermitage Road), handles furniture, rugs and carpets, mattresses and homefurnishing bulk items, the second warehouse (4th Street), handles all of the apparel and textile lines. Customer deliveries of bulk items are made from the Hermitage warehouse.

Thalhimers

This organization is a department store with a published annual sales volume almost identical with that of Miller and Rhoads. Here, however, the buying division is organized on a different basis. All of the nine out of town stores buy independently, with their purchases shipped directly to them from the vendors. This method eliminates the need for a central warehousing and distribution point in Richmond. The Richmond warehouse handles the merchandise purchased by the Richmond buyers for the local stores,

distributes this to the main store, five branches and one 'twig' (limited lines) in the Richmond metropolitan area. Before the installation of the present buying and distribution system several years ago, all merchandise was funneled through the Richmond warehouse, as is still being done by Miller and Rhoads. This innovation has eliminated the need for warehouse space in Richmond, as a result of which almost two-thirds of the original warehouse has been turned into the Westmoreland branch store. Although additional space is being planned for the warehouse, a great part of the original non-productive warehouse space has been turned into productive selling space. All local customer deliveries are made from the Richmond warehouse, the Richmond stores forwarding purchases to this point for distribution.

Richmond Dry Goods Company, Inc.

This organization is a wholesale distributor of nationally branded items, chiefly in the children's wear and related textile lines. This company was formed a few years ago following the dissolution of a general line wholesale house affiliated with a chain of retail stores. As a wholesale distributor, the Richmond Dry Goods Company serves its customers throughout Virginia and in North Carolina east of Greensboro, from the Richmond warehouse. In addition to the Richmond warehouse, the company operates five other warehouses.

Richmond Food Stores, Inc.

Thirty years ago thirteen food retailers formed this organization on a cooperative basis. Members now number more than 600 and this cooperative expects sales in 1965 in excess of fifty million dollars. About half of the members are located in the Richmond area, the other half in other sections of Virginia, the District of Columbia, Maryland and North Carolina. This cooperative warehouse handles all kinds of case goods, fresh vegetables, fruits, frozen foods and is currently engaged in building its own milk processing plant. The warehouse covers an area of eight and one-half acres.

Friedman-Marks Manufacturing Company

This company is engaged in the manufacture of men's suits, slacks and jackets with a present capacity of about 11,000 suits a week. Its stock room has a capacity of 80,000 garments. The writer has included this company in his study because of the interesting methods and equipment used in the handling of finished garments. None of the materials handling of work-in-process has been included.

Foremost Warehouse Corporation

This is the one public warehouse which was visited by the writer for the purpose of comparison with the general merchandise warehouses. Foremost is a wholly owned subsidiary of the Overnite Transportation Company with a large, new, modern warehouse handling a wide variety of merchandise.

Overnite Transportation Company

This company operates thirty truck terminals with a fleet of 1672 mobile units. In 1963, Overnite's operating revenue was slightly less than 21 million dollars. In 1964, a new terminal was opened in Richmond with a platform area of 25,000 square feet capable of handling 56 truck trailers at the same time.

Having identified the organizations whose warehouses have been included in this study, the writer will undertake, in the succeeding section, to compare and evaluate the warehouse operations with respect to their materials handling methods and equipment.

Comparison of Warehouse Operations

In order to draw a direct and objective comparison between the warehouse operations studied, each of the three major functional areas will be discussed separately.

First, the Receiving Operations,

Second, the Storage Operations, and

Third, the Shipping Operations.

Each of the three major functional areas will be presented in a series of three charts as outlined below.

Receiving Operations

Chart A-1	Comparison of Facilities
A-2	Evaluation Point System
A-3	Evaluation Score Board

Storage Operations

Chart B-1	Comparison of Facilities
B-2	Evaluation Point System
B-3	Evaluation Score Board

Shipping Operations

Chart C-1	Comparison of Facilities
C-2	Evaluation Point System
C-3	Evaluation Score Board

To preserve the anonymity of the organizations, each of the six general merchandise warehouses compared is identified only by a letter A through F on the charts numbered 1 and 3.

Comparison of Facilities

Explanation of the Charts numbered 1

In each of the three functional areas, the first chart lists the type of facility to be compared, then shows, in tabular form, the use being made of this facility in each of the six warehouses. The facilities offered for comparison are those now being used by at least one of the warehouses. When equipment is compared, a number indicates the pieces of equipment being used, where the number is of value. Where the number of pieces of equipment is not considered important, the word 'yes' indicates that the equipment is in use. The name of a particular piece of equipment is used where this is of value. Shown also on this chart are warehouses G and H for use as reference although they are not included in the evaluation.

Evaluation Point System

Explanation of the Charts numbered 2

Each chart numbered 2 lists the facilities offered, corresponding to those in charts numbered 1, and identifies each of these facilities by a number. Following this is an explanation of the way in which each facility is to be judged, and finally, the minus point value assigned to the facility. The reader will notice that under the explanation section of this chart, certain facilities have been listed with no minus point value assigned. This has been done to indicate that

this method is considered ideal with variations from this ideal assigned minus values. In other facilities, minus values have been assigned when a particular type of equipment is lacking, if needed. This form of evaluation takes into consideration the need or lack of need for this equipment under certain operating conditions. If a warehouse could use a piece of equipment but does not provide it, a minus point value is debited to the warehouse. On the other hand, if certain equipment is lacking but could not be used to advantage, no minus value is given. The author realizes that criticism might be made of this evaluation on the grounds that it is subjective, since it is the author who is making the judgment, but believes that he has achieved a considerable degree of objectivity after close observation and study of the warehouses themselves and available literature covering the subject.

Evaluation Score Board

Explanation of the Charts numbered 3

Each chart identified as 3 lists the facilities, using the identification number shown on chart 2. In succeeding columns, one for each warehouse, the minus point value, if any, assigned to each facility, is shown, with a total for each warehouse shown at the bottom. In accordance with the minus point value system, the warehouse with the lowest number of points is established as the most efficient.

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RECEIVING OPERATIONS

COMPARISON OF FACILITIES — CHART A-1

TYPE OF FACILITY	ORGANIZATIONS							
	A	B	C	D	E	F	G	H
Platform Capacity Trucks	15 expansion possible	3 full	6 full	3 full	15 expansion possible	3 full	10 expansion possible	56 expansion possible
Platform Condition	Covered Not Separated	2 Enclosed 1 Open Not Sep'd	Enclosed Not Separated	Enclosed Not Separated	Covered Part Separated	Not Covered Not Separated	Not Covered All Separated	Covered All Separated
Rail Siding Capacity and Condition	5 Covered	None	None	None	4 Enclosed	None	5 Covered	None
Dock Boards Portable	1	1	None	1	2	1	2	None
Fixed	None	None	None	None	None	None		
Hydr.							2	---
Elec.							1	---
C-W.							---	56
Lifts								
Hand	---	3	3	2	6	1	3	---
Low	1	---	1	---	4	No	2	2
High	1	---	No	No	12	Need	1	---
Gas	1	No	Need	Need			---	---
L-P	---	Need			---		3	---
Elec.	1		1		all		---	2
Attachments	standard knife ram		standard --- ram		standard knife --- chisel side shift		standard knife ram chisel side shift scoop	standard knife
Hand Trucks								
Steve	yes	yes	yes	yes	yes	yes	yes	yes
Plat	---	---	yes	yes	---	---	yes	yes
Hamper	---	canvas	metal	---	---	canvas	---	---
Rack	---	yes	yes	---	---	---	---	---

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RECEIVING OPERATIONS

COMPARISON OF FACILITIES
(continued)

CHART A-1

TYPE OF FACILITY	ORGANIZATIONS							
	A	B	C	D	E	F	G	H
Conveyors								
Portable No Power	—	1 Skate Wheel	1 Skate Wheel	—	1 Roller	—	—	1 Roller 1 Sk.Wheel
Portable Power	—	—	1 Belt	—	—	—	—	—
Fixed Power	—	Roller + Belt,75ft.	Belt	—	—	—	—	—
Tow Trucks	—	—	—	—	Platform	—	—	Platform Shelf Cage
Tractor-Trailers	—	—	—	—	Lewis-Shepard Electric	—	—	
Dragline	—	—	—	—	1500 feet chain under no switch	—	—	1400 feet chain under automatic switch
Personnel Carriers	—	—	—	—	1 man 2 man	—	—	—
Pneumatic Tube	—	—	—	—	—	—	—	yes
Pallets								
Wooden	yes	None	yes	None	26,000	None	yes	None
Metal	—	No	—		—	No	—	No
Disposable	—	Need	—		—	Need	yes	Need
1-Way	yes		yes		yes		yes	
2-Way	yes		yes		yes		yes	
1-Sided	yes		yes		yes		yes	
2-Sided	yes		yes		yes		yes	
Solid	yes		yes		yes		yes	
Skids	yes	yes	—	—	yes	—	yes	—
Rollers	yes	yes	—	—	—	—	—	—
Dollies	yes	yes	yes	—	—	—	—	—

EVALUATION POINT SYSTEM CHART A-2

NO.	FACILITY	EXPLANATION	MINUS VALUE
1	Platform Capacity	Room for expansion ..... Operating at capacity,but sufficient Operating at capacity,but insufficient	None 1 2
2	Platform Condition	Enclosed - bays separated ..... Enclosed - bays not separated Covered - bays separated ..... Not covered - separate doors ..... Covered - not separated ..... Not covered - not separated	None 1 2 2 3 4
3	Rail Siding Capacity Conditio	Enclosed - sufficient capacity .... Enclosed - insufficient capacity .. Covered - sufficient capacity .... Covered - insufficient capacity ..	None 1 2 3
4	Dock Boards	Fixed and adjustable ..... Portable only ..... Insufficient for needs ..... None	None 1 1 2
5	Lifts	Lacking hand lift ..... Lacking low mast (if needed) ..... Lacking high mast (if needed)	1 1 1
6	Hand Trucks	Lacking (if needed) ..... Wooden or canvas instead of metal .	1 1
7	Conveyors	Lacking portable,power or gravity Lacking fixed,power or gravity....	1 1
8	Tow Trucks	Lacking (ifneeded)	1
9	Personnel Carrier	Lacking (if needed)	1
10	Pneumatic Tube	Lacking (if needed)	1
11	Pallets	Lacking (if needed) ..... Wooden instead ofmetal	1 1
12	Skids	Lacking (if needed)	1
13	Rollers	Lacking (if needed)	1
14	Dollies	Lacking (if needed)	1

RECEIVING OPERATIONS

EVALUATION SCORE BOARD CHART A-3

FACILITY No.	ORGANIZATIONS					
	A	B	C	D	E	F
1	-	2	1	1	-	1
2	3	2	1	1	3	4
3	2	-	-	-	-	-
4	2	2	3	1	2	1
5	1	-	-	-	-	-
6	-	1	-	-	-	1
7	1	-	-	1	-	1
8	1	-	-	-	-	-
9	1	-	-	-	-	-
10	-	-	-	-	-	-
11	1	-	1	-	-	-
12	-	-	-	-	-	-
13	-	-	-	-	-	-
14	-	-	-	-	-	-
Totals	12	7	6	4	5	8

Comments on Results Shown on
Receiving Operations Evaluation Score Board

Based on the score, warehouse D is operating most efficiently. This should be interpreted as meaning that this warehouse has adapted its methods and equipment to its current problems most adequately of all the warehouses. In examining Chart A-1, Comparison of Facilities, it will be noted that warehouse D is not a large operation. It has platform space for three trucks with the space enclosed, but the bays are not separated. This facility could be improved. There is no rail siding because it is not needed. Only one dock board is provided although more than one would save time and labor. D uses hand lifts and does not need fork lifts because the inflow of goods is not rapid enough or in sufficient quantities to require this. D also uses hand trucks. No conveyors are used although there should be at least one portable gravity or power conveyor. D does not use pallets or skids because the rate of inflow allows freight to be handled without this facility. In summary, it would be fair to state that although warehouse D is now doing a competent job, a substantial increase in the amount of merchandise handled would require increased mechanization.

Now look at warehouse A which shows the largest total of minus values. This is a large warehouse with a covered platform for 15 trucks without bay separations. A has a rail siding for 5 cars, covered but not enclosed. Here there is

one portable dock board although it should have fixed and adjustable boards; it has only one hand lift, only one portable gravity conveyor and no power conveyor. Warehouse A does not use tow trucks which would assist materially in taking the load of work from its one low mast and one high mast fork lift trucks. Wooden pallets are used rather than metal. In this large warehouse, a personnel carrier would make it possible for the supervisory staff to move quickly from point to point, but this has not been provided. In summary, warehouse A is a large operation, with room for expansion, but, with respect to the receiving operation, it is being operated as though it were considerably smaller than is actually the case.

Summary

From this evaluation of the receiving operations of the six general merchandise warehouses, the writer moves on to consideration of the storage operations, beginning with the chart on the following page showing a comparison of facilities.

STORAGE OPERATIONS

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COMPARISON OF FACILITIES

CHART B-1

TYPE OF FACILITY	ORGANIZATIONS							
	A	B	C	D	E	F	G	H
Square Footage	120,000	57,000	130,000	25,000	335,000	20,000	127,000	None
Cubic Footage	2½ million on 1 level 3½ million on 2 levels	685,000	1½ million	375,000	7¼ million	300,000	2½ million	
Storage Height	19 feet / 30 feet	12 feet	12 feet	15 feet	19 feet	15 feet	19 feet	
Storage Height Use	12 feet / 18 feet	7 feet	12 feet	7 feet	19 feet	15 feet	19 feet	
Lifts								
Hand	yes	yes	yes	yes	yes	yes	yes	
Fork								
Low	1	Not	1	Not	3	Not	2	
High	2	Needed	—	Needed	12	Needed	1	
Gas	1		—		—		—	
L-P	—		—		—		3	
Elec.	2		1		12		—	
Stationary								
Portable	1		1		—		—	
Elec.	1		1					
Hand Trucks								
Steve.	yes	yes	yes	—	—	—	yes	
Plat.	yes	—	yes	yes	yes	—	—	
Hamper	yes	yes	—	—	—	yes	—	
Shelf	—	yes	—	—	yes	—	—	
Rack	—	yes	—	—	—	—	—	
Box	—	—	yes	—	—	yes	—	
Special Trucks								
2 Wheels	mattress	Not Needed	—	Not Needed	package	Not Needed	—	
4 Wheels	bed lamp		Not Needed					
Dolly	chair, sofas mirror							

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STORAGE OPERATIONS

COMPARISON OF FACILITIES
(Continued)

CHART B-1

TYPE OF FACILITY	ORGANIZATIONS							
	A	B	C	D	E	F	G	H
Conveyors								
Power	None			None	None		None	None
Belt		yes	yes			yes		
Roller		—	—			—		
Cable		—	—			yes		
No Power				None	None		None	None
Pipe	None	yes	yes			yes		
Rail		—	yes			—		
Gravity				None	None		None	None
Roller	yes	yes	yes			—		
Wheel	yes	—	—			yes		
Chute	—	yes	—			—		
Rail	—	—	—			—		
Tow Trucks	—	—	—	—	yes	—	—	
Tractor Trailer		—	—	—	Lewis-Shepard Elec.System	—	—	
Dragline	—	—	—	—	1500 feet chain under no switch	—	—	
Pallets	wood	—	—	—	wood	—	wood	
Skids	yes	yes	yes	yes	yes	yes	yes	
Roller Tables	yes	—	yes	—	—	—	—	
Personnel Carrier	—	—	—	—	1 man 2 man	—	—	

EVALUATION POINT SYSTEM CHART B-2

NO.	FACILITY	EXPLANATION	MINUS VALUE
1	Storage Height	19 feet -highest reached by lift equipment	None
		16 feet	1
		15 feet	2
		12 feet	3
2	Storage Height Used	All Used	None
		66% Used	1
		60% Used	2
		50% Used	3
3	Aisle Width	6 feet,using narrow aisle lifts	None
		over 6 feet	1
4	Lifts	Use of gasoline indoors	1
		Lacking hand lift	1
		Lacking low mast lift,if needed	1
		Lacking high mast lift,if needed	1
5	Hand Trucks	Lacking stevedore truck	1
		Lacking any other type needed .	1
6	Conveyors	Lacking gravity,if needed	1
		Lacking power,if needed	1
		Lacking 'no power',if needed ..	1
7	Tow Trucks	Lacking,if needed	1
8	Tractor-Trailer	Lacking,if needed	1
9	Dragline	Lacking, if needed	1
10	Pallets	Lacking, if needed	1
		Wooden instead of metal	1
11	Skids	Lacking, if needed	1
12	Roller Tables	Lacking, if needed	1
13	Personnel Carrier	Lacking, if needed	1
14	Special Trucks	Lacking, if needed	1
15	Special Extras	Extra credit for ingenuity Bridged aisle, mezzanine	Plus 1 each

STORAGE OPERATIONS

EVALUATION SCORE BOARD CHART B - 3

FACILITY NO.	ORGANIZATIONS					
	A	B	C	D	E	F
1	-	3	3	2	-	2
2	2	1	-	3	-	-
3	1	-	1	1	-	-
4	1	-	-	-	-	-
5	-	-	-	1	1	-
6	-	-	-	-	-	-
7	1	-	-	-	-	-
8	-	-	-	-	-	-
9	-	-	-	-	-	-
10	1	-	-	1	1	-
11	-	-	-	-	-	-
12	-	-	-	-	-	-
13	1	-	-	-	-	-
14	+1	-	1	-	-	-
15	+1	-	-	-	-	-
Totals	-7 +2	4	5	8	2	2

Comments on Results Shown on
Storage Operations Evaluation Score Board

Two warehouses are tied with the lowest minus point values, warehouse E, the largest of the six, and warehouse F, the smallest of the six. Warehouse E is well equipped with the only item of equipment needed being a small hand truck, and the only major improvement needed is the technical one of replacing wooden pallets with metal pallets. Warehouse F suffers chiefly from a lack of ceiling height which, if greater, would enable it to store more goods in a smaller square foot space by making available more cubic foot space.

Warehouse D shows the highest minus point value. This warehouse is the second smallest in square footage. Warehouse D lacks ceiling height, fails to utilize fully its present ceiling height, provides wider aisles than needed, lacks one type of common but useful hand truck, and fails to make use of the unitized load method of handling materials.

Warehouse A shows the second highest minus point value. This warehouse is the third largest in square foot space but fails to make use of its ceiling height potential, provides wider aisles than necessary, uses a gasoline powered fork lift partly indoors, fails to make use of tow trucks to carry large loads with a minimum of power, uses wooden pallets instead of metal and does not provide personnel carriers for its supervisory staff. This warehouse does

offer certain plus values through its ingenuity in bridging aisles, suspending a mezzanine from the warehouse roof to add space, together with its use of a group of special duty hand trucks for specific types of hard-to-handle merchandise.

Warehouse C, the second largest of the six warehouses, shows the third highest minus point value due to lack of ceiling height, aisles that are too wide, and the lack of certain special duty trucks.

Summary

The third and last functional area for consideration is that of shipping operations which is discussed beginning on the next page with Chart C-1.

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SHIPPING OPERATIONS

COMPARISON OF FACILITIES

CHART C-1

TYPE OF FACILITY	ORGANIZATIONS							
	A	B	C	D	E	F	G	H
Platform Capacity Trucks	9 expansion possible	3 full insufficient	6 large 24 small expansion possible	6 expansion possible	12 expansion possible	3 expansion not possib. sufficient	10 expansion possible	56 expansion possible
Platform Condition	Enclosed Not Separated	2 Enclosed 1 Open Not Separated	Enclosed Not Separated	Enclosed Not Separated	Covered Part Separated	Not Covered Not Separated	Covered All Separated	Covered All Separated
Dock Boards								
Portable	yes	yes	yes	yes	yes	yes	—	—
Fixed	—	—	—	—	—	—	3	56
Hydr.							2	—
Elec.							1	—
C-W.							—	56
Lifts								
Hand	yes	yes	yes	yes	yes	yes	yes	yes
Fork	yes	—	—	—	yes	—	yes	yes
Hand Trucks								
2 Wheel	yes	yes	—	yes	yes	yes	yes	yes
4 Wheel	yes	yes	yes	yes	yes	yes	yes	yes
Conveyors								
Portable								
gravity	None	—	None	None	skate wheel	skate wheel	None	skate wheel
power		yes			—	—		—
Fixed	None			None	None	None	None	None
power		—						
belt			yes					
No-power								
chute		—	yes					
pipe		yes	yes					
Dollies	yes	yes	yes	yes	yes	yes	—	—
Rollers	yes	—	—	—	—	—	—	—
Pallets	—	—	—	—	yes	—	yes	—
Skids	yes	yes	—	—	—	—	yes	—

SHIPPING OPERATIONS

EVALUATION POINT SYSTEM CHART C-2

NO.	FACILITY	EXPLANATION	MINUS VALUE
1	Platform Capacity	Room for expansion ..... Operating at capacity, sufficient Operating at capacity, insufficient	None 1 2
2	Platform Condition	Enclosed - bays separated .... Enclosed - bays not separated. Covered - bays separated .... Not covered -separate doors .. Covered - not separated ..... Not covered - not separated ..	None 1 2 2 3 4
3	Dock Boards	Fixed and adjustable ..... Portable only ..... Insufficient for needs ..... None	None 1 1 2
4	Lifts	Lacking hand lift ..... Lacking low mast, if needed .. Lacking high mast, if needed .	1 1 1
5	Hand Trucks	Lacking, if needed ..... Other than metal	1 1
6	Conveyors	Lacking portable, gravity or power Lacking fixed, gravity or power	1 1
7	Dollies	Lacking, if needed	1
8	Rollers	Lacking, if needed	1
9	Pallets	Lacking, if needed ..... Wooden instead of metal	1 1
10	Skids	Lacking, if needed	1

SHIPPING OPERATIONS

EVALUATION SCORE BOARD CHART C-3

FACILITY NO.	ORGANIZATIONS					
	A	B	C	D	E	F
1	-	2	-	-	-	1
2	1	2	1	1	2½	4
3	2	1	1	1	1	1
4	-	-	-	-	-	-
5	-	-	-	-	-	-
6	1	-	-	1	1	-
7	-	-	-	-	-	-
8	-	-	-	-	-	-
9	-	-	-	-	1	-
10	-	-	-	-	-	-
Totals	4	5	2	3	5½	6

Comments on Results Shown on
Shipping Operations Evaluation Score Board

In this final stage of operations, warehouse C leads with the smallest minus point score of 2, given because it has not separated its truck bays and because it does not provide fixed and adjustable dock boards on its shipping platform. Warehouse D is the next lowest in minus values based on failures identical to those of warehouse C but with the additional failure to provide any kind of conveyor for loading goods.

The least efficient is warehouse F due to its poor facilities for handling trucks. Note that this warehouse has no room for expansion of its truck facilities, does not provide an enclosed or covered platform or separated truck bays, nor does it provide fixed dock boards.

Warehouse E is the second least efficient operation due to its covered platform but only partly separated truck bays, its failure to provide fixed dock boards and its lack of power conveyors. Warehouse B is close to E in minus points due chiefly to its poor facilities for handling trucks.

This concludes the separate evaluations of the three major functional areas of operations of the six general merchandise warehouses. In the succeeding pages, the writer will summarize the functional evaluations of the warehouses, showing a composite total score for each and make relevant comments regarding the conclusions to be reached.

Evaluation Summary

A summary of the three Evaluation Score Boards follows:

	ORGANIZATIONS					
	A	B	C	D	E	F
Receiving Operations	12	7	6	4	5	8
Storage Operations	7	4	5	8	2	2
Shipping Operations	4	5	2	3	5½	6
Totals	23 -2	16	13	15	12½	16
Efficiency Standing	5	4	2	3	1	4

In studying the warehouse operations to determine the reasons for the comparatively good performance of warehouse E and that of the runner-up, warehouse C, certain significant facts stand out. Warehouse E is the largest of the six warehouses with an almost continuous flow of merchandise into and out of storage. The facts stated above have enabled this warehouse management to utilize the most modern methods of materials handling and to justify the mechanization of its equipment with the greatest advantage. In addition, management has provided up-to-date types of equipment to handle materials with a minimum use of manpower, to handle maximum unit loads with a minimum use of powered equipment and to reduce waiting time of both men and equipment. The large volume of goods handled enables this warehouse to reduce warehouse handling time by arranging for the pre-palletizing

of goods before receipt at the warehouse and to unitize materials after receiving. By making maximum use of vertical, one-level storage space obtainable through the use of high lift equipment, this warehouse has accomplished the following:

1. the increase of cubic foot storage space,
2. the reduction of the need for square foot storage space, and,
3. the reduction of time consuming horizontal movement of materials and equipment.

Warehouse C, the runner-up, operates within a restricted space, and, although it lacks sufficient ceiling height, it utilizes fully the existing height. Warehouse C is more fully mechanized than several of the other warehouses which enables it to handle larger quantities of materials more rapidly and efficiently.

In the opinion of the writer, all six of these warehouses are operated with a considerable degree of efficiency when each is examined separately. One conclusion reached by the author is that a warehouse is in the position to operate most efficiently when it has provided room for expansion when needed but does not spread itself into more space than it actually requires at any given time. By providing and utilizing maximum vertical storage space to obtain the maximum cubic foot space, thereby limiting the need for square foot space, the warehouse is able to concentrate its use of mechanical equipment with maximum efficiency and to handle

maximum unit material loads in the shortest possible time with the least expenditure of manpower.

Additional Comments

There are many interesting and revealing details of the individual warehouse operations some of which the writer feels are worthy of further explanation in the following pages.

The author visited for observation and study, the six general merchandise warehouses, the one public warehouse and the one transportation terminal described earlier in this study. The first visits were to the public warehouse and the transportation terminal. Of the eight facilities visited, these were the most recently constructed and probably, for this reason, included some of the most modern equipment of all eight. For example, only these two have receiving and shipping platforms equipped with built-in self-adjusting dock boards. Each of the 56 truck bays in the transportation terminal is equipped with a self-adjusting dock board manufactured by the well known Kelley Company of Milwaukee, Wisconsin. These dock boards operate by hand with a counterweight mechanism. The public warehouse platform is equipped with two different types of dock boards, all self-adjusting, some actuated by hand with hydraulic power, others by a push-button electric mechanism. Not all of their bays, however, are so equipped. Obviously, it is easy to install

permanent dock boards at the time a platform is under construction but difficult to do so after completion. The older warehouses, therefore, have been satisfied to do without rather than incur the expense.

Both of the organizations mentioned above are the only ones of the eight to have separated their truck bays so that there is a minimum of wasted platform space. The truck trailer is backed into an opening which it fills entirely so that most of the bad weather is cut out and the merchandise and personnel protected. On the other hand, neither of these platforms has enclosed bays as do two of the general merchandise warehouses. Apparently, there is a difference of opinion regarding the advantages of the enclosed bay over the open or covered and separated space.

Two other points of interest to be seen in the transportation terminal are the automatic, self switching carts in the chain dragline, controlled from a central dispatcher's desk, and the use of metal cage package trucks which are carried in the trailer trucks, then, after reaching the receiving platform, are set into the dragline for transfer to another trailer. This dragline was installed by the SI Handling Systems, Inc. of Easton, Pa. The only other dragline in use among the six general merchandise warehouses is a continuous track without switches.

The only pneumatic tube in use in Richmond, as observed, by the writer, is in the transportation terminal, carrying

shipping orders from the office at one end of the platform to a central point on the platform. It is possible that this method could be used by at least two of the warehouses visited which are large enough to require their maintaining a separate file of orders at the receiving platform to be checked against invoices.

It was in the public warehouse that the writer observed a pallet load of heavy paper bags glued together in order to form a unitized load which could be handled by a fork lift truck. This is a method which could be applied elsewhere to similar types of goods.

It is the conclusion of the author that much may be learned from the warehouse and terminal operators because they are in the business of making a profit chiefly from the handling of goods rather than from the sale of goods with the warehousing function as an auxiliary, as is true in the case of the warehouse of a wholesaler or retailer. The writer was informed by a public warehouseman that he makes very little profit from the storage of goods so that he depends, for the bulk of his profit, upon his ability to handle goods efficiently in and out of storage.

The most efficient of the six general merchandise warehouses has only recently installed a tractor trailer system, following a large addition to its floor area. This system enables

the warehouse to pull, by a small tractor, 5 platform trucks, each capable of carrying a 2,000 pound load. One trip of this tractor train equals five trips by a fork lift truck. And yet, this warehouse was operating 235,000 square feet of space with fork lift trucks only. This is referred to as an experiment by the warehouse staff. Obviously, this should be considered a very valuable experiment.

This tractor vs fork lift discussion brings up the question of the limited capacity of powered load-carrying equipment and the time required for it to make a round trip between the platform and the storage area. A valuable comparison of the savings to be made from the use of tractor trains rather than fork lifts is offered in a study by Harry E Stocker.[1] This study shows that, at 1943 costs of equipment and wages of $1.00 an hour, there was a saving of $0.55 per day for a 100 ton lift (1 ton carried 100 feet), during an 8 hour working day, through the use of a tractor pulling only 8 tons per trip, in comparison with the use of a fork lift carrying 2 tons per trip.

The use of fork lifts in the storage function presents worthwhile comparisons. The most efficient warehouse studied by the writer, requires the use of 12 high lift forks because

[1]Stocker, Harry E., Materials Handling, New York; Prentice-Hall, Inc., 1943, p. 279.

of its heavy flow of goods and its full use of its potential vertical storage space. Two other warehouses, however, have failed to use their full vertical storage potential and two others lack ceiling height, which accounts for the fact that they have made little or no use of high lift equipment.

Warehouses B and C are utilizing powered belt conveyors very effectively to carry goods long distances from the receiving platform into handling areas and both warehouses provide elaborate systems of overhead pipe gravity conveyors for moving hanging goods from the order picking areas to the delivery platforms.

Another instance of well planned and efficient handling and the only equipment of its type observed in Richmond, was seen in warehouse F. Here there is a rotating cable, overhead conveyor moving hanging goods into storage for a distance of 165 feet. This equipment is produced by the M-H Standard Corp. of Hamilton, Ohio, under the trade name Monoflo. In the same warehouse, a second unique installation, is a narrow, notched rubber, overhead belt conveyor moving garments to the order filling section from storage. This efficient equipment, called the V-Matic, is produced by Juengel V-Matic System, Inc., of Charlotte, N. C.

The shipping operations in the six warehouses present most of the same problems that are seen in the receiving operations.

Specifically, these problems are the enclosed vs covered platforms, the separated vs non-separated truck bays, and the fixed vs the portable dock boards.

This evaluation summary reveals the operating advantage to a warehouse, of a steady incoming and outgoing flow of goods, enabling the full application of mechanical and powered equipment, of providing maximum ceiling heights afforded by the use of high lift equipment and the full use of vertical storage potential, of the concentration of storage into the smallest possible square foot space by utilizing fully, cubic foot space. A previously unmentioned but possible solution to the space problems of a warehouse serving widely spread customers or its own branch stores, is to increase its use of, (1), direct shipments from manufacturers to branches through consolidated truck shipments or, (2), the containerization provisions of railroads in order to maintain its lower car load freight rates.

Summary

Chapter V completes the comparison and evaluation of the six general merchandise warehouses included in this study. The succeeding and final chapter will summarize the areas covered by the study, conclusions reached by the author, and suggestions for further research.

CHAPTER VI

SUMMARY

The Study Attempted

Like most persons exploring a new and unknown field, the writer did not know, at the start, in which directions his research might take him, how far it might lead or what he would find.

The stated purpose of the study was to learn what methods and which types of equipment for handling materials were being used currently in general merchandise warehouses in Richmond. The stated objectives were to make a comparison between methods and equipment being used in Richmond and to evaluate them in light of these methods and types of equipment which were considered best by the authorities on these subjects.

The author considered it probable that he would find differences in points of view and actions taken to solve similar situations and problems and in this respect he was not mistaken. It was the hope of the writer that he would be able to make direct comparisons of methods and equipment which would lead to definite conclusions, establishing that certain warehouses were superior to others in particular respects.

The writer hoped also, to be in a position to be definitive with respect to suggested changes for the improvement of currently used methods and equipment.

There has been no attempt to evaluate methods and equipment from the point of view of costs, as the author has explained in Chapter II, under the section, Cost Considerations. Early in his research, the author realized that an evaluation of the decisions of management with respect to the selection of methods and equipment was too involved for him to attempt in the time and space allowed for this study.

Limits of The Study and Conclusions Reached

The first step taken by the author was to accumulate as much background information as possible to provide himself with an understanding of the terminology, the problems, the methods and the types of equipment concerned with materials handling. To do this, the writer reviewed available texts bearing on these subjects together with the articles which had appeared in issues of the periodicals dealing with this area, published during the past several years. Following this, the author visited and observed the operations of the six general merchandise warehouses, the public warehouse and the transportation terminal. A complete comparison and evaluation of the facilities offered, and the use being made of these facilities has been made in the preceding chapter.

Suggestions have been offered by the writer which he believes might be an aid to greater efficiency in one or more of the warehouses studied. In summary, the author concludes that a number of improvements in the existing warehouse facilities is possible (as discussed in the Evaluation Summary of Chapter V beginning on page 115) if each is preceded by a study to determine the specific applications of materials handling methods and equipment to the problem.

Areas for Additional Study

It is fair to assume that every author wishes he had the time and space to pursue his study more deeply into the same channels or to dig into new channels which his research has opened. This writer suggests the following areas of research which should bring valuable information to the student of warehouse operations.

1. Cost considerations of the equipment as outlined briefly in Chapter II of this study. The result should be the determination of a break even point of unit load for each piece of equipment.

2. A study of inventory control methods and space allocation to types of merchandise.

3. A study of interior warehouse locations for goods, considering their rates of inflow, outflow, travel distances from receiving into storage and from storage to shipping and unit load capacity of equipment.

4. A study of ideal ceiling height in one level warehouses considering factors of construction costs, equipment costs and equipment capacity.

5. A study of receiving and shipping platform methods and equipment including experimental work with the Air-Glide Systems (air-in-floor and air-in-pallet) of the Industrial Truck Division of the Clark Equipment Company of Battle Creek, Michigan.

6. A time study of order filling to determine warehouse costs and expense allocations to types of merchandise and size of order, thus determining fair proportional charges to users of the warehouse.

From this list of possible research areas, the reader will realize the complexity of warehouse operations, the need for continued and constant study to stay abreast of new developments in improved methods and applications of equipment and to reduce operating costs. The constant improvements in methods and equipment through technological advances places a responsibility on the warehouse operator to remain militantly alert for opportunities to increase efficiency and to reduce costs.

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Automatic Warehousing
Automation by Alvey-Ferguson

Big Joe Manufacturing Company, Wisconsin Dells, Wisconsin
In Between Handling Hydraulic Lift Trucks
Power Drive Series

Clark Equipment Company
Industrial Truck Division, Battle Creek, Michigan
Load-Glide, Air-in-Floor System
Load-Glide, Air-in-Pallet

Conveyor Systems, Inc., Morton Grove, Illinois
What is Your Materials Handling Problem?

Kelley Company, Inc., Milwaukee, Wisconsin
Industry's No. 1 Dockboards

Lewis-Shepard Products, Inc., Watertown, Massachusetts
L-S Equipment Selector

The Materials Handling Institute, Inc., Pittsburgh, Pa.
The Basic Concepts of Industrial Materials Handling
General Rules-Analysis-Cost Data
Plant Layout-Maintenance-Relation to Other Departments

Meese, Inc., Madison, Indiana
Use Shamrock Canvas Baskets, Hampers

M-H Standard Corporation, Hamilton, Ohio
Monoflo, Rotating Cable Conveyor

Rapids-Standard Company, Inc., Grand Rapids, Michigan
Rapistan Full-Dimension Service
Rapistan Materials Handling Equipment and Services

Richmond Materials Handling Corporation, Richmond, Virginia
Yale Industrial Lift Trucks
Yale for Hoisting Equipment
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