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DEVELOPMENTS IN WAREHOUSING WITH EMPHASIS UPON ADVANCES
SINCE WORLD WAR II

DISSERTATION

Presented in Partial Fulfillment of the Requirements for
the Degree Doctor of Philosophy in the Graduate
School of The Ohio State University

By

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******

The Ohio State University
1963

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# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acknowledgements</td>
<td>ii</td>
</tr>
<tr>
<td>List of Tables</td>
<td>vii</td>
</tr>
<tr>
<td>Chapter</td>
<td></td>
</tr>
<tr>
<td>I  Introduction and statement of the problem</td>
<td>1</td>
</tr>
<tr>
<td>Introduction</td>
<td>1</td>
</tr>
<tr>
<td>The problem</td>
<td>9</td>
</tr>
<tr>
<td>Objectives of the study</td>
<td>11</td>
</tr>
<tr>
<td>Methods employed</td>
<td>11</td>
</tr>
<tr>
<td>II  Historical and traditional developments in the need for warehousing</td>
<td>14</td>
</tr>
<tr>
<td>Historical roots of the problem</td>
<td>14</td>
</tr>
<tr>
<td>Storage requirements grew out of basic changes</td>
<td>20</td>
</tr>
<tr>
<td>A demand derived from manufacturing</td>
<td>22</td>
</tr>
<tr>
<td>A demand derived from consumer goods</td>
<td>24</td>
</tr>
<tr>
<td>A look at the development and ownership of warehouses</td>
<td>27</td>
</tr>
<tr>
<td>III The development of the warehouse as a facility in the distribution</td>
<td>32</td>
</tr>
<tr>
<td>of goods</td>
<td></td>
</tr>
<tr>
<td>One of the marketing functions is storage</td>
<td>32</td>
</tr>
<tr>
<td>Increased interest in improving warehouse operations</td>
<td>34</td>
</tr>
<tr>
<td>Control, movement, and communication emphasized</td>
<td>35</td>
</tr>
<tr>
<td>A change in building structures, a change in locations</td>
<td>39</td>
</tr>
<tr>
<td>Single story and multi-story designs: some comparisons</td>
<td>42</td>
</tr>
<tr>
<td>Chapter</td>
<td>Page</td>
</tr>
<tr>
<td>---------</td>
<td>------</td>
</tr>
<tr>
<td>Chains developed interest in single story structures</td>
<td>45</td>
</tr>
<tr>
<td>Portending changes</td>
<td>47</td>
</tr>
<tr>
<td>Pressures for future changes</td>
<td>50</td>
</tr>
<tr>
<td>Reevaluation of warehousing operations with a consideration of the primary service objective</td>
<td>51</td>
</tr>
<tr>
<td>Emergence of warehouse as a facility in the distribution of goods</td>
<td>53</td>
</tr>
<tr>
<td>IV Organizing, controlling, and training for warehouse operations</td>
<td>58</td>
</tr>
<tr>
<td>Organizational possibilities</td>
<td>58</td>
</tr>
<tr>
<td>Organizational balance is essential to an efficient operation</td>
<td>72</td>
</tr>
<tr>
<td>A consideration of the warehouse with respect to grounds and location</td>
<td>73</td>
</tr>
<tr>
<td>Personnel and the handling of goods</td>
<td>75</td>
</tr>
<tr>
<td>Planning for control of inventories</td>
<td>78</td>
</tr>
<tr>
<td>Training and development of warehousing personnel</td>
<td>80</td>
</tr>
<tr>
<td>A consideration of the content of training</td>
<td>83</td>
</tr>
<tr>
<td>V Coordination of procurement with storage</td>
<td>90</td>
</tr>
<tr>
<td>Procurement</td>
<td>90</td>
</tr>
<tr>
<td>Relationship of procurement to warehousing and storage</td>
<td>93</td>
</tr>
<tr>
<td>Procurement and the managing of materials</td>
<td>94</td>
</tr>
<tr>
<td>Pressures for coordination</td>
<td>97</td>
</tr>
<tr>
<td>The concept of flow</td>
<td>98</td>
</tr>
<tr>
<td>Chapter</td>
<td>Page</td>
</tr>
<tr>
<td>------------------------------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>Storage is unavoidable</td>
<td>99</td>
</tr>
<tr>
<td>VI Incoming shipments</td>
<td>101</td>
</tr>
<tr>
<td>Taking possession of shipment</td>
<td>101</td>
</tr>
<tr>
<td>Management of receiving</td>
<td>103</td>
</tr>
<tr>
<td>VII Warehouse layout and order flow</td>
<td>111</td>
</tr>
<tr>
<td>Layout</td>
<td>111</td>
</tr>
<tr>
<td>Order flow</td>
<td>111</td>
</tr>
<tr>
<td>Relationship of layout to order flow</td>
<td>111</td>
</tr>
<tr>
<td>Relationship of order flow to sales</td>
<td>113</td>
</tr>
<tr>
<td>Use of pre-printed order forms to facilitate order flow</td>
<td>116</td>
</tr>
<tr>
<td>Automation in order-filling reappraised</td>
<td>118</td>
</tr>
<tr>
<td>VIII Classification, arrangement, location and identification of stored items</td>
<td>124</td>
</tr>
<tr>
<td>Serving customers</td>
<td>124</td>
</tr>
<tr>
<td>Arrangement of stock and its relationship to work of receiving and classification</td>
<td>126</td>
</tr>
<tr>
<td>Warehouse planning work sheet</td>
<td>129</td>
</tr>
<tr>
<td>Arrangement of stored items</td>
<td>134</td>
</tr>
<tr>
<td>Commodity grouping and the slot system</td>
<td>136</td>
</tr>
<tr>
<td>The 45 degree slot compared to the 90 degree slot</td>
<td>142</td>
</tr>
<tr>
<td>Identification and selection of stored items</td>
<td>144</td>
</tr>
<tr>
<td>IX Possible developments which will affect warehousing</td>
<td>148</td>
</tr>
<tr>
<td>Chapter</td>
<td>Page</td>
</tr>
<tr>
<td>------------------------------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>Warehousing is affected by other developments and by leadership</td>
<td>148</td>
</tr>
<tr>
<td>Work in marketing and in related disciplines</td>
<td>154</td>
</tr>
<tr>
<td>Cost reduction</td>
<td>155</td>
</tr>
<tr>
<td>Cost increases</td>
<td>165</td>
</tr>
<tr>
<td>Developments in world trade</td>
<td>172</td>
</tr>
<tr>
<td>Developments in the realm of speculation</td>
<td>178</td>
</tr>
<tr>
<td>X Summary, conclusions and recommendations</td>
<td>184</td>
</tr>
<tr>
<td>Summary</td>
<td>184</td>
</tr>
<tr>
<td>Conclusions</td>
<td>194</td>
</tr>
<tr>
<td>Recommendations</td>
<td>208</td>
</tr>
<tr>
<td>Appendix, Glossary of Terms</td>
<td>212</td>
</tr>
<tr>
<td>Bibliography</td>
<td>221</td>
</tr>
<tr>
<td>Autobiography</td>
<td>226</td>
</tr>
</tbody>
</table>
# List of Tables

<table>
<thead>
<tr>
<th>Table</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>A Comparison of Annual Warehousing Cost in a 40,000 square foot Multi-story Warehouse with Estimated Cost in a New 1-floor Warehouse both with a Business Volume of $2.5 Million</td>
<td>159</td>
</tr>
<tr>
<td>2</td>
<td>Estimated Annual Warehousing Cost using Present Methods Compared with a Conveyor System in a 40,000 square foot 2-floor Warehouse both with a Business Volume of $2.5 Million</td>
<td>159</td>
</tr>
<tr>
<td>3</td>
<td>A Comparison of Annual Warehousing Cost in a 47,000 square foot Multi-story Warehouse with Estimated Cost in a New 1-floor Warehouse with a Business Volume of $8 Million to be Handled in each</td>
<td>160</td>
</tr>
<tr>
<td>4</td>
<td>A Comparison of Annual Warehousing Cost in a 140,000 square foot Multi-story Warehouse with Estimated Cost in a New 1-floor Warehouse with a Business Volume of $17 Million in Dry Groceries</td>
<td>162</td>
</tr>
<tr>
<td>5</td>
<td>Average Weekly Earnings and Average Weekly Hours of Production Workers in two Selected Industries for the years 1950 through 1961</td>
<td>166</td>
</tr>
<tr>
<td>6</td>
<td>Annual Average Number of Employees in non-agricultural Establishments in two Selected Industries During the years 1950 through 1961 in thousands</td>
<td>168</td>
</tr>
<tr>
<td>7</td>
<td>Employees in non-agricultural Establishments in two Selected Industries during the 12-month Period, February 1961 through January 1962 with Respect to a/ Number in thousands b/ Average weekly earnings c/ Number of hours worked weekly</td>
<td>169</td>
</tr>
<tr>
<td>8</td>
<td>Building Cost Trends in Selected Years, 1946 to 1962 Based on an Index of 100 Established for the Year 1913</td>
<td>171</td>
</tr>
</tbody>
</table>
CHAPTER I
INTRODUCTION AND STATEMENT
OF THE PROBLEM

Introduction.-The storage of commodities and articles needed in productive efforts and the subsequent storage of finished goods is unavoidable in any society. In the maintenance and development of modern society it is absolutely essential. Storage is required in the production and distribution of all goods; it is of paramount importance in the distribution of consumer goods. In the production and distribution of those items which account for standards of living, some storage must occur at the points of production, within the channels of distribution, and in the homes or other places where they are to be consumed.

Storage is a major activity in a group of activities which can be brought under the heading of warehousing. Warehousing in a business firm needs to be organized and managed to embrace the work activities which have a direct bearing upon the performance of the storage function. In a total summarization for organizational purposes, the work of warehousing would include the following:

(1) Receipt of goods from carrier
(2) Tally in of incoming goods
(3) Inspection of goods at time of receipt
(4) Assignment of incoming goods to specific storage locations
(5) Physical movement of goods to assigned storage spaces
(6) Maintenance of bin cards and other records used to keep itemized counts of goods on hand

(7) Handling of customers' orders and other authorizations for withdrawal and shipping

(8) Selection of goods for shipment

(9) Physical movement of goods for checking and assembly incident to shipping

(10) Turning shipments over to a carrier for forwarding

(11) Maintaining commercial liaison with carriers used for incoming and outgoing goods

(12) Maintaining internal relationships in the interest of coordinating the activities of warehousing with other activities within the business firm

Warehousing activities must be performed under conditions of constant change. Changes occur because it is the nature of a dynamic society to alter goods, sources of supply, demand for certain goods, and the methods of procedures used to facilitate distribution. From the standpoint of warehouse management, the changes requiring adjustment are largely external to the storage facility. Good management here requires a flexible organization which can modify its storage operations to receive, store, and account for new goods and new packaging; make best use of storage space with respect to handling costs; and adjust to the variety of changes made by the sales organization for competitive purposes. These changes affect volume and it is the cost relationship that warehouse management maintains with the volume of goods handled which determines its degree of efficiency. The fact that
a sales organization needs to arrange for a volume which is profitable from the standpoint of total operating costs, points up the need for integration and economic performance of work in warehousing.

There are changes in demands for goods which affect marketing planning. Such demands, with respect to a particular good, may be increasing, stable, or declining. The astute marketing planner gives attention to demand. If it is increasing for one of his goods, he understands why it is increasing. He also understands the nature and reasons for stable or declining demands as these pertain to each line of goods offered by his firm. It is from such understandings that he makes plans for the future to increase volume, or in some instances when it is determined that a declining demand can not be arrested his planning will include a recommendation for the discontinuance of a particular item. The marketing planner for a manufacturer or a merchant middleman must also give consideration to the incidence of demand. This may point up a need for the use of a new channel of distribution or the use of a variety of channels of distribution. When marketing management makes changes that result in the addition of new customers, the warehouse management must adjust to any changes which may be required in units of package, filling of orders, procedures for shipping, and in storage space allocations.

Current marketing and other periodical literature point to changes now in process that emphasize the dynamic rather than the static nature of our distribution system. Such changes are having an effect upon marketing institutions that must be recognized by executives who are responsible for the management of warehousing operations. A listing
of major areas of change in the distribution of goods would include the following:

(1) Increases in volume and in the variety of goods handled in mass distribution.

(2) Changes reflected by new names for certain types of retailers. Examples: bantam stores, bargain cities, closed door discount chains, discount department stores, discount houses, highway retailers, leased department chains and mill outlets, all of which may be termed low margin retailers. These retail outlets are more new in name than they are in operation. But their existence, appeal, and methods of operation require the attention of marketing organizations concerned with the distribution of consumer goods. At the end of World War II the low margin retailers became most active in hard goods. By 1962 they were broadening their lines to include drugs, foods, soft goods, toys, and other items that could be sold on a self service basis.

(3) Increases in accessibility: making goods more accessible to customers has provided competitive advantages for some middlemen. Consumer goods may be made more accessible by providing parking facilities, longer store openings, more accessible locations, and physical access to goods within a store. Planned shopping centers have attempted to provide those conditions. Manufacturers may make their goods more accessible by maintenance of branch warehouses, by providing a better and more intensive sales coverage, by providing for telephonic and telegraphic ordering and reordering, and by providing prompt and accurate shipping.

(4) One result of the foregoing changes has been scrambled merchandising. This has resulted in an unspecialization of specialty stores.
Food store inventories, for example, may contain non-food items ordinarily found in appliance, clothing, garden, drug, hardware, and department stores, as well as items usually obtained in automobile service stations, and those which could be obtained from music shops.

(5) Emphasis upon profitable volume may create changes requiring warehouse adjustments. Sales analysis methods adapted to the processing of data in electric accounting machines can provide relatively fast information showing the profitability or unprofitability of lines of merchandise or items of goods. As work progresses in the field of data processing, marketing executives will have more timely information on which to make decisions.

(6) Increased use of marketing research and sales planning. Work in this area is not limited to marketing specialist, per se. Case histories show that economists, mathematicians, psychologists, sociologists, and engineers trained along operation research lines, are making contributions in this work.

(7) Improvement in quality of sales administrators.

(8) More opportunities for wholesalers and retailers to broaden or otherwise alter their procurement bases. Since World War II domestic production has increased in both volume and in variety. There has also been a growth in the variety of items that can be obtained from foreign markets.

Changes, as indicated above, are being made by business executives who seek wider markets, greater volume, or more profitable volume for their goods. Such changes are made with an awareness of demand, and also with an awareness of the incidence of demand for a particular good.
Both must be considered in any planning concerning channels of distribution. The choice in channels will have a direct effect upon the quantities and locations of inventories. Merchandising and warehousing are inseparable; no planning for one can be properly made without a consideration of the planning for the other.

Back of demand in a given society is the culture of that society. Cultures with respect to consumption and use of goods, are shaped by magical, religious, and hygienic rules. What a person eats and when he eats have been culturally determined.¹


While the influence of culture cannot be ignored in marketing planning, the planner must also keep in mind that society is dynamic rather than static. The cultures that have provided the economical and political climate for the free enterprise system have permitted the growth and development of innovators, who by their innovations modify the culture in which they engage in their business activities.

Buying habits change. There is evidence of diet and consumption habit changes to be found in reports coming out of the field of medicine which attribute the generally better health of the population to better diets. Some medical reports have attributed increases in stature which the population of the United States has been showing in recent decades, to improved diets. If diets are improving, and considerable evidence indicates that they are, then it can be concluded that eating habits of
one generation are not carried on without change by a succeeding generation.²

²U. S. Department of Labor, How American Buying Habits Change (Washington: U. S. Government Printing Office), pp. 103-25. (No date for this publication is contained in it. It does, however, contain tabulated data for the year 1956, which indicates that publication was subsequent to that year.)

In addition to the changes in food habits which have been taking place, has been an increase in labor mobility in the United States. American people have shown considerable labor mobility. Adaptable persons move from one kind of employment to another and frequently this is done to take advantage of better opportunities. Persons moving up into more remunerative occupations ordinarily change their consumption patterns. But is the geographic movements of labor that account for greater changes in goods and services procured. Patterns of such movements show that migrations are mainly from regions with a low per capita income, to regions having a relatively higher per capita income³


People traditionally consume and use that which is available in their environment. There is a tendency for mature persons to like that which they have been accustomed to eating rather than eating what they like. They may not have had consumption experiences with items they would like better. The same would apply also to other consumer goods, but to a lesser degree. The tendency of consumption patterns to hold with the past provides for some marketing predictability and stability,
but it also provides marketing opportunities. There are opportunities to promote the sale and use of a good in geographic areas where it has not previously been used. There are also opportunities for introducing an old good into another geographic area, when a part of the demand for it moves along with a movement of labor or some other shift in the population. Coffee blended and packaged to suit Puerto Rican tastes may be found on the shelves of some neighborhood food stores in New York and other eastern cities.

There are other changes, aside from those which are generally of a merchandising nature, that affect the economic performance of warehouse operations. A progressive business firm gives attention to its competitive position and looks for ways and means for improvement. A decrease in storage and/or handling costs would be one way to improve a competitive position. There are continuing improvements in equipment and machinery for the physical handling of goods. Some installations of specialized handling and storage equipment have been made which provide for a high degree of machine power utilization. One significant development having possibilities for widespread adoption and usage is built around the unit load principle and the employment of pallets.\(^4\)


Specialized business service firms have come into existence since World War II to promote interest and the affairs of the material handling industry. Example: Publication of a trade periodical, *Material Handling*
Engineering, by the Industrial Publishing Corporation, Cleveland, Ohio.  

Other indications of the post World War II interest in the problems of handling and storage can be found in the work of specialized consulting-engineering firms, as for example the Ballinger-Meserole Company, Philadelphia, and the organization of George A. Ramlose in Boston.

The magazine, Material Handling Engineering, was established in 1945 as Flow magazine. The name was changed by the publisher in October, 1958.

There is a new concept in warehousing that the purposes to be served are the assembly, break-down of quantities, and the reshipping of lots in keeping with customer requirements, and that in the performance of this work movement of goods is to be emphasized rather than storage.


The problem.—The problem of warehousing is essentially one of organization and operation. This study and report was begun on the premise that a searching out and analysis of published and operational data could result in a synthesis pointing up possibilities for improvement of warehouse operations with respect to: (a) The organization and place of warehousing in the business firm, (b) The role played by the warehouse in distribution, (c) Innovations.

It is believed that work which could further advancements in the
performance of warehousing activities has been held back by a number of reasons as for example:

1. Lack of executive interest in storage operations.

2. Specific warehouse problems may seem unimportant when executives can direct their efforts toward gaining increases in sales volume.

3. The expenses that would be incurred if substantial improvements were undertaken. The purchase of new warehouse equipment can often be postponed.

4. Difficulties in attracting and maintaining a force of efficient personnel.

5. Inefficiencies in storage and order-filling brought on by changes in inventories: changes in volume for some items, introduction of some new items, decline of volume for other items, and packaging changes.

6. While there have been significant developments in pallets and in the improvement of equipment to handle unit loads, technological advances in material handling have not found a ready adaptation in many warehouses.

7. Lack of communication between those who study warehousing problems with an engineering orientation, and business executives who have responsibilities for storage.

8. A general lack of literature in the field of warehouse operations.

The problem is essentially the need to improve the organization and integration of warehousing activities with other activities of the
business firm, and the further need for achieving a more efficient performance of those activities.

Objectives of the study.- The primary objective of this study has been to research the place and need for performance of warehousing activities in commercial and industrial firms, with the purpose of ascertaining problem areas, their causes, and possible solutions.

Another objective has been to collect, evaluate, and analyze available information with the intention of making known in some way, any knowledge that could be beneficial to persons concerned with the solution of receipt, storage, and shipping problems.

Exploratory research indicated a general lack of information in the field of warehouse operations. Preliminary surveys of the available information did, however, provide references to articles dealing with specific goods or physical handling problems within a particular industry. This study has been concerned with the possibility that techniques and practices developed to fit a particular handling or storage problem or the needs of a particular industry, may have transferability and could be adapted for use in other problem areas.

A further objective has been the analysis of all information secured, including that obtained from observations made of operational practices, in the interest of making some contribution to marketing knowledge through a discovery or a restatement of valid principles.

Methods employed.- It was contemplated that this study and report would assemble pertinent information from whatever sources that could
provide it. In the conduct of the study, information was gained from the following sources:

(1) Observations made in warehouse operations
(2) Interviews with line executives and employees in selected warehouse operations
(3) Interviews with staff executives of the Kroger Company, Cincinnati, who were concerned with development of handling and storage techniques
(4) Articles, booklets, journals, manuals, and monographs prepared by a number of United States government agencies
(5) Business periodicals
(6) Company literature
(7) Material printed under the direction of a trade association
(8) Publications in the field of marketing
(9) Publications in social science fields
(10) Professional journals
(11) Professional publications of universities
(12) Publishers of trade periodicals and trade periodicals
(13) Newspapers

In the review and analysis of information collected the attempt was made to maintain a critical and objective attitude. This was necessary as a basis for correct evaluations and interpretations. In view of the variety in the contributing sources, it was necessary to consider the position and purpose of the person or organization making the information available. As an example, the publisher of a periodical which attempts to serve the manufacturers and distributors of materials
handling equipment, is interested in promoting the sale of such equipment.

To learn of sources for information, the usual references in university libraries and in public libraries were used. References providing leads to information included the library card catalogs, general purpose directories, directories of periodicals, directories of American Business, trade association directories, and various government publication lists including the Monthly Catalog of United States Government Publications. The services of the United States Department of Commerce, Cincinnati Field Office, were helpful in obtaining articles available only in government channels. A most important general source providing leads for information has been the Marketing Information Guide (formerly Distribution Data Guide), prepared by the United States Department of Commerce.
CHAPTER II

HISTORICAL AND TRADITIONAL DEVELOPMENTS

IN THE NEED FOR WAREHOUSING

Historical roots of the problem. The problem of man's need to improve established methods and techniques used in the storage and handling of goods intended to satisfy human needs is not a new one. It has been learned from history that in the civilization process man progressed from the role of hunter and forager to that of planter and reaper, and from that stage on we can find historical roots for development of various specializations in our economic processes. With the development of mental abilities man obviously became more observant. The artifacts of primitive tribes which have come to our attention through the efforts of archaeologists, anthropologists, and historians, reveal the interests which early social groupings had in nature. Early religious beliefs were often founded upon observable phenomena in nature which had to do with basic human needs.\(^1\)

\(^1\)Joseph Campbell, The Masks of God: Primitive Mythology (New York: The Viking Press, 1959), pp. 5-8

It is from natural resources that man obtained food as well as other basic needs. The need for products of nature which could satisfy basic subsistence requirements was a pressing problem to early man. Archaeological diggings reveal that higher cultures began their developments where the natural resources were sufficient to sustain the pop-
ulation concentrations. This brought most of the individuals who came to live in the early towns further away from the role of hunter and forager. Because of the need for daily consumption of food, we can envision storage problems arising as soon as two or more families elected to live in the same immediate land area. We can also see in such arrangements the early beginnings of specialization in the procurement, assembly, preservation, storage, and issue of basic subsistence items. Because of scarcities and the possibility of starvation that was often immediate and real, early communal groups had to make policy in regard to collection, storage, and issue of subsistence items.

There is reference to a public policy concerning storage in the Old Testament. In Egypt of biblical time a dream of Pharaoh in which seven fat cattle were consumed by seven lean ones, was interpreted by Joseph as forewarning that the next seven years would provide good harvests, but that they would then be followed by seven years of famine. As Joseph explained to Pharaoh, the seven lean years of famine would consume all productivity of the seven years preceding. To prepare for the seven years of scarcity, Pharaoh directed that one fifth of the production during each of the seven good years would be preserved and stored to sustain his kingdom during the subsequent seven years of famine. As a result of that action, Egypt sustained its population during seven years of extreme scarcity and was also able to sell a part of its stored food to buyers who came from Canaan and other areas outside Pharaoh's rule.

\^Genesis 41: 1-57

\^\[2\]
Evidences of ancient policies are still being observed by anthropologists who study primitive peoples. One such policy, dating from antiquity, has been based on the belief that each individual has a right to share in the necessities which the tribe can collect or produce. While that belief is generally inconsistent with the thought patterns upon which western civilization has developed, it does indicate that the problems of storage and distribution are present in any community of persons.\(^3\)


While it is not the purpose of this study to consider the problems of preserving basic food and clothing items, we can see that problems of storage began with the earliest successes in their assembly and preservation. The parallel exists today. Storage problems follow the successes of production.

With the growth and development of larger towns, the problems of procurement, assembly, preservation, and storage, became magnified. There is evidence available to show that political leaders recognized storage problems, and records as well as unearthed ruins have reflected some of the efforts that were made in an attempt to provide for adequate storage. This was, for example, a problem with which the Roman Emperor
Hadrian (76 - 138 A.D.) had been concerned as indicated by the following statement attributed to him:\(^4\)

In time of shortage a judicious distribution from the State granaries helps to check the scandalous inflation of prices.


A more indirect reference to storage facilities maintained as a matter of public policy is contained in the following statement which is also attributed to the Roman Emperor Hadrian:\(^5\)

The founding of libraries was like constructing more public granaries, amassing reserves against a spiritual winter.

\(^5\)Ibid., p. 128.

The recorded history of man's efforts points up the growth of trade, beginning with inter-tribal bartering that developed into inter-regional trade. Nature seems to have encouraged commerce. Exotic tastes can be acquired, and when a sufficient number of persons in a given geographic location learn that they have a desire for a product not then being produced in their locality, their wants may be translated into an effective demand. When this occurs the possibilities for satisfying their wants for a particular product or material may be viewed by commercially minded persons as an opportunity for trade. It has been said that the early traders around the Mediterranean Sea became good geo-
graphers within the limits of the radius of their operations. From the study and analysis of geographic data we get information and an understanding of side-bysideness. This would be in contrast to history from which we get information and explanations for sequences of events; a one-after-the-other kind of data. From geography information can be obtained which gives understanding for side-by-side existence of plants, animals, and people in specific regions. Such information, when made known and utilized in a potentially effective market, can result in gains for the person or business firm which can arouse latent demand and bring supply and demand together in a trading process. In following this direction of deduction we see not only the historical importance of persons with an entrepreneurial bent, but we see also that the need for marketing information and marketing research arose with the beginnings of commerce.

The importance of commerce in a Grecian age is reflected by the following thoughts of a Professor of English and Government at Indiana University.6

The hellenistic Age, of course, is commonly regarded as a vulgar aftermath of the glorious classical age, and the Roman era as a still grosser one. Nevertheless the classical age also threw on business. If mere businessmen could never have built the Parthenon, it could never have been built without the wealth and leisure they provided. Like it or not, the beauty-loving, freedom-loving Greeks rose on commerce and industry. Like most civilized peoples they came to profess a low opinion of business, but they were obviously good at it, able to hold their own with the Phoenicians, who were frankly devoted to it. And in many ways it was good for them too, even aside from the qualities of enterprise and resourcefulness it developed. Commerce promotes civilized intercourse, the exchange of spiritual as well as material goods; the Greeks profited immeasurably from peaceful trade with the East. From such reasons their
genius first came to fruition in the busy ports and marts of Asia Minor.


Trade of an inter-regional nature required then, as it does today, solutions for problems that arise when quantities of goods are assembled from a number of small producers. There are both assembly and storage problems. We can envision the necessity for storage at some concentration point determined by transportation facilities. Consumer goods could be extracted from nature as a family effort, or as a joint effort within a tribe.

During man's early ventures in production for commerce, food-stuffs were gathered, dried, preserved, and packaged in some primitive manner, and were then brought to some concentration point for consolidation with other goods. At the beginning the consolidation point was probably a seaport to which goods could be brought in one caravan haul. Consolidation points required storage. As commerce extended inland from sea ports, the need for more storage points increased. Commerce requires transportation and assembly of goods with the concurrent need for storing such goods until shipping can be arranged. Shipping could be arranged then, as it can be today, when transportation facilities are available and when the cargo is sufficient in volume and in value to bear the costs of transportation. It is not difficult to imagine some of the early verbal negotiations that must have been carried on between the masters of Mediterranean vessels and
the custodians or owners of goods stored at port side points awaiting shipment to other ports where the goods would have more value.

There were storage problems resulting from the assembly following production there were also storage problems developing at ports to which the goods were destined. The breaking down of cargoes and the distribution of those goods could not have been accomplished without the performance of the storage function. Warehousing and storage are not new requirements. They arose with the beginnings of commerce.

_Storage requirements grew out of basic changes._—From the works of anthropologists, archaeologists, and historians, we may determine the development of certain conditions which gave rise to commerce and the concurrent need for warehouses in which goods could be stored and protected. Storage requirements grew out of basic situations and fundamental changes which would include the following:

1. Seasonal gathering, preservation, and storage for use within one tribe of what could be classified as consumer goods.
2. Discovery of agriculture
3. Improvements in the art of ceramics
4. Discovery of metallurgy
5. Storage for barter with other tribes
6. Recognition and acceptance of the concept of private property.

When one family or one partnership could collect or produce goods and make dispositions as they wished, the climate became more favorable for the development of entrepreneurial activity. Storage is a necessary part of such activity.

7. Storage of materials needed in production.
(8) Storage in connection with tithings and support of religious organizations

(9) Storage in connection with the manorial system

(10) Storage incident to the formation of towns

(11) The rise of city-states and the subsequent rise of nation-states.

(12) Improvements in record-keeping as for example the double-entry bookkeeping system

(13) Navigational inventions and discoveries including the galley, use of sails, the compass, and the fundamentals of astronomy

(14) A change in the position of the Roman Catholic Church during the Middle Ages which recognized the rights of lenders to receive interest payments in business transactions

(15) Development of business organization for joint ventures, as for example the joint stock company

(16) Discovery of ways to spread risks in business ventures through use of basic principles of insurance

(17) Storage incident to colonialism and trade with under-developed areas

(18) Growth of scientific ideas

(19) Development of economic theory, particularly in the areas of over-production and under-consumption

(20) A recognition of the importance of distribution

(21) A recognition of the importance of marketing

(22) A recognition of the values which adequate storage and adequate storage records have in the use of stored goods as
collateral in financial arrangements: field warehousing.

(23) A recognition of the importance of world trade in international relations.

A demand derived from manufacturing.- The changes and developments mentioned in the foregoing reflect certain peaks and turning points in the growth of trade. It was the growth of trade which had an indirect but yet a most important effect upon the developments of warehousing. The activities of warehousing are created and carried out in response to a demand for the receipt and reshipment of certain goods. This is in a very real sense a derived demand. The need for the performance of warehousing activities at a selected geographic location, stems from the demand for goods that can be shipped, stored, and then reshipped. Such goods may be agricultural, fishing, mining, or forest products on the move from their original sources to the processing industries which will modify them in some way. After that modification, which may be the first stage of a manufacturing process, certain of the products which could then be classified as semi-manufactured goods, will be moved to a second manufacturing process. Some products may require the processing of three or more manufacturing operations before they are ready for industrial fabrication or consumer use. Such manufacturing operations may be separated by geographic distances as well as in the distances of time. Storage and the other activities of warehousing, including receipt, handling, and the maintenance of inventory records, may be required for materials and manufactured goods which in a sense are in transit between original producer and ultimate user. It is significant that railroads have
provided special manufacturing-in-transit rates for certain commodities.

In the production of aluminum ores and earths containing bauxite obtained from both domestic and foreign mining, are moved by inland waterway to East Saint Louis, Illinois, where they are processed. This extractive process produces a material known as alumina which is then shipped to manufacturing plants, as for example those located in Niagara Falls, New York, and Alcoa, Tennessee where electric furnaces are used to extract aluminum from alumina. The aluminum may then be shipped to other plants where it is formed into bars and sheets, or into extruded shapes. The production of those plants is sold to other manufacturers or fabricators who form the metal so that it will serve particular industrial, commercial, or consumer uses. Aluminum and other products which follow a similar manufacturing pattern will require a number of stops and storage before they come finally into the possession of a buyer-user. The storage requirements here may come about for three reasons. First the delays incident to manufacturing schedules. Secondly, the delays in marketing; the time that may be required by industrial sales organizations to locate buyers, negotiate prices, quantities, qualities, designs, and delivery dates, and then make shipping arrangements. A third requirement for storage can arise when demand for a particular good is seasonal. A manufacturer may find it more economical to produce and store rather than schedule a seasonal production to coincide with demand. Storage, as well as the maintenance of inventory records, is required until possession and title pass to a buyer.
The need to perform warehousing activities in support of manufacturing operations is derived from the demand for manufactured goods. If the demand for certain goods were nonexistent, or inadequate from the standpoint of production costs, no planning for the production of such goods would be made. Warehousing would not be required. In such cases a manufacturer looks at his investment in plant, equipment, and organization, and attempts to assess the demand for other goods that could be produced. When a manufacturer is engaged in using his production facilities, he has storing requirements for incoming materials as well as for finished goods. When he considers utilization of his production facilities for a new product or one which he has not previously produced, his marketing planning must consider the channels of distribution to be used and the warehousing that will be required. Marketing planning may require a build up of inventory for a new good and strategic locations for such goods. If the planning is for a new consumer good, merchandising planning may require a careful consideration of stock pile locations. The performance of warehousing activities is important in the management of manufacturing.

A demand derived from consumer goods.—In reviewing the warehousing needs which arise in manufacturing activities, consideration was given to the need to acquire and store materials used in production, and the resultant need of storing finished goods until they could be shipped to customers. Goods which are finished to the extent that they are ready for consumer purchase and use create a somewhat different problem pattern. Most of the information in trade literature since
World War II presented as warehouse subject matter, has been concerned with the handling of packaged consumer goods.

It is the handling and movement of goods in the distribution channels between producers and ultimate consumers that have provided the most interesting innovations. One explanation for this is that power-driven machinery is relatively new in the performance of middleman activities. The addition of automatic equipment is especially novel. Manufacturers, on the other hand have used animal, water, steam, and electric power for many years. As power was used in the cutting, drilling, grinding, molding, shaping, and welding of materials in the fabrication of a unit of production, it was quite natural to use the same power source to move the finished unit out of the production shop. In some plants the conveyor which moved finished goods into a storage area was a continuation of the one which had moved materials along the production line. With power-driven conveyors bringing goods into storage, it was not difficult for wheelwrights to adapt the same power to a movement of goods from storage to shipping dock.

Warehouses operated in the channels of distribution generally have not had horsepower geared and belted to provide torque for mechanical movement, and they also have lacked the mechanical aptitudes which would have been needed in the adaptation of that power. There was some truth to the statement that goods were produced by horsepower but were distributed by manpower. A final explanation for the lateness of mechanized movement in warehouses is found in the study of automation. One requirement of automation is consistency in package sizes and shapes. The manufacturer, moving only the production of his own assembly lines
could exercise control over that requirement. He needed only to gear it to his production planning. The wholesaler, on the other hand, who served retail hardware establishments had to be equipped for intermittent movements as well as for the movement of odd shapes. He had to use chutes and elevators as best he could in the movement of cross-cut saws, kegs of nails, and kitchen ranges.

The demand for items in a wholesaler's inventory is derived from the demands of retailers being served who try to maintain a variety of goods in keeping with the demands of consumers whom they serve. As a wholesaler assessed such demands and attempted to maintain inventories accordingly, he created an inventory of dissimilar items. Such items were procured from a variety of industries; they were packaged in barrels, bundles, boxes, crates, and drums, and they were also dissimilar with respect to customers and with respect to turnover. All were of course affected by a demand derived from the wants and needs of consumers that were not always clearly established or easy to identify.

The service wholesalers serving retailers were also faced with the problem of dealing with inexperienced merchants. Freedom of entry and exit in entrepreneurial activity is a condition inherent in our economic system. This has allowed untrained persons to enter into the ownership and operation of a retailing business of their choosing. As bankruptcy records in our federal court will show, many retailers fail during the first few years of their operation. This has been a factor that has had a deterring effect upon the management and modernization of warehousing facilities operated by merchant middlemen.
The concept of derived demand is not new. It was well established in the works of neo-classical economists as the following quotation indicates:  

The demand for the things used for making other things, and their factors of production, is indirect; it is derived from the demand for the things towards the production of which they contribute; or, in other words, the demands for all the various factors of production of a finished commodity are joined together in the joint demand for it.  


A look at the development and ownership of warehouses. In its early history, this country had two basic needs for warehousing facilities. First was the need to store and account for raw materials collected or produced for manufacturing plants in Britain and in Europe. The second need was in connection with the importation and distribution of manufactured goods which were made in other countries.

In the commerce of the colonies, the distinction between wholesaler and retailer was not always clear. The retailers who were most able financially had their locations in cities which were Atlantic seaports. As they had developed the practice of buying directly from English exporters, some of them expanded their buying to cover the needs of retailers located at inland points. Such retailers developed businesses which were partly retailing, and partly importing-wholesaling.

As infant industries began to produce domestic goods they, too, required distribution and the necessary facilities for handling, storage and shipping. The importing-wholesaling firms, some of which had started as retailers, served also as middlemen in the distribution of American made goods. Wholesaling firms that did not also engage in the handling of imported goods, were not established until the early part of the nineteenth century.

Warehouses to facilitate the business of wholesalers were established in commercial cities. Economic historians report that it was commerce rather than manufacturing which gave importance to early American cities. At first, warehouses were constructed at the ports of Boston, New York, Philadelphia, Baltimore, and Charleston. As inland waterways came to be used in westward migrations, the cities of Chicago, Pittsburgh, Cincinnati, Louisville, Saint Louis, and New Orleans became important for their docks and water front storage facilities. When railroads were extended west of the eastern mountains, warehousing facilities became important in the economic activities of inland cities. In the post Civil War period a significant development in distribution was a marked expansion in warehousing.9

9Ibid. p. 631.

The warehouses were invariably constructed from local materials and architects report that they had no particular style or design. They were utility buildings erected to serve utilitarian purposes. They were constructed as one story rambling affairs when land values
would permit, but more often they were of the multi-floor type with as
many as five floors or more. The problems of hoisting between floors
required power adaptations as the following quotation will indicate:

The idea of elevators was an old one. They had long
been employed for hoisting goods to the tops of ware­
houses, often by horse power. A familiar sight from
Clark Street in Chicago had been that of a horse's
head thrust out of the window of the top story of such
a warehouse. By the middle '50s steam-powered grain
elevators were common in America and were replacing
rope whenever new installations were made. When the
future Edward VII visited Chicago in 1860 he was most
fascinated by Sturgis and Buckingham's Elevator B, a
block from his hotel. A year later Anthony Trollope
saw it too and thought it interesting enough to des­

10 John Burchard and Albert Bush-Brown, The Architecture of America

In a brief look at the development of warehouses in the United
States, some consideration should be given to the ownership of such
building and the kinds of business which provided for their operation.
There are public warehouses owned and operated by business firms which
rent or lease storage space. Warehouses of that classification are
not included in the scope and study of this report. They are, however,
important institutions, and have facilitated the work of physical
distribution. Marketing executives need to know about them, where they
are located, and the kinds of services that they can provide. Public
merchandise warehouses, may for example, be able to furnish immediate
space and facilities for a branch house operation that would require
a manufacturer or middleman months to build. Any marketing organization
planning a geographic extension of its operations is well advised to
investigate the storage and services available in public merchandise warehouses.\textsuperscript{11}

\textsuperscript{11}Information concerning locations and facilities of member warehouses can be obtained from the American Warehousemen's Association, 222 West Adams St., Chicago 6, Illinois.

This study is concerned primarily with the problems of warehousing that arise in operations conducted to provide warehousing facilities for a middleman or a manufacturer. It is such warehouses that have most opportunity for change in physical handling and they are more concerned with turnover. When operated by manufacturers, warehouses are linked to production and are subject to the controls which may have been established for production. As an inter-dependent activity, warehousing can be synchronized with production and sales; the better the synchronization the lower the storage and handling costs.

Warehouses operated to support business activities of merchant middlemen face a greater variety of problems. To begin with, their buyers consider and sometimes buy a number of new items every month. New items pose problems: storage space must be provided and this should be done so as to minimize handling costs. There is also the problem of what to do with obsolete and unsalable goods. The writer once worked for a wholesale automobile parts firm which discovered in its inventory a quantity of connecting rods to fit Terraplane cars that were no longer manufactured. Calculations, based on the number of such rods sold during the preceding year, indicated that the inventory would last 90 years.

Other problems result from the adjustments which must be made
in handling customers' orders. They vary in form, in method of submission, in frequency of submission, in clarity, in quantities, and in the line item listing of items ordered. The independent wholesaler serving independent retailers has been hampered by this condition.

With the advent of chain stores, and group associations, warehousing operations have had more opportunities for improvement. One explanation for the generally smoother operations that can be found in warehouses owned by a marketing chain is the control which parent management exercises over the management of store units.

The innovating developments in warehousing today are being planned and carried out very largely in storage facilities that support a manufacturer of consumer goods, and in those which support store units under some kind of a chain arrangement. In both situations the coordination and control needed can be secured.
CHAPTER III

THE DEVELOPMENT OF THE WAREHOUSE AS A FACILITY
IN THE DISTRIBUTION OF GOODS

One of the marketing functions is storage.-The need for man to store various items required for the maintenance of life and for human comfort has been evident from the historical researches of all cultures. Complexities of the storage problem grew with the problems arising out of congested population areas. The growth of population clusters created situations in which there were too many persons in relation to the amount of need satisfiers which could be obtained from nature for current requirements in food, shelter, and clothing. Nature produces some goods by season which man requires during all seasons. Necessity prompted the invention of ways and means for preserving goods and storing them for future use. This facilitated inter-regional barter and along with community developments came the increasing consumption and use of items produced in other regions. 1


Storage for production and use cannot be avoided. This is so because of (a) seasonality of foodstuffs which are packaged in metal, glass, or wood, and which are consumed in all seasons. (b) Goods produced during all or most of the year, but which are consumed or used...
primarily during certain seasons. Examples of the latter are warm outer clothing, anti-freeze for water cooled gasoline engines, and beach wear. The examples offered are non-food items, but yet items which can be found in many retail outlets operated primarily as food stores. Foodstuffs are also stored for a third reason, (c) in order to meet sales expectations. There is some truth to the old saying sometimes attributed to yankee peddlers, that "You cannot do business from an empty wagon". (d) Preserved foods are also stored in lots gathered for transportation purposes. Storage facilities may therefore be needed at both the beginning and at the end of a haul. (e) Goods may also be procured and stored in advance of assignment to sales points when it is anticipated that price rises for such goods will occur, or that they will be in short supply. Another reason for storing goods, (f) especially goods which will satisfy human want, has been public policy. (g) A last but very appropriate reason which can be offered for storing goods is that certain items are enhanced in value as a result of an aging, curing or ripening process.²


Storage practices carried out because of the foregoing reasons can be observed. The storage function in marketing is as old as bartering, but in connection with improved warehousing practices, techniques, and possibilities, it has been the purpose of this study to consider storage in relation to the efficient movement of goods rather than as an
indeterminate stay or as an end in itself. Gold, for example, has been placed in storage at Fort Knox, Kentucky, and silver has been stored at West Point, New York, and this has been done as a matter of public policy. In storing those two metals, accountability and security are emphasized. In comparison with a storage operation in private enterprise handling finished goods, shipments in and out are minimal. The government facilities in this instance are in a real sense depositories. While the terms warehouse and storage may carry some connotation or suggestion of limited activity, this is not in keeping with a new concept which is being developed. Since World War II, increasing efforts have been made to design and build warehouses as facilities for the redistribution of goods.

Increasing interest in improving warehouse operations.- There are perhaps two major reasons or causes for the increased interest in improving warehouse operations. To begin with, there were significant improvements made, often in connection with movement of materials for the war effort, in unit loads, pallets, and in material handling equipment. Secondly, as a simple truism points out, the success of a business firm may be assured by either increasing sales or by cutting costs. The advantages of cutting costs whenever and wherever possible to do so are obvious. Periodical literature which stresses the selling function of marketing, as for example the magazine Sales Management, feature articles from time to time which suggest ways and means of getting greater personal selling effectiveness at lower costs. When a business firm evaluates its operational costs, it may find that the storage and
handling activities have added significantly to the cost portions of accounting records.

**Control, movement, and communication emphasized.** - The new trend in warehousing emphasizes movement rather than storage of goods.  

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Fortune magazine for June, 1948, recognized the trend and credited new techniques and better material handling machinery for the improvements.

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As indicated in the Fortune article, the term materials handling covers the physical movement of materials through manufacturing, storage, and distribution. The manhour costs for such movements in manufacturing have been sizeable, but there was a time when unskilled labor could be obtained at relatively low wages for performance of this work. As an indication of the change in labor costs which has occurred since World War II, Fortune reported that in manufacturing, for the year 1946, handling expenses accounted for about one third of the labor payroll. As some 80 per cent of the factory workers engaged in the movement of materials were doing this work manually, pressure to mechanize the handling and storage operations was developing from the manufacturing industry which was building more complex but more efficient production machinery. The use of fork lift trucks in partnership with pallets
which permit movement of goods by unit loads, can reduce the costs for some movement operations very considerably. It was reported that an A. & P. warehouse by changing from all manual labor to the use of one fork lift truck had reduced the cost of unloading a box car of coffee sacks from $44.00 to $7.00.\footnote{Ibid.}

As pointed out also in the same reference, gains in using fork lift trucks and the unit load principle do not result entirely from the substitution of a machine for manual labor. A skilled fork lift truck operator can store some goods as high as twenty feet which is more than twice the height this can be done without the use of a machine. In most warehouses, increasing the height of the tiers, will provide for better utilization of storage space. The Kraft Foods Company found, as reported by \textit{Fortune} in the article cited above, that by using a fork lift truck and a pallet system, the capacity of one storage space for boxes of finished cheese was increased from 1800 to 4500 boxes, an increase of 150 per cent.

The development of the warehouse as a facility for the redistribution of goods is indicated by observable trends in storage practices. The March, 1960 issue of \textit{Factory} magazine reported the top trends in warehousing as those of:\footnote{\textit{Factory}, March, 1960.}

(1) Increasing automation in warehouses that lend themselves to automation, but that most companies are making such changes realistically, after measuring costs against gains.
(2) Standardization of packages, by sizes and markings

(3) More controls: management controls as well as material handling controls, the aim being to make warehousing simpler and less costly. The gains would come from continuous flows, smaller factory inventories, shorter handling time, and fewer man-hours

(4) Faster communications: use of two-way radio, for example, is spreading

(5) More flexibility: it is needed to accommodate inventory surges and drop-offs

(6) Single story buildings, especially for heavy goods

(7) Higher stacking (Today's upper limit is about 20 feet)

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Factory based its special engineering and technology report on a study of industrial warehousing. The study, which considered information obtained from visits to warehouses, consultants, managers, and operators, found that industrial warehousing today is a complex managerial job having four major parts: (a) control, (b) movement, (c) communications, (d) storage.

Control. While there is a trend to automate warehouses in manufacturing, and some of this trend is having an effect upon the warehousing of finished goods in distribution channels, it is well established that a system of automation requires four conditions if it is to be operated economically: large volume, a reasonably steady
volume, standard sizes in packaging, and a minimum variety among the packages handled.

It is difficult to conceive of an automated warehouse without drawing up an image of a punched card and some form of an electric accounting machine suitable for handling such cards. A system of warehousing which fills orders through the use of punched cards can also provide much control information, as for example, balances on hand, balances on hand in relation to predetermined warehouse stock balances, and other information needed for management and procurement purposes. It is not only the mechanical picking of goods to fill orders that some business executives find interesting in automation, but it is also the control possibilities inherent in such a system that they find attractive. With reference to movement, it was found by the Factory study that:

The big trend in warehouse movement today is to continuous flow, live storage, smaller inventories, faster in-and-out.

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7Ibid.

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This presents a picture of the operation of a modern warehouse as consisting of two flows of goods: incoming shipments of larger quantities of like items, and an out-going flow of orders each made up of items selected from appropriate lots of the debit flow. This emphasizes the breaking down of larger quantities procured from individual suppliers into orders made up of more heterogeneous assortments as determined by customers' needs and reflected by their orders being
Movement is a desirable goal or objective toward which business executives charged with warehouse operations should strive to attain. It is recognized, however, that the storage function does not always permit or desire a steady flow of all goods.

With reference to communications, the Factory study noted that more warehousing operations were finding special types of radio equipment adaptable to communication needs within the storage facilities. The trend is to devices (such as walkie-talkie radio) that will solve the problems created by more square footage in the warehouse and greater mobility in handling equipment.

A change in building structures, a change in locations. The new warehouse has one floor and usually a one level layout. It is located in some outlying section of a commercial city and is so situated that it can utilize both rail cars and truck trailers for receiving and shipping.

A study completed in 1960 on freight movement in the New York City metropolitan area, reported a decline in warehousing activity in the New York City area proper. The study found that since World War II not a single warehouse as such had been built in Manhattan south of 59th Street and very few had been built in the rest of that borough. There has been a movement of warehousing activity beyond the five boroughs which comprise New York City, (The Bronx, Brooklyn, Manhattan, Richmond, and Queens). In 1915, the five boroughs had accounted for more than 90 per cent of the metropolitan region's public

8Ibid.
warehousing activity as measured by space. In 1956, for which the study used numbers of persons employed rather than space as a measurement, it was found that New York City proper, or the five boroughs, accounted for only 54 per cent of the region's warehousing activity.


It is to be noted, however, that the above data have reference to public warehousing activities. To evaluate fully the trend in this instance, comparable data would be needed with respect to regular warehousing by wholesalers and other middlemen.

Certainly the automobile has been an important factor in causing the relocation of warehousing activities away from central city locations, and away from the wholesaling and commission house districts of the World I and earlier eras. The development of automotive transportation has set up pressures for loading and unloading facilities in locations more accessible to that mode of transportation. Automotive transportation has also made it possible for warehouse employees to commute by private conveyance and this has meant that a warehouse operation's ability to attract and maintain the required labor force would not necessarily be lessened by a relocation out of the traditional warehouse district.

A large warehouse put into operation in 1958 at Richmond, California as a distribution center for Safeway Stores would not have been feasible in a location of limited space. This warehouse, covering 8 acres, contains 348,480 square feet of floor area, with a ceiling 24
feet above the floor. This storage facility was designed and built to serve 209 stores of the Safeway chain. Accessibility by truck transportation is highly important to this operation as 80 per cent of incoming goods are brought in by highway transportation. Trucks arrive and enter a maneuvering area where they are spotted and subsequently dispatched to unloading bays. Drivers are informed of the unloading bay for their particular shipment by way of a public address system.

The operation of this large and unique warehouse has not only provided an efficient receipt and reconsignment of merchandise for Safeway retail stores, but it has also increased the size of the units of purchase. Instead of procurement by unit, gross, or by the case, purchase orders for this destination are negotiated on the basis of pallet lots. Standard pallets, 48 inch by 40 inch are used and as part of the purchase agreement, vendors furnish their goods in palletized unit loads.¹⁰


The trend to one story warehouses was stepped up by activities connected with the war effort during World War II. The war effort required new production facilities and many of these were constructed where land was readily available in suburban and rural areas. As cost was not a primary determinant in such land acquisitions, acreage was not usually limited. Factory buildings of the one story type could therefore be erected as there was sufficient land space to get the square footage needed. It was considered also that the one story design could be erected with less construction time and speed was of
the essence during the early months of the war production effort. Storage facilities needed for such new plants followed a similar design criterion. Tractors and fork lift trucks were ideally suited to the horizontal movement of goods in and out of one story storage structures.

Single story and multi-story designs: some comparisons. When comparative construction costs are considered, the single story warehouse represents about the same investment as a multi-story unit affording the same square feet of storage space. As of 1948, the Turner Construction Company in 46 years of experience had built 163 warehouses, of which 146 were multi-story and 17 were one story. Cost analyses adjusted to February 1948 construction costs showed comparable costs of from $5.00 to $6.00 per square foot. These costs did not include plumbing, heating, lighting, elevator and sprinkler installations.\(^{11}\)

\(^{11}\)Clark C. Wright and John P. H. Perry, "The Trend to One-Storied Warehouses", Distribution Age, April, 1948, pp. 33-36.

The construction experiences of the Turner Construction Company in building one story and multi-story warehouse structures were probably not typical. The authors in the article cited above were of the opinion that more one story warehouses had been erected in the past 50 years than multi-story types. Certain factors have stimulated the trend toward one story warehouses:\(^{12}\) (a) Merchandising handling requirements. (b) Heavy loads: need or desire to keep goods on main floor or on solid foundation. (c) Where there is a definite requirement for rapid in and out handling of merchandise. (d) Where unusually large railroad platform areas and trucking platforms are deemed advisable. (e) Development
and improvement of modern equipment for horizontal handling of merchandise, as for example improvements in tractors, trailers, stacking devices, and conveyors.

While there has been an observable trend toward the one story building for storage usage, it does not necessarily follow that this is the best arrangement. A storage facility whenever possible, should be designed and constructed for the purposes it is intended to serve. In some instances a downtown location may be needed when the warehouse is intended also to house display rooms for out-of-town buyers. In such cases land costs would ordinarily require a multi-floor arrangement. There are also costs to be considered other than those of initial construction. Maintenance and operating costs would need to be considered. In some climates, roofs on a one story building would be more expensive to maintain, and painting and heating costs might also be higher. Operating costs which would include insurance and fire prevention outlays could conceivably be greater for the one story building in many locations. While the one story building usually has more windows in relation to storage space, and this arrangement can therefore provide more natural light, insurance rates go up as the window space increases.

The multi-story warehouse was developed in the United States as a sensible solution to a problem of space utilization. The first warehouses were located at seaports, at waterfronts of river towns, and at canal stations. The first American warehouses were one story structures.
But as competition increased, the land areas adjacent to docks and piers which could be used for loading, unloading, storage and reorganization of cargoes, became more valuable. The development of multi-floor storage and service buildings was then merely a part of the growth of trade. As more storage and transportation service space came to be needed, and as congestion, land ownership, and costs would not permit a horizontal expansion, the needed space was acquired by vertical expansion; warehouses were built up instead of outward. In order to move goods from ground to upper floors, warehouse operators during the early part of the nineteenth century adapted the block and tackle, the sling, the burton, and other rigging equipment and machinery which had been used on ships.

The multi-story warehouse became more efficient about the middle of the nineteenth century with the introduction of the elevator. Without the elevator, multi-story buildings of the height in use today would not have been feasible.

Another development took the warehouse away from the waterways. The construction of railroads made it possible for warehousing operations to be located on sites not connected directly with waterways. Railroads became significant as an addition to our transportation system and could have spurred a return to one story warehouses, but this did not occur. Wholesalers prior to 1900 continued to use multi-story storage buildings. In some instances factory buildings were converted for storage, and such buildings ordinarily at that time contained more than one floor. When buildings were designed and built for the storage of finished and packaged goods, wholesalers and others performing the storage function usually
decided to erect multi-story buildings for this purpose. Factors influencing such decisions were the cost of suitable sites, and it had become traditional to think of a warehouse as having more than one floor.

Chains developed interest in single story structures. It has been considered that wholesalers generally overlooked the influence which the buildings used in their operations had upon their operating costs. Their attention was directed to building design by apparent economies being obtained by chain store supporting operations during the 1920's. For reasons which are not entirely clear, the operators of chains developed an early interest in work simplification and cost reduction in the warehouse. The chain operators recognized the gains which could be had by storing and moving goods on a horizontal plane, and many of the new warehouses built during the 1920's to serve chain retail outlets were one story structures.  


A logical explanation for the attention which chain store operators gave to modernizing their storage and handling operations may be found in the fact that they were innovators and saw opportunities in breaking with the past. The multi-floor warehouse had become traditional with wholesalers who were supported by independent and locally owned retail stores; the chains were quite ready to break with tradition if it hampered their operations. Another explanation for the return to the
single floor warehouse during the 1920's may be found in the assembly line developments in manufacturing which were being publicized at that time. It has been considered that the successes attributed to the assembly line, and more particularly those of Henry Ford, drew attention to possibilities for using continuous flow techniques in other work. The assembly line method of manufacturing had an influence upon industrial building design.14

When Henry Ford introduced the assembly line, more than a generation ago, he touched off a major trend in building design as well as in manufacturing methods. One-story industrial buildings replaced multi-story structures to a large degree.


Also during the late 1920's an arrangement for adapting assembly line methods to the handling and storing of goods was introduced. Known as the Davidson System, it attracted the attention of many business executives concerned with food storage. The System was built around the use of punch cards, tabulating machines, and unit loads. In comparison with most wholesale operations of that time, the Davidson System promised worthwhile reductions in the expenses of handling both inbound and outbound shipments. The System could best be used in one story buildings and as the cost reductions were quite attractive, it influenced the trend toward one story warehouses in distribution, particularly in food distribution.15

15Bromell, loc. cit.
While there has been a return to structures of the one story type for the receipt, storage and reshipment of goods, this does not indicate that the ultimate has been reached in warehouse design. In a few instances, and this is presently in the realm of speculation, unique warehousing which will utilize gravity flows have been contemplated.

Portending changes. - As contemplated by William B. Meserole, President of the Ballinger-Meserole Company of Philadelphia, the warehouse of the future will be constructed on a sloping land site which will permit goods to slide by the effect of gravity from one end of a warehouse to the opposite end. The building would be designed and constructed so that unloading and receiving would be accomplished at the up hill side of the building. Shipping would be accomplished at the down hill side.  


While application of gravity flows to a warehouse operation seems novel, the method itself is not new. It can be observed that ore processing plants located in the mining areas of the Western United States, make use of the same principle in their extractive processes. Ore is unloaded into crushing and grinding machinery which is located up hill in relation to the rest of the plant. The ore moves then, largely by gravity, through the process until the minerals desired have been separated and retained and the tailings released to clear the plant below the down hill part of the plant proper.

The warehouse as envisaged by Mr. Meserole would have a minimum
of lighting as illumination would be needed only when repairs or adjustments to machinery were required. There would be few workers in relation to the volume of goods handled and these workers would be either engineers or highly skilled technicians. Machines would be used to palletize goods and also to remove cartons from pallets as required. It is foreseen also that the mechanized warehouse which is a generation or so away, will be equipped with high pitched sound beams that will effectively drive away all rodents and insects. The gains that would come from the elimination of losses due to pests are pleasant to contemplate. Such sound beams will be inaudible to human ears.

No prototypes or bench models of an all-automatic warehouse are presently known; there is much work yet to be done in the application of electronic developments. Cost is another obstacle in the development of the all-automatic warehouse. The initial cost of such an operation would exclude many business firms which might otherwise give the matter serious consideration. All-automatic warehouses will become realities when cost reductions are promising and when the proponents of such plans can give reasonable proof of such cost reductions.

The developments which apparently lead in the direction of automatic, electronically-controlled, and mechanized warehousing operations are interesting subjects. There is no doubt but that changes in the work of storage are occurring. But the changes which are occurring and which point toward a push-button warehouse are not the most significant at the present time. There will be more automation in warehousing and there will be more automated storage operations within the next few years. As it is technologically possible to improve the machinery,
equipment, and controls needed for handling storable goods, their installation will be made by business firms that are financially able to do so and whose executives see cost reductions or innovational gains as a result.

It was reported by Architectural Record for December 1958 that the design and plans for new warehouses were being influenced by the purposes to be served by the new buildings. Such buildings were being planned by architects and engineers to fit a particular situation with respect to handling, storage, and service needs of a firm. As a result, new warehouses are specialized buildings. They may house a number of activities, as for example, offices, display areas, sales areas, maintenance areas, packaging areas, and other activities of a service nature. Where buildings of this type have been built to support department stores, there is a tendency to call them service buildings.

The Abbott, Merkt and Company, a firm of architects and engineers, reported in 1958, that their firm had since 1945 participated in the engineering, materials handling, and architectural design of some 100 warehouse and service buildings. Most of these buildings were designed for use by operators of department stores and so this information is not entirely appropriate for the study of the moment, but it seems significant to introduce this reference as it points up the trend in designing warehouse (or service) operations to give active support for sales operations. The architectural engineering firm in this instance considered that the new buildings which it had helped plan and equip
were to serve a "... greatly expanded role as an active sales tool".  


Pressures for future changes.-Two general areas of pressure which augur changes in traditional warehousing methods have been developing. One draws attention to warehousing through cost considerations. The second pressure arising more definitely outside the warehouse, comes from technological developments which are introduced more often into production but which may be adaptable to handling and storage operations. The second pressure has been more widely publicized. Actually the two pressures do not reflect separate problems. Both point to the need for attaining more efficiency in warehousing operations.

In the ideal problem solving approach, cost considerations should come first. Existing costs should be classified, analyzed, and understood before ventures into any form of automation are undertaken. Not all storage operations have the volume or other requirements for automation. Astute business executives need, however, to be aware of developments in storage and handling in their own industry as well as in non-related industries in order that possible application can be considered. It has been suggested that manufacturers could benefit from experience of progressive wholesalers.  

Some manufacturers, paradoxically perhaps, have benefitted from the experiences of progressive wholesalers in improving their physical distributive operations. For instance, the modern, one-story, streamlined warehouse building in the wholesale grocery trade is an outstanding example of how efficiency can be improved and costs reduced. Here orders are made up according to the
assembly line principle and mechanical tabulating equipment is used for preparing invoices, making sales analyses, and for perpetual inventory control. It was found that progressive wholesale distributors have taken a new view of the warehouse building. Instead of using the building as a storage warehouse only, they now also see it as a machine for the low-cost movement of merchandise.


If business executives are to adapt the new way of looking at warehouses as facilities for the movement of goods rather than as places of dead storage, they will need to view the storage and handling operations as integral parts of their particular marketing operations. It is necessary to start with an understanding of the primary service objective. 19


Reevaluation of warehousing operations with a consideration of the primary service objective. By considering initially a primary service objective of furnishing customers the economic values which they need or desire, the importance of satisfying customers will not be overlooked. The starting point in considering possible improvements in the warehouse should then be customers. There is need to know who they are, where they are, and the values they secure from the purchase of seller's goods. There is need also to know the frequency of their purchases, the modes of transportation they prefer,
if their economic future is promising, and what quality or qualities would they prefer in the seller's goods.

Any planning to change warehousing methods without considering how proposed changes would affect customers, would be a planning start with an incorrect beginning. Warehousing is a part of a larger problem which is the need to reduce costs and gain a better management of the flow of goods from producer to user.

A timely treatment of this subject appeared in July-August 1960 issue of the Harvard Business Review, under the heading, "The Logistics of Distribution". The author of that article, Mr. John F. Magee, suggested that business executives search out the opportunities available to them in an improvement of physical distribution. Mr. Magee suggested that business executives could capitalize on the opportunities which improvements in physical distribution would bring, by: 20 (a) Thinking of the physical distribution process as a system with need for all components and functions to be properly balanced. (b) Taking a fresh look at responsibilities, capabilities, and organizational positions of executives in traffic, warehouse management, inventory control, and other parts of the system. (c) Reexamining the company's physical plant and distribution procedures in light of technical advances in such areas as transportation, data processing, and material handling.


Responsible executives could hardly work through steps (a), (b), and (c), suggested by Mr. Magee, without gaining a better overall
picture of their firm's operations. The executive reorientation which could result from new patterns of thinking, would affect decisions in production as well as marketing. Storage and handling costs for example, rise when a product line is broadened. If reasonably firm costs for handling and storing a proposed new product could be secured prior to the production of a new item, fewer "flyers" would need to be taken on items of doubtful salability. But on the other hand, if the cost data with respect to handling and storing new items, new colors, and new sizes, become too influential in decision making this could cause a business firm to miss desirable opportunities. There are sales gains to be had by giving old customers wider ranges in colors, sizes, and flavors, and a broadened product line will frequently open up sales opportunities with new customers. New data will be made available to executives in the future which will give more light to what is occurring cost wise in the warehouse. But the new cost data will need to be evaluated realistically and in consideration of the particular needs of each firm to broaden product lines when productive capacity, marketing opportunities, and other factors indicate that this should be done.

Emergence of warehouse as a facility in the distribution of goods.

Perhaps the strongest statement made in recent years with reference to the need for change in warehousing was contained in Fortune magazine for December 1956. The statement was made that "The typical warehouse today belongs in the nineteenth century". 21

The *Fortune* article presents an argument for a speed-up of the trend which is moving warehousing operations toward a push button era. The successes achieved in mechanical storage and handling installations at the Hickok Manufacturing Company, Lyons, New York, the H. J. Heinz Company, Pittsburgh, and at the C. Schmidt & Sons Brewery, Philadelphia, were noted. The operation of the Brewery's warehouse indicates the attainment of a desirable goal in the achievement of live storage. "... no case of beer stays in storage for more than three days; the warehouse is intended to be only a surge between production and shipping". Another modernization of warehousing operations reported was that of the Penn Fruit Company in Philadelphia. A new warehouse designed by William H. Meserole, President of Ballinger-Meserole Company, was planned after a careful analysis of the inventory to be handled had been made. In planning this distribution operation, a simple criterion was followed that 80 per cent of the volume of goods in movement would be accounted for by 20 per cent of the items which the Penn Fruit Company held available for its retail stores. This provided a guide which caused the planners to be constantly aware of the distinction that needs always to be made between fast moving and slow moving items. The principles of automation could be applied to storage and handling operations more economically if a warehouse had only to handle fast moving items. It is necessary to ascertain then, as a part of the pre-planning for operational improvements the warehouse speed and seasonality nature of each line item carried in the inventory. It is necessary also to start with a defining and understanding of the work which the warehouse is expected to perform.
as part of the marketing or distribution effort. *Fortune*, in the above reference, considered that warehouses have seven basic functions: (a) Receiving. (b) Sorting and stacking. (c) Storing. (d) Order picking. (e) Order assembly and packing. (f) Shipping. (g) Inventory control.

Planning for improvements in warehousing operations must consider when, where, and how these basic functions are to be performed. As these functions will vary from one warehouse to another, there is a definite need to plan each warehouse for the work which it is supposed to perform. Each operation, including the building and all material handling equipment should be tailored to fit particular handling and storage requirements. Each operation needs also to be installed with the need for flexibility in mind. As customers and products can be expected to change in any forward looking marketing operation, the storage and handling operation must be adjustable.

There has been a demonstration of equipment tailored to fit a particular need in the distribution center of the Colgate-Palmolive Company at Kansas City, Kansas. Designed and built by the Alvey-Ferguson Company of Cincinnati, the system is a teaming of punched cards, electronic equipment, gravity conveyors, and live storage racks. In this operation, impulses released through the medium of punched cards, result in cartons of Colgate-Palmolive products moving down from live storage racks onto conveyors which roll toward loading docks. Cartons are picked from the racks at the rate of 50 per minute.
and the system accommodates on the average a picking and movement requirement of 9000 cartons in a days operation.  

22 The Cincinnati Enquirer, June 26, 1960, p. 12, Section C.

There is reference to an 80 per cent - 20 per cent principle in the Colgate-Palmolive operation. In this instance it was determined in the designing of equipment and controls, that 80 per cent of the volume would be picked automatically, and that 20 per cent of the volume, accounted for by slow moving items, could best be picked by hand.

Information to which references have been made in this chapter indicates that possibilities for improvements in the work required to carry out the storage function are unfolding. As these possibilities continue to unfold, they will be viewed by more and more business executives as opportunities for making business gains.

At the present time, and existing information indicates that this situation will continue, there is no general rush of the storage industry into automation. The movement toward automated warehouses can be described as being spotty. Not all business firms performing the storage function can afford the initial cost of such installations. But a more important reason for the lack of a widespread move toward automation in warehouses is that not all storage activities have the basic requirements of a steady and large volume, and the standardization of packages needed to justify automation costs. There is also a third brake on the move, and this is the general lack of
interest for storage and warehousing. It is not a fascinating area of interest for many business executives. But sufficient changes are being made to indicate that the role of the warehouse is being altered; it is coming to be an integrated facility in the distribution of goods.
CHAPTER IV
ORGANIZING, CONTROLLING, AND TRAINING
FOR WAREHOUSE OPERATIONS

Organizational possibilities.-Storage is an essential function in the production and distribution of goods. In a society which uses competition to determine distribution for its goods there is competitive pressure to secure performance of essential functions with a reasonableness of cost. Any business firm that performs the storage function must then give managerial attention to the quality and nature of that performance. The difference between an operational loss and an operational profit could well hinge upon inefficiency or inadequacy in the storage operation. Articles appear in the business press from time to time which suggest that physical distribution is an unexplored profit area for many business firms. One article provided six steps for better inventory management:1 (a) Recognizing the need for control. (b) Determining optimum turnover. (c) Analyzing the inventory problem. (d) Ordering the right quantity. (e) Minimizing work in process. (f) Educating everyone involved.


Mr. H. F. Dickie was manager, Production Control, Manufacturing Services Division of the General Electric Company, Schenectady, New
York, and his six steps were concerned primarily with controls for inventories used in manufacturing processes. His article shows a need for an integration of thinking within the firm concerning goods stored for further use. His information seems significant at this time in view of the coordination and cooperation that would be required if a business firm were to carry out his six steps to better inventory management. Organized effort would be needed. Organized effort is usually insured by some form of organizational structure which permits the alignment of procedural responsibilities of new assignments with responsibilities previously established.

A study of the service wholesale drug industry by Albert B. Fisher, Jr., found that warehousing activities were carried out under an executive responsible for an Operating Department. Dr. Fisher located that department on an organization chart in the following manner.²
The general pattern of the organizational structure employed to carry out operational activities of business firms in the service wholesale drug industry, were sketched by Dr. Fisher, substantially as shown by the chart on the next page.  

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Albert Benjamin Fisher, Jr., *Warehouse Operations of Service Wholesale Druggists* (Columbus: The Bureau of Business Research, College of Commerce and Administration, The Ohio State University, 1948), pp. 7-22.
Operating Department Operations Manager

Order Control Supervisor
- Registry
- Routine Credit
- Scanning
- Label Preparation
- Routing and Scheduling

Telephone Sales Supervisor
- Telephone Sales Clerks

Waiting Order Section
- Waiting Order Clerks

Warehouse Superintendent

Invoicing Section
- Pricing
- Extending
- Adding
- Auditing
- Charge Backs
- Back Orders

Statistical Section
- Coding
- Reports

Claims and Adjustments
- Handling Returned Goods
- Credit Memos

Floor Supervisor Class I Goods
- Picking
- Checking
- Packing
- Shelving

Floor Supervisor Class II Goods
- Picking
- Checking
- Packing
- Shelving

Maintenance and Service
- Janitors
- Elevator Operators
- Heating

Traffic Section
- Re-Packing

Floor Supervisor Class III Goods
- Picking
- Checking
- Packing
- Shelving

Floor Supervisor Class IV Goods
- Picking
- Checking
- Packing
- Shelving

3 Ibid.
An analysis of functions performed in an operating department as shown in the foregoing will point up the importance of work performed and the essentiality of coordination between sales and shipping. The functional titles suggest the facilitating nature of most of the work performed in an operating department. The top tier of the organization chart shows seven supervisors reporting to a department head. One of those is the warehouse superintendent who is a line supervisor. The other six supervisors who report from the same level occupy staff positions. It is to be noted also that the line of command extends downward through the warehouse superintendent. Reporting to the warehouse superintendent from the second tier are seven supervisors including the one heading the traffic section. With the exception of the maintenance and service section and the repackaging section the supervisors in this second tier are directly concerned with the receipt, storage, selection, and shipping of goods. That such work facilitates the work of a sales department is evident.

A responsible sales representative recognizes that completion of a sale occurs when activities beyond the writing of an order are carried out. It is well established in the thinking of sales representatives for manufacturers that a sale is not complete until a good has been delivered as directed by the buyer, put into use by the buyer, and then commences to perform or give the service which the buyer expected when the good was purchased. Salesmen for manufacturers of finished goods who sell to middlemen can also see value in that kind of reasoning. A sale to a middleman may not in one sense be a completed sale until the good is resold and is giving satisfaction to the purchaser-user.
The organizational arrangements reported by Dr. Fisher show a recognition of the need to point the activities of an operating department toward the serving of customers. This is evident in the classification of inventories into four major categories, with a supervisor and certain personnel assigned to each class. A division of labor here strengthens the ability of a wholesale drug firm to ship to a customer the goods which he has ordered and which he expects to receive. An order is correctly handled when an agreement results between buyer and seller that the tally in at destination shows items received to be those as ordered with respect to descriptions, quantities, qualities, and condition of each item at time of receipt.

In this study the storage operation has been considered to be a business activity that receives, classifies, and places in storage goods from which selections will subsequently be made for reshipments.

In a recent publication concerned with management of physical distribution facilities, the authors refer to a storage facility actively engaged in the in and out movement of goods and materials as a "distribution warehouse".  


Professor Smykay, et al, while recognizing that no model organization may be outlined for all distribution warehouses, have suggested that an organization could be built around the functions needed to be performed. They provide the following model which was determined by bringing together for control purposes, each special movement function.
A somewhat different approach to the problem of organizing for control of operations having to do with managing materials is provided by a recent publication of Dr. Dean S. Ammer, Executive Editor of Purchasing magazine. Dr. Ammer's work in this instance was developed from the viewpoint of a manufacturing firm. He sees a definite need for integrated materials management in organizational approaches of the future. Among the organizational possibilities suggested by Dr. Ammer was one developed in accordance with work functions. With a manufacturing plant in mind, he offers this chart.\(^5\)

The work of Dr. Ammer in this instance has a strong purchasing orientation. The foregoing organization chart and other organizational possibilities suggested by the author show a concern for coordinating the management of traffic, purchasing, and material control. No analysis of the work to be accomplished under the supervision of the material control manager was provided, but the author's discussion implies a continual movement of materials which under optimum conditions in manufacturing would appear to make storage unnecessary. Elsewhere in his
book he stated, however, that inventories will be needed because of:

(a) Protection against uncertainty: as insurance against unan-
ticipated failures at a supply source, to permit production in keeping
with increases in demand, and to protect against delays in deliveries.

(b) To secure efficiencies in the processing of material: nor-
mally, lower unit costs are obtained when purchases of large quantities
are made. Also, certain manufacturing processes require processing in
quantities greater than current needs.

(c) Transit and handling: materials needed by a business firm
must sometimes be moved great distances. They are a part of some in-
ventory during time in transit.

\[6\] Ibid., pp. 139-140

The need for having some goods on hand in a manufacturing firm is
recognized by that author as a cost of possession: storage, obsolescence,
and capital cost are the three major costs of possession. Of the three,
storage was the most significant expense. According to Dr. Ammer, many
companies estimate that costs for inventories are increased by as much as
20 to 25 per cent over landed cost because of what he defines as possess-
ion cost.\[7\]

\[7\] Ibid., p. 173

In making an observational study of a warehouse operation serving
units of a food distribution chain in the Cincinnati area, an organization
with line and staff relationships substantially as follows was determined.
A consideration of the functions performed in the organization reflected by the foregoing chart will point up activities which are constantly moving goods, as well as work which processes goods so as to make them more ready for display and sale under self-service conditions.

The garage foreman and the maintenance foreman, it will be noted, appear on the chart as heading staff activities. They have line responsibilities in supervising their respective crews, but they report to the warehouse and transportation manager as heads of staff activities. The garage foreman is responsible for the over-the-road equipment, the tools and equipment incident to vehicle maintenance, and for a limited stock of frequently-used spare parts. Standardization of tractors in the use of equipment made by one truck manufacturer (in this instance, White Motor Truck Company of Cleveland, Ohio), had simplified the procurement and maintenance of a spare parts inventory for the first and second echelons of maintenance performed under the direction of the garage foreman.  

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8 The term "echelon of maintenance" was not used by the company in this instance. This term, developed by the military, refers to maintenance responsibility levels. The first echelon of maintenance is largely preventative maintenance; it covers the corrections and adjustments, as well as the trip-ticket reporting required of each individual driver. Briefly, it requires the operator of a piece of equipment to be responsible for checking fuel tank, cooling system, battery, and condition of tires. Through the trip-ticket, the driver reports any malfunctioning which he could observe as well as any mechanical needs which would require future attention. The second echelon of maintenance in this instance would cover the work performed within the motor truck garage space of the warehouse under the garage foreman. The garage in this case was equipped to replace tires, wheel bearings, make adjustments and replace parts in the ignition, and cooling systems of truck engines, lubricate tractors and
trailer, and make various other mechanical corrections short of an engine over-haul. As used by the military, the third echelon shop would be one equipped to change engines, restore brakes, modify trailer bodies, and re-finish equipment. This would be a centralized repair shop with generally better trained mechanics and a more careful division of labor. The fourth echelon, if we consider this arrangement for non-military vehicles could be a major over-haul shop owned and operated by another business firm.

The maintenance foreman in this instance had responsibility for rolling equipment operated within and on the warehouse premises. This consisted largely of fork-lift trucks. He also was concerned with maintaining refrigeration equipment, and the maintenance of facilities so as to exclude birds and pests. He too operated a garage in which warehouse trucks were given mechanical adjustments. The work of his mechanics was complicated by the fact that material handling trucks then in use operated on three different kinds of energy: electricity from storage batteries, gasoline, and bottled gas.

The transportation foremen were concerned continually with the coordination of their activities with needs of retail store units served. Much of the time of the general transportation foreman was spent in planning for and coordinating the assembly of goods called for on store orders and the actual movement of such items to the proper retail outlet. Training here was considered important and hence the employment of a full time training foreman.

The general night foreman supervised three lower level foremen who had responsibilities centered at the loading and unloading docks, concerned generally with the work of assembling orders for early morning
deliveries. Some of the work accomplished by the night crew was performed in the banana store room and other store rooms for perishable goods.

The general warehouse foreman had direct line supervision over four lower level foremen. The grocery assembly foreman was concerned with the final check of pallet loads against the items called for on the pertinent store order. He was observed spot-checking quantities being shipped against counts of store orders. This foreman was also concerned with the routing of fork truck operators so as to avoid back-tracking, save effort, and so as to achieve an orderly flow of fork truck traffic within the warehouse and at the shipping dock. The grocery stock foreman was concerned with utilization of space, arranging space for incoming shipments, making space assignments for new items, reconciliation of stock counts with accounting records and alerting buyers located within the same food distribution center to any slowness of movement detected among items for which they had placed orders with vendors. This was a partial responsibility of the grocery stock foreman. Each buyer was required to visit the warehouse once a week for the purpose of looking over and seeing at first hand the goods currently in storage for which he had placed orders for their acquisition. This requirement had a double purpose: the buyer gained constructive impressions from visual contacts with slow moving goods. (Some buyers actually pencilled their initials and dates of visits on containers of goods which were becoming slow moving items, and this was done each time they visited the warehouse.) The second purpose of the visit requirement was to provide buyers with an
opportunity of learning directly from warehouse personnel any weaknesses in containers or packaging which the buyer might want to bring to the attention of the vendor concerned.

The title of the processing foreman indicates work which changes the form or size of package. Work of this supervisor's unit had to do with the processing of items in accordance with quantity standards established by the meat, grocery, and produce departments. The salvage foreman managed a small crew under the very general instructions to collect the maximum amount of salvage at the lowest cost. This supervisor's duties were essentially those of a crew foreman. An interview indicated that he was provided with descriptions and classifications of salvage which the service center might generate and he was also furnished with instructions with reference to packaging and baling. The arrangements for disposition of collected salvage were made by personnel of the purchasing department, who are not shown on the organization chart above as they came under the jurisdiction of another division of the particular food distribution center.

Organizational balance is essential to an efficient operation. It is well established in organizational theory that the work of management includes and could be considered as being made up entirely of planning, organizing, and controlling. 


An organization provides for a systematic operation. A warehousing operation must first be systematic before it can be efficient.
To be efficient, the work required of the warehouse and its personnel to aid in the attainment of the objectives of a firm must be arranged with a reasonably good balance of men and equipment with the physical properties of the storage facility. In achieving this balance, planning is required to pre-determine the number and quality of personnel, number and sizes of bins and racks, and the number, sizes and capacities of equipment needed for the movement of goods.

The warehousing organization, in order to do its assigned work effectively and efficiently, requires a proper blending of the warehouse personnel with the equipment and facilities available for their use. This proper blending and balance does not come by accident. It is the result of planning and managerial attention.

In achieving efficiencies which organizational effort can make possible, there is need to give consideration to: (a) The warehouse buildings, grounds, and approaches. (b) The personnel needs with respect to number, special skills and qualifications. (c) The material handling and other equipment needs. (d) The nature and characteristics of the goods which are to be received, stored, and reshipped. (e) The organizational structure which can best manage the foregoing in the situation.

A consideration of the warehouse with respect to grounds and location. In a recent study and report made by the United States Department of Agriculture which concerned wholesale fruit and vegetable warehouses, eight layout objectives of warehouse planning were determined.\(^\text{10}\) (a) Maximum utilization of space. (b) Direct flow of commodities. (c) Flexibility in use of space. (d) Protection of quality of products.
(e) Future expansion. (f) Maximum utilization of equipment. (g) Safety and comfort of employees. (h) Minimum supervision.


The foregoing layout objectives may not be attained for any warehouse operation unless planning considers tonnage handled by month or by season, high, low and average months from the standpoint of storage space needs, and the physical characteristics of goods with respect to temperature and other seasonal changes. There is need also to consider the approaches to buildings and the outside areas which are needed to facilitate the receiving and shipping of goods. The kinds of transportation used regularly in the acquisition and in the shipping of goods will influence the planning for areas maintained which are external to the warehouse buildings. If highway trucking companies represent the only mode of transportation used by a particular warehouse operation, the planning needs only to consider the maintenance of truck docks for carrier unloading and loading.

Some business executives have been prompted to move warehouse operations from downtown areas to suburban areas because of a pressing need to have such facilities more accessible to highway transportation. This has influenced the move from multiple-story warehouses to one-story warehouses. Multiple-story warehouses have been a part of the urban wholesaling districts of commercial cities. One of the factors which has prompted the moving of such operations into suburban locations was
the need to make the warehouse more accessible to motor truck shipping. The advantages of one-story storage buildings could hardly be overlooked when business executives obtained suburban land sites and began to discuss their storage facility requirements with architects.

There are certain cautions which should not be overlooked in any planning for relocation of a warehouse facility at the edge of a city. One is the possibility that the firm will be placed in a position of complete reliance upon trucking companies for all goods. As the construction of a new warehouse represents a long term investment, the firm may not in future years be able to take advantage of shipping improvements that may be made in railroad shipping or in other kinds of carriage. The complete reliance also extends to rate structures. If they became relatively unfavorable in highway shipping, the firm may be faced with drayage costs in order to use other modes of transportation. A second caution in any relocation planning is to consider the customers served and their customs with respect to buying. If it is their custom to visit warehouses and inspect goods before placing orders, then the storage facility must not only provide for the display and inspection of such goods, but it might need also to be accessible for passenger travel.

**Personnel and the handling of goods.** A warehouse receives, stores, selects, and then ships goods as they are called for on customers' orders. Considerable information appears in the business press to indicate a growing consideration for the replacement of warehouse manpower with warehouse machinepower. It is evident that personnel needs are changing and that warehouse employees working with better equipment and better
procedures are showing an increasing productivity. If productivity per worker increases, then it is conceivable that the number of employees required in a given operation could be decreased if the volume remained constant.

Management must be concerned with efficiency and economies in operation. In a storage facility where it can be determined that a more efficient operation would result from an increase in machines and equipment, such an increase should be given managerial consideration. Such changes have the effect of decreasing the number of warehouse employees, but not the elimination of employees. This is not a new situation and it is not one peculiar to warehousing operations. Responsible managements from the time of commercial and industrial beginnings have been making decisions in the interest of getting a different mixing of men and tools to the end that more costly inputs of energy can be reduced. Historically such changes have been made gradually since the beginning of the industrial revolution and until the comparatively recent coining of the term automation, the replacement of manpower by machinepower has not been widely heralded.

When a storage facility is set up to make widespread use of a system of automatic materials handling equipment coupled with electronic data processing equipment, the operational results are quite unlike the warehouse image which most business executives hold. Such operations are viewed as automated distribution plants rather than warehouses. A distribution plant of this kind has been developed
by the Jerseymaid Milk Products Company of Los Angeles to serve several food chains.  

The Jerseymaid operation reportedly carries a variety of more than 350 frozen food items and has 14 employees. The plant has 750,000 cubic feet of storage area maintained at a temperature of five degrees below zero. In its semi-automatic operation, 2500 cases of goods are moved in one hour from storage to trucks for delivery to stores. Two employees are required to remove the cases from conveyor in the loading out of each highway truck. Employees classified as fork lift truck operators are also required in the handling of incoming goods.

Management of the Jerseymaid distribution plant has learned that in addition to a steady and high volume, more standardization in case packaging is needed to fully exploit an operation of this kind. The optimum case size should be 14 to 16 inches wide and about 21 inches in length.

Dr. Robert W. Roop, vice President of Atronic Products, Bala-Cynwyd, Pennsylvania, was quoted in the March, 1960 issue of Factory magazine. Automation is a powered system in which control decisions are usually made by equipment, while people monitor the operation and exercise overriding judgement if necessary, whereas mechanization is a system in which powered equipment and information are controlled electrically, while people make the decisions.


Dr. Roop is in agreement with others who have given intelligent consideration to the application of automatic equipment and controls to warehousing operations. To automate a warehouse you have to have three conditions. (a) Large volume. (b) A standard-size package. (c) Minimum variety among the products to be handled.

Planning for control of inventories.—Business activities need to be controlled in order that they may accomplish effectively and efficiently those functions for which they are set up to perform. From established controls, responsible executives learn of the need for adjustments in their areas of responsibilities. Through the exercise of controls, business activities are constrained and guided toward the achievement of certain goals or the attainment and maintenance of conditions considered necessary for the firm to attain its major objectives. Activities incident to controlling inventories can be grouped under two general classifications, physical control and internal control. Physical control, i.e., the safeguarding of goods by use of fireproof storage facilities, strong doors, barred windows, floodlights, fences, night watchmen, burglar alarms, and check-out stations for warehouse employees so as to reduce pilferage. The second general grouping of controls for inventories is internal control. Internal control is achieved largely by use of records and the assignment of workers so that some division of labor is maintained between those who maintain inventory counts or authorize stock withdrawals, and those who have access to the stored items. 13

In planning for internal control the possibilities for collusion between a person responsible for procurement and the person who tallies in goods at the receiving station should not be overlooked. A system of internal control would require periodic comparisons of record counts with bin counts and should provide information on which to fix responsibility in case of shortages.

An inventory control system when properly operated will facilitate the work of buyers, provide for economies in maintaining inventories, permit a business firm's sales force to be more specific in promising deliveries, and permit a more effective coordination of sales effort with order-filling and shipping. The promise of gains to be had in those areas has been a factor in the development of machine records for inventory control purposes.

It is essential that physical control devices and practices be designed and carried out so as to complement the internal controls which have been instituted. Good controls may not be had without cost and it is therefore well to understand what is needed and what it will cost to cover each specific need. Some physical controls are extant in any storage situation even though management may not have thought of them as such.

Goods are stored for some anticipated future sale or company use. The purpose of storage would be defeated if the goods were not in salable or usable condition when they are removed from storage. In planning for inventory controls, a realistic starting point would be to recognize, list, and describe the physical controls presently in use. This work could then be followed with study and determination as to the additional
physical controls, if any, which are needed. The determinations for internal control could then be made in a similar way. By first an appraisal of the accounting records which provide control and then considering the additional records or modification of existing record-keeping practices which should be made. When determinations have been made in the two areas of control as suggested in the foregoing, the control needs in a given situation are more evident and the planning of a system which will integrate physical control with internal control can then follow.

Training and development of warehousing personnel. While the developments in warehousing point to a greater use of machines and equipment in the in and out movement of inventories, the need for manpower in the storage facilities has not been eliminated. Where greater investments are made in machines and equipment which can be used to facilitate the storage, movement, and accounting for inventories, a reduction in personnel should be expected and this would perhaps have been a factor considered when such investments were authorized. Machines and equipment used in the performance of the storage function can alter the mix of men, machines, and materials needed in the receipt, storage, and issue of goods, but they do not serve to remove or eliminate one ingredient of that mix. Men will still be needed although the number of man-hours required in a particular warehousing operation can certainly be decreased by an intelligent application of machines and equipment.

Developments in warehousing indicate that as an individual making a contribution toward his firm's goals or objectives, the warehouse employee is becoming increasingly more important. In instances where the number of warehouse employees has been high in relationship to volume,
an untrained or otherwise inadequate employee could in a sense be hidden in the process of the work. Working with limited abilities, limited tools, and limited training, his contribution to the achievement of company goals was seemingly minor and difficult to measure.

Observations made by this writer in storage operations maintained by prime contractors for agencies of the federal government during the late nineteen forties and early fifties have indicated that many warehouse employees paced themselves with respect to time and set their own work standards. They were frequently supervised in a loose manner and occasionally one could be found who could not name his immediate supervisor. Job descriptions for such employees were often vague and incomplete.

In discussing warehousing and storage problems with a staff specialist in a large company (who requested that he not be credited in writing with this communication) information was obtained which indicated that management's low opinion of warehouse employees in his company had once influenced the physical location and stacking of goods so as to eliminate places which could be used for sleeping. Bagged goods, as for example coffee and sugar, were pyramided so as to eliminate surfaces which could be used for reclining or sleeping. Obviously this was an expensive plan for dealing with the problem of warehouse productivity. In time the business firm in this instance recognized that low productivity in its warehouses could not be solved entirely by eliminating the possibilities for sleeping on the job.

The move toward a greater mechanization within storage facilities has brought a decrease in the number of warehouse employees in some
operations. In specific operations absolute decreases in employees by number have been reported. In the storage industry in total a relative decrease with respect to volume would certainly be shown if pertinent before-mechanization and after-mechanization statistical data were available. This decrease in number of employees has made each individual employee more important. He operates more expensive tools and equipment which are often capitalized and therefore reflected by operational cost records and reports to management. The absence of an employee who has been trained to operate equipment in which significant amounts of capital have been invested, points up his importance. Such operators must therefore be trained, and they must also be dependable.

One result of the introduction of more mechanization into the storage facilities, has brought about better job analyses and a rewriting of both the job specifications and the man specifications for warehouse employment. This has of course affected the recruiting and selection of workers to fill such positions. Man specifications in this personnel area need to influence the selection of men who have the necessary aptitudes and skills for this kind of employment; persons filling such positions must also be receptive to the training required. To responsible executives who wish to improve the performance of their storage functions, the warehouse is no longer a place for haphazard employment. High turnover in the warehouse is uneconomical just as it is uneconomical in production and in sales.

Since World War II, the increased interest in employee training has not completely bypassed the warehouses. Some executives have reasoned that if training will reduce turnover and in other ways reduce
turnover and in other ways reduce costs in other business operations, it might have a similar effect upon storage and material handling personnel. There has also been some recognition of the warehouse as a place of interim management training for new employees who are expected to become qualified for more responsible work in the particular company. In spot checking the training programs as they are made known by personnel executives who recruit on college campuses, it is found that actual work experience in storage and/or shipping is quite often a part of the training which the college graduate as a trainee will undergo. For that kind of training to have full value, it must be designed and conducted by supervisors who understand the aims and objectives of that learning experience.

It would be a waste of training opportunity for a management trainee to be assigned to a warehouse where he would spend several weeks in learning only how to operate a fork lift truck, or develop some other operational skill. Such wastes will occur unless the warehouse supervisors understand the reasons for having employees assigned to a storage facility on an interim-training basis. A prerequisite for that kind of training is the recognition of storage supervisors as persons having roles to play in the management training program. This recognition would point up the need for the training of warehouse supervisors as trainers and this could be a beneficial part of the training program.

A consideration of the content of training. The training in the warehouse of new employees considered to have management potential is only a phase of the instructional possibilities which a firm may have.
More appropriate in this study and report is the consideration of what should be the content of the training of employees who were selected for initial employment in a storage facility. In general, consideration should be given to the presentation of information under the following headings.

**Purposes served by the particular warehouse facility:** Instruction here would give trainees an understanding of why goods are stored at a particular location and why they may be received in one lot size but be reshipped in another (usually smaller) lot size. In general, instruction under this heading should acquaint trainees with the contributions made by the warehouse facility toward attainment of company objectives.

**Customers and others served:** Warehouse employees will be better trained if they learn early in their employment something about the customers who in effect support their employment. Customers can be grouped or classified by volume, by ownership, by nature of operation, by location, and along institutional lines. Ordinarily the well-managed firms should not need to make classifications for training purposes in this instance. Classifications already in use for sales analysis purposes as well as sales breakdowns should be available in accounting records.

Periodical literature in the field of warehousing indicate that storage facilities, in addition to serving as machines in the receipt and redistribution of goods, may also function as service centers. When this is the case, training should give trainees information concerning any services assigned to warehouse personnel for performance. Examples could be operation of box-making machinery, pallet repairing,
fleet maintenance, and other services. It seems especially important for new employees to know about work performed in a storage operation which is essential to the operation of company activities, but which is not storage work as such.

**Records maintained:** While warehouses are not intended to be record-keeping establishments, they do require some records. For good internal control as well as for cost considerations, the primary records controlling stored goods will usually be maintained in accounting offices under the supervision of accounting personnel. Subsidiary, satellite, or operational records may, however, be needed in the storage facility. Bin cards would perhaps be the simplest example. Trainees should receive instruction in the maintenance of such records as well as in the procedures for periodic reconciliation of stock balances with records maintained by accounting, purchasing, and other personnel.

**Warehouse layout:** Instruction under this heading would introduce the trainees to stored goods by class and by physical location. If the training is being conducted in training facilities removed from the storage areas, sketches, floor plans, visual aids and other descriptive materials will be needed. But before the trainee can become a contributing warehouse employee, he will require observational tours and instruction at points of storage within the warehouse.

**Purchasing:** While arrangements with suppliers for goods needed are not ordinarily conducted by personnel responsible for storage operations, a warehouse employee will be better trained if he understands something of the procedures of procurement and timing of deliveries. The classes of goods become more meaningful to a handler if he has some
understanding of how they were obtained and can envision also why they will be resold and reshipped. Instruction here will give the trainee a more complete picture of the one begun under the heading of customers and others served. The trainee should gain from this instruction some understanding of the seasonality of deliveries for certain classes of goods, and why units of purchase are as they are.

**Receiving and Inspection:** The procedures which have been developed for the receipt and initial handling of incoming goods should be explained to warehouse trainees under this heading. Procedures which have been established to insure that goods received from vendors are actually those ordered by purchase action should be explained. To follow good practices of internal control and to secure the advantages of a division of labor, personnel responsible for storage would not have direct responsibility for ascertaining that goods received in a particular shipment meet quality and quantity specifications of pertinent purchase order. The warehouse employees need to be able to follow procedures which have been established to coordinate receiving and inspection with purchasing, quality control, sales, and other interested departments.

The procedures made known to warehouse trainees should include the following: (a) Informing purchasing, sales and other interested departments of the receipt of shipment. (b) Names of those authorized to break seals on car load lots. (c) Information as to how to proceed in the acceptance of less than car load lots. (d) When and how to alert personnel responsible for inspection. (e) Special instructions for the receipt and handling of sensitive goods. (f)
Equipment to be used for each class of goods and the mechanics of such equipment. (g) How to ascertain storage space assignments for incoming goods. (h) Safety measures.

Order handling and traffic management: The warehouse is a service facility. In the frame and reference of this study and report it serves a marketing activity, or serves a manufacturing activity having a need to store its finished goods or those received from suppliers. In any event, marketing activity is significant. If there were no marketing activity, if goods were not bought and sold, the operation of a storage facility could be eliminated. In American business there is considerable truth to the hackneyed marketing statement that "Nothing happens until a sale is made". Certainly, with respect to outgoing shipments, it is an order from a customer which triggers the activities that cause goods to be selected, assembled, packed, and forwarded to some point named by the buyer. It would seem desirable to emphasize such matters in the training of warehouse employees. Their jobs are maintained by a flow of sales orders. This is within the concept of marketing management.

In certain training situations it might be desirable to explain further that orders are received: (a) From the firm's own salesmen; brought in personally or sent in by mail. (b) Mailed in by customer. (c) Telephoned or telegraphed by customer. (d) Customer visits selling firm and places order while there.

Following instruction which will give trainees information as to how the firm comes by the orders, could be a treatment of the steps taken with an order from the time it is received until goods are placed
in transit. Perhaps not all work set off by receipt of an order would be explained to personnel being trained for warehouse assignments. Cer-
tain steps, as for example those pertaining to credit-checking, price-
checking, computation of extensions, billing, and sales ledger posting,
might not require specific coverage in the training. But if responsi-
ble warehouse personnel are to fully comprehend the work of their activ-
ity they should receive information in the following areas: (a) Regis-
tration or logging of order. (b) Authorization for filling order.
Warehouse employees may need initially, only a limited understanding of
credit-checking and other financial checks which permit an order to be filled. It will help warehouse personnel to see their work as a part of the other necessary and purposeful activities of the firm if they know generally what constitutes an authorization to begin the selection of goods called for on an order. (c) Transcription of sales order: order may call for goods stored by class, or in different storage loca-
tions. (d) Equipment available for use in selecting and moving goods by class. (e) Procedures for making individual selections and the com-
pletion of bin cards, move order cards, or other bookkeeping devices which may be in use to maintain running balances or to alert personnel concerned with procurement. (f) Pertinent procedures for moving goods to an assembly point. (g) Checking selections against items called for on the order. (h) Procedures for packing and crating. Instructions here should emphasize company policy with respect to the observance of customers' instructions. (i) Policies and procedures of company having to do with variations in quantities, back orders, and bad shipments. (j) Turning the goods over to traffic or shipping personnel for forwarding.
Equipment, Facilities and their maintenance: In this phase of instruction the trainees will become acquainted with equipment assigned to the warehouse or made available for the movement of goods. Capacities, limitations, and special features of each piece of equipment should be explained with the view of having each trainee understand its intended use. A warehouse employee who has been selected to become a materials handling equipment operator, as for example an operator of a forklift truck, would be given additional instruction in the actual operation of that piece of equipment. Training in the operation of a particular piece of equipment is frequently given as on-the-job training. Some storage executives view vestibule training as being too costly and slower in the achievement of productivity. They consider it more desirable to train each warehouse employee in the actual storage facility where he has been assigned.
CHAPTER V
COORDINATION OF PROCUREMENT WITH STORAGE

Procurement.—Procurement as the term is used in a business sense, is the work of acquiring something. A manufacturing firm may have specialized employees engaged in activities which will cause the acquisition of needed men, materials, and machines. There may be specialized activities for the procurement of personnel needed; there may be employees with especial training and experience who deal with suppliers for the purpose of having the right materials on hand and at the right time; and there may be other procurement specialists who work closely with production planning to insure that procurement of plant machines and equipment will be geared to production needs.

In the larger firms where the division of labor is more specialized, the three major areas of men, materials, and machines, may be divided up and the specialization more refined. In personnel procurement there may be employees who serve their firm by locating and hiring persons who can fill certain employment positions. There could be a personnel placement officer for accountants, another for chemists, another for skilled machinists and so on. In the acquisition of materials in a large business firm the procurement specialization will usually have developed with the growth of the organization. Procurement here will be within compartments of materials or in families of materials. There may be a specialized staff to buy aluminum and other non-ferrous metals; there may be a steel-and-iron procurement staff; there may be a group of procurement specialists
who deal with suppliers and arrange for the purchasing of cloth and fibers; and there may be one or more persons who have responsibility for procurement of oils, lubricants, and other maintenance items. Similar examples could be offered to show an organizational working division of those who buy machines and equipment.

While the foregoing examples indicate that procurement is often specialized, this does not necessarily affect the problems of arranging for storage and in maintaining minimum balances. Specialized procurement brings especial training, interests, and knowledge to bear on problems peculiar to certain materials or a particular industry. The advantages of specialization are apparent when it is considered that a procurement specialist with good training and experience in ferrous metals could not make an immediate adaptation of his knowledge to the buying of man-made fibers for manufacturing needs. The disadvantages in specialization arise from greater numbers of persons working in the same general employment area (e.g., procurement) and the attendant problems of dividing up the work, defining lines of responsibility and in the coordination of all efforts in the interest of achieving goals with economy. Specialized procurement effort can lessen the problems of storage when it results in lower inventory balances through better coordination of receipt, storage, and issue. This results in better turnover, lower investments in inventory, less storage space, and tends to hold down inventory obsolescence. This suggests a rather steady and consistent tempo in the in-movement to storage and out-movement of a particular good, and this then points up the place of the warehouse
in a modern business enterprise. It must be geared to other operations of the business firm which it serves.

The term procurement as considered in the foregoing with reference to goods and materials, has been limited to the acquisition or buying of needed items from suppliers who are manufacturers or distributors operating as separate enterprises. In agencies of the federal government, needed items may be procured from two general sources, and hence the work of procurement could come under two general areas: (a) Acquisition from within the particular agency or from another agency. Procurement work here would be concerned with ascertaining balances and availability of a particular item from storage facilities under government control and then arranging for the physical movement of the item if it is needed immediately. Procurement here could be made within a particular agency as for example within the Atomic Energy Commission. It could also involve two agencies, as for example the Atomic Energy Commission acquiring automobile tires from the General Services Administration. Such arrangements are usually followed by the processing of papers necessary to effect an inter-agency transfer of funds to cover cost of the items involved. (b) A second general source of supply is made up of the vendors for a particular item. Ordinarily it is the policy to eliminate source (a) before vendors are requested to submit proposals. It is desirable to draw from existing inventories as this will hold down procurement costs and make for a more efficient operation.

Procurement in certain agencies of the federal government may then involve the work of locating the item within existing government
owned inventories and then arranging for its physical movement. It may also involve procurement in the usual business sense, i.e., making a need known to vendors and then placing an order with the most responsive bidder. It seems appropriate to discuss procurement in this manner, as similar practices could be used in various business situations. There are many American firms with decentralized locations or multi-plant arrangements, which use or could use comparable procurement practices. In a sense this is a continuation of the "make or buy" problem. Here it could be stated as the "withdraw from inventories or buy". In determining a policy in that regard, business executives would need to consider carefully the condition of their storage operations including the quality of itemized accounting and perpetual inventory records.

**Relationship of procurement to warehousing and storage.** In considering the relationship between procurement and storage it is necessary to keep in mind that there is a difference between storage and warehousing. This would be especially true in the examples offered above where storage incident to manufacturing activity was used as a model. Professor David A. Revzan of the University of California at Berkeley, makes the following distinction.¹

Storage, in the external sense used here, refers to the incidence of the time-bridging function in the channel within the framework of the funnel concept. It refers to interruptions in the physical flow of goods in the channel, Warehousing, on the other hand, is the assumption of responsibility for the adaptation of storage in this external aspect to the internal organizational framework of a given middleman or facilitating agency.

Warehousing executives would then assume responsibility for storage and would adapt storage operations to the business activities of the firm. This principle should apply in manufacturing activities as well as in the operations of middlemen. The point that Professor Revzan was making was that storage was time-bridging and referred to an interruption in the flow of goods. As he was writing under the general heading of Wholesaling he had the operations of a middleman in mind. His treatment of warehousing shows a recognition of the importance of control and co-ordination in connection with inventories procured for the purpose of being resold.

**Procurement and the managing of materials.** The case for managing inventories has been presented more strongly by Dr. Dean S. Ammer, Executive Editor, *Purchasing Magazine*, who provides certain objectives for materials management.  

**Primary materials objectives:**
- Low prices.
- High inventory turnover.
- Low-cost acquisition and possession.
- Continuity of supply.
- Consistency of quality.
- Low payroll costs.
- Favorable supplier relations.
- Development of personnel.
- Good records.

**Secondary objectives of materials management:**
- Favorable reciprocal relations.
New materials and products.
Economic make-or-buy.
Standardization.
Product improvement.
Interdepartmental harmony.

Forecasts.

The position of Dr. Ammer is tenable. He considers that all business firms buy and move things, but most have not given enough consideration to integration in managing materials. There is a need for top executives to gain an over all understanding of the internal movement of materials, why they are moved, when they are moved and where they are moved. There has been a development of specialists in business who carry out responsibilities in production control, in purchasing, in traffic management, and in storage, but a definite need exists for executives who can plan, organize, and control all activities concerned with purchasing, receiving, storing, shipping, and all internal movements necessary to carrying out those functions.

If the argument for materials management is a good one, then it must follow that the warehousing operation is an important management area for any business firm which receives and stores goods. The business press since World War II, has been disseminating a steady increase of information concerned with inventories and their need for management and control. Often this information is presented from the standpoint

of financial orientation and emphasis. The articles will frequently stress the desirability of reducing inventories so as to make cash available for a more productive usage. Certain business publications of which Business Week is an example, publish information showing increases or reductions in inventories with the usual economic interpretation that increasing investments in inventories point to good business conditions during the months ahead in the industries affected. The interpretation of a widespread effort on the part of business firms to reduce their investments in inventories, would be that it portends a business slowdown in the industries involved. Inventories have then become a sort of composite business barometer; an economic bellwether which shows a direction for business conditions to come.

The increasing concern for information about the status of inventories is part of a general recognition that inventories for most business firms command a good share of assets, a situation providing opportunities for savings and a more profitable utilization of capital. This concern has, in the last five years, fostered the American Production & Inventory Control Society, an organization devoted to the goal of gaining more recognition for the work of its members. At its fifth national conference held in Boston in 1962, it was reported to have had 70 chapters and almost 3000 members. As an organization it has the objective of establishing the work of inventory and production control as a professional management function.³

³"Inventory Men Move Up", Business Week, October 6, 1962, pp. 50-52.
Pressures for coordination. — Pressures to coordinate procurement and storage have come from the efforts of persons who see a need for better inventory management and control. But antedating the current interest in inventory management, has been two other lines of thought in distribution which contributed to marketing knowledge. One, dating back to about 1935, was the "Streamliner" operation in warehouse operations. With reference to a streamlined operation for a wholesale grocery warehouse, the elements were stated to be.

(a) Emphasis on the turnover phases of operation
(b) Use of one-story warehouse buildings
(c) Use of the assembly line supplemented by the punch-card system or some substitute providing the same basic advantage
(d) Use of skids or pallets, and machine operation insofar as possible.


A principal advantage of the streamlined operation for a wholesale grocer, came from a more efficient handling of fast-moving items which could be procured in car load lots. The author in his study had found that more than half and sometimes as much as 70 per cent of a wholesaler's tonnage would be made up of fast-moving items. The adoption of the streamliner operation provided for a reduction in the number of times a fast-moving good would be moved, and reduced also the
distances of such movement. A second pressure for coordinating procurement and storage has come from efforts to apply the concept of flow.

5Tbid., pp. 81-82.

The concept of flow—Marketing literature since World War II, has been developing the concept of a flow in the movement of goods from producer to ultimate user or consumer. This concept is not unrelated to mechanical developments in machinery and equipment for internal movements of materials and finished goods. A magazine concerned primarily with information having to do with materials handling, bore the name Flow. Published by Industrial Publishing Corporation, 812 Huron Road, Cleveland, Ohio, this monthly was renamed Materials Handling Engineer with an issue in October, 1958.

The concept of channels of distribution, well established in marketing literature, has no doubt contributed to the flow concept. While a channel of distribution refers to changes in ownership of goods as they move out from their producer, rather than a physical route of movement, the adaptation to a flow concept could be made. A so-called depot theory of distribution dating from 1945, contained a flow of goods concept. It was an attempt to explain the rates of flow for goods in marketing process.6

The thesis of the depot theory of distribution is that goods tend to move towards the point of final consumption at a rate established by the ultimate consumer. 

The depot theory of distribution envisions a steady flow of goods from the point of production to final consumption.

6Leo V. Aspinwall, "The Depot Theory of Distribution", Managerial
The concept of flow and efforts to advance a depot theory of distribution suggest that in a highly perfected system of marketing, storage as such will be largely eliminated. Goods will always be in transit and the storage facilities which they will utilize between production and end use will be the rolling stock of transportation companies. While that might appear to be an attainable and a desirable goal, a review of the reasons for storage will place the matter in a different perspective.

Storage is unavoidable. Man has found it necessary to store goods for a number of reasons: (a) Seasonal production of goods which are consumed in all seasons. (b) Seasonal consumption of goods which are produced during all seasons. (c) In order to meet sales expectations. (d) In order to accumulate in lot sizes sufficient for transportation purposes. (e) As a hedge against price rises or as an insurance against short supply. (f) Public policy. (g) As part of a curing or ripening process.

Not all goods require storage for all reasons given, but many goods will continue to require storage for one or more reasons, and so the major problem in physical distribution is how to improve and integrate warehousing activities, rather than how to eliminate them. There are improvements afoot in certain areas which affect physical distribution, as for example more specific distribution cost data, automated handling of certain goods, faster communication, better shipping arrangements for some goods, and a growing awareness by management that the activities
of warehousing need to be integrated with other activities of the firm.

Procurement is the work of acquisition and when goods and materials are acquired, they create immediate storage problems. A building contractor who receives notice from a railroad that a car load of Portland cement consigned to him has been spotted for his unloading, which he must do within 48 hours or pay demurrage charges, has an immediate storage problem. His immediate need is a dry storage facility, accessible by motor truck, which will accommodate some 3500 cubic feet of a powdery substance that would lose its value if exposed to moisture. The need for coordination here between procurement and storage is quite clear. A building contractor in this example will ordinarily have anticipated the delivery and would have made arrangements for unloading and removal to storage in advance of delivery. This example can be applied to the coordination of procurement with storage in general. The quantity of a good procured can change. There may be economies to be gained in acquiring goods in different quantities, or in different lot sizes. But such economies could turn out to be losses, if the changes in procurement brought on additional costs for storage.

A change in management policy within a firm affecting any one of the seven reasons for storage indicated above will affect both procurement and storage. The dissemination of such policy changes must be made to both the procurement and the storage areas of responsibility, in order that they may make the necessary adjustments and the coordination of such changes.
CHAPTER VI
INCOMING SHIPMENTS

Taking possession of shipment. - The receipt of goods requires the carrying out of certain organized activities. In small firms the receipt of goods and the tally in process may be accomplished by the same personnel using much the same equipment and space. 1


This is a practical arrangement because it can provide for a better utilization of manpower, space and equipment, but it may also have a benefit in maintaining relationships with common carriers and other transportation companies. The same modes of transportation and the same carriers may often serve a business firm for both incoming and outgoing shipments.

The importance of receiving, and the relationship of that activity to shipping may be indicated by the statement often made by warehouse executives that "goods properly received are goods properly shipped". The statement contains sound advice in two ways. First it refers to the proper receipt of goods, and secondly it cautions against the thought that goods are received for indefinite storage; the goods are to pass through the warehouse, not remain in it.

In setting up the steps which would be accomplished in a proper
receipt of goods, consideration would be given to the following: (a) Having the necessary manpower and equipment available to facilitate the removal of shipment from carrier's conveyance in a safe and economical way. (b) Extending reasonable commercial courtesy to the carrier's driver or agent and providing him with the signatures his employer may require to show that delivery was made. (c) Having available, when the shipment arrives, such tally in forms as may be required to insure an accurate count. (d) Making a physical count of the items received and recording each count on a tally in form, a non-extended copy of the purchase order or other appropriate form. (e) Compiling without delay any information that should be recorded to report overages, shortages, or damages detected in the shipment. (f) Making quality checks of incoming goods. Often this is done on a spot check or random sampling basis. It is difficult to generalize about this step in the receiving operation as the kind and amount of quality checks would depend upon the nature of the goods and it would also depend upon the reputation which the supplier involved is maintaining for the quality of his products. (g) Reconciliation of the goods received with the descriptions called for on purchase orders or contracts, and processing without delay the papers required by established procedures to notify personnel responsible for accounts payable that goods were received. (h) Submitting information pertaining to the shipment, including counts and descriptions, to personnel responsible for inventory records. (i) Movement of accepted goods to specific storage locations. The well-managed warehouse will have specific space assignments for each good by description or other controlling designation. (j) Segregation of
goods set aside by the over, short, or damage check. They should be removed so as not to occupy the valuable work space of the receiving floor. If activity in bad shipments is steady, the warehouse manager should allocate space for the receipt of such goods where they could be stored temporarily for subsequent viewing by carrier or vendor agents.

Management of receiving.-A consideration of the above phases of work or steps in the receiving operation can lead to efficient procedures in the receipt of incoming goods and will provide for a steady movement of each shipment through the receiving department. It is evident when one studies the available literature on receiving and then observes the actual handling of incoming shipments on the premises of business firms, that here is an area of work which should not be left to chance or undirected group effort.

When it is considered that a supervisor in the act of managing divides up his time in efforts which could be classified as planning, organizing, and controlling, it then can be seen that the work of handling incoming shipments requires managing. While establishment of routine steps and procedures is essential to an efficient accomplishment of this work, it must be recognized that considerable variations will occur in meeting day-to-day receiving problems. Shipments are received at different times and under different conditions. Periodic shipments received from suppliers on a standing delivery order basis, may be delivered from period to period by the same carrier who makes no variations in his procedures or schedules, but that would be an exception. The supervisor of the receiving department in an active business firm must alter his crew, equipment, and facilities in some
way for practically every shipment received. He must make adjustments for changes which occur outside and beyond his control in areas which would include weather conditions, cooperation of carriers, quantities, packaging, and procedural changes including those of shippers.

A brief discussion of some of the changing conditions listed above would seem to be needed. Weather provides a good example of change, and many shipments must be unloaded in open or partially uncovered areas. Shipments may therefore be exposed to weather conditions which are wet or dry, and may be hot or cold. To be prepared for such changes in conditions, the receiving supervisor should have on hand or accessible for use, tarpaulins, covered hampers or other protective equipment that might be needed. Where a part of the receiving operation must be performed during inclement weather, many employers provide ponchos and other protective clothing for the employees required to work under such weather conditions. To do all this does of course require the attention of management.

Changes in the spotting of car, trailer, or truck, for unloading may also cause the supervisor to modify his unloading practices. If it is a rail car to be unloaded, the carrier may spot the car at an inconvenient spot on a railroad siding. Receiving departments which have their own railroad spurs can exercise more control in the spotting of incoming cars. In any event, the placing of a car for unloading at the most accessible spot is important and this is a major reason for maintaining cooperative relations with carriers. Deliveries made by truck carriers create fewer problems with respect to unloading, but here too the spotting of a truck or trailer so that it can be entered with a fork
lift truck or other handling equipment can be important in planning for an efficient operation.

The work of receiving may require minor adjustments as the result of variations in quantities. This can come about because procurement ordered fractions of a car load when it had been the practice to procure certain goods in car load lots. The adjustments necessary in the receiving operation as a result of such change in quantity can be planned for rather easily if the supervisor is furnished a copy of the purchase order or other information showing the quantities on each order. When the variation in quantity of an order occurs as a result of the supplier back-ordering a part of the order, and the receiving supervisor has no information in advance, a waste of man hours and equipment utilization can result.

Suppliers may change their shipping procedures, and they may make changes in the containers used. This requires corresponding changes in the receiving work. Evidence of a problem arising in this area was observed by the writer during a field study. In a warehouse operated by the Kroger Company, the fork lift truck operators experienced difficulty in handling the first shipment received of a household bleach product packaged in plastic containers in gallon sizes. Some unit containers of the bleach became "leakers" while being moved from highway trailer to storage and the warehouse superintendent considering that plastic containers were inadequate for the product, made strong recommendations to the director of purchases, that no further shipments from the vendor involved should be received. The goods in this instance were being obtained from a food broker. Representatives of the broker came to the
warehouse and solved the problem by replacing all leaking units and by suggesting modifications and adjustments in the clamp attachment on the fork truck handling the particular goods. The operators of the fork trucks were apparently applying more pressure in the clamp attachments than was necessary to pick up and move the unit loads.

New goods create changes which are obvious. Adjustments may need to be made in materials handling, and slots or other space allocations must be made for the new goods. With the advent of scrambled merchandising, and considering that buyers for commercial enterprises consider and evaluate the addition of several new items every month, this is not a minor problem. The new goods require determinations with respect to handling and how and where they should be stored. Without sales experience for a good, the warehouse manager does not know if a new good will be a fast mover or a slow mover. He must quite often give it storage space on a tentative basis, as he does not know the rate or volume of movement, and he does not know if it will become a regular item or be dropped after the initial sales experience.

Carriers must also adjust to changes affecting their operations and they should also attempt to make gains by innovating. Such changes may be in rates, in unit loads, in methods of making delivery, or in frequencies of deliveries. Business firms utilizing carrier services should adjust to such changes so as to minimize increases in landed costs, and if possible realize some gains from carriers' changes.

Because of changes in volume in established goods, addition of new goods, and changes in customer demands, the well-managed firm must make a continuous review of warehouse space allocations. Hauls
and the physical handling of goods must be decreased whenever possible and any action in this regard will affect space allocations, shelving, and bins for certain goods. Economies may also result in an in-and-out handling of some fast-moving items. Some food distribution firms have secured economies by checking goods within a rail car and then moving pallet loads directly to highway trailer. The economies in such procedures are obvious. The goods received were moved directly from common carrier to a supermarket.

The warehouse exists and is operated as a service activity. It serves a particular firm and assists the firm in serving its customers. The warehouse can provide the best service only if its activities are integrated and coordinated with other activities of the firm. There are data processing changes in accounting and there are other progressive changes in procurement practices. There is an increasing desire on the part of top management to know more about inventories. They wish to know currently the total dollar value of the inventory, its structure, i.e., which classes of goods account for major parts of the investment, turnover rates by class of goods, and what if anything could be done to reduce the assets tied up in inventories. The warehouse manager must then operate in a climate of change. He must create and maintain a flexible organization which can adjust to change and he must create some changes of his own through planning and innovation.

Turnover of personnel has been an old problem in receiving work. Pay scales are not too high and an alert person may be able to move to another position, sometimes within the same company. A receiving
supervisor told the writer that he has accepted turnover of personnel as a condition he would always have to tolerate. There are personnel changes in this area of work, but no figures were found by the writer to indicate that turnover here was substantially higher than in other job classifications. But there is the matter of job mobility and a relatively inexperienced worker can seemingly gain clerical experience in receiving which permits him to move into more rewarding work.

In addition to personnel changes, there are changes which can be made in materials handling equipment. Equipment depreciates and new equipment is procured. Rarely is a piece of such equipment replaced with an identical unit. The industry which produces such equipment is aggressive and makes its new equipment and systems known. But changes in equipment come rather gradually and the supervisor can plan for such changes.

A more difficult matter to plan for, however, is the general lack of control which the receiving department has over the timing of incoming deliveries. Shipments may come intermittently. There may be periods of rush in the unloading of two or more deliveries at one time and there may be days of complete calm when it would be difficult to justify the personnel assigned to receiving. The solution to the first situation can come only from planning and coordination with procurement personnel. The solution to the latter situation is in saving work elsewhere in the firm which can be performed by members of the receiving department when the receiving work is slack.

The information presented in this chapter pertaining to incoming shipments has been developed with a centralized receiving operation in
mind. There are of course possibilities for decentralized receiving in which vendors or carriers would be given shipping instructions to make delivery at some point other than a central warehouse. When such arrangements can be made and carried out efficiently, savings in handling costs can be had. An example in a food distribution chain would be the delivery of a trailer load of canned tomatoes directly to a supermarket rather than making delivery to the warehouse which serves that particular supermarket. In food chains this arrangement can sometimes be carried out economically and efficiently, with the actual receiving and tally in of goods being accomplished at the point of delivery. Manufacturers are sometimes in a position to use decentralized receiving and decrease handling costs. A manufacturing firm which operates a foundry would, for example, buy sand for use in making molds. The sand, being used only by the foundry and not used in any other part of the firm, could be delivered directly to the foundry where records and reports of receipt would be completed and submitted in much the same way as when goods are delivered to the central receiving point. While decentralized receiving is not warehousing within the frame of this study and report, it has possibilities which should be considered by anyone planning for or evaluating receiving procedures.

The receiving of goods is an activity requiring accurate clerical work and an efficient handling of all items delivered. It is an activity which must be managed, and responsible persons must direct this work with consideration for planning, organizing and controlling. The details of receiving operations are largely dependent upon classes of goods to be handled, distances such items must be moved, types of materials handling
equipment available, and physical characteristics of the storage area. The planning of receiving operations requires full coordination among personnel concerned with accounting, personnel management, procurement, sales and/or production forecasting, sales management, traffic management, and staff personnel concerned with organization and procedures development.

In organizing for the accomplishment of the work required in receiving, consideration must be given to classes of goods, materials handling equipment available, volume of receipts including information as to peaks and valleys, manpower needs, horizontal distances of movement, and vertical distances of movement. In controlling the receiving operation established procedures are required. They must be established and put into use for all work that falls into recurring patterns. But procedures in this kind of work may not always be established as rigid law. Flexibility would be required in certain procedures to allow adjustments for changes that may occur for reasons indicated in the foregoing pages of this chapter. In addition to the control that comes from the establishment of procedures would be the personal supervision of a competent receiving department supervisor.
CHAPTER VII
WAREHOUSE LAYOUT AND ORDER FLOW

Layout.-Layout is the physical arrangement of the warehouse. As defined by the United States Department of Defense, it is "The detailed, planned arrangement of space for storage, aisles or other necessary use". ¹


Layout is space allocation for receiving, for shipping, for aisles and other maneuvering space, and for bins, shelving, and other repositories for goods handled by a warehouse.

Order flow.-Order flow is the physical movement of goods from the point of their selection until they are assembled and made ready for forwarding to a customer. Order flow refers also to the processing of tally-out forms, copies of customers' orders, or other papers that may be used to record the selection and movement of goods toward the shipping department.

Relationship of layout to order flow.-From the standpoint of efficiency in warehouse operations, there is a definite relationship between the physical arrangement of the storage and work space, and the procedures which can be followed to achieve a good utilization of facilities, manpower, and equipment in the withdrawal and shipping of goods. A smooth flow implies a movement without interruptions. This is not easily
achieved and can be had only through planning, development of procedures, and the cooperation of the sales department. For the personnel concerned with the actual picking of goods and filling of orders, purchase orders of customers are work orders for the out-movement of goods. If a steady stream of such work orders can be maintained, a working force can be more fully utilized and this is a basis for reducing costs in order-filling work.

Dr. Albert Fisher, Jr., in a study of warehouse operations of service wholesale druggists completed in 1948, reported that the results of an unbalanced order flow were: (a) Inability to meet delivery schedules, (b) Over-all reduction in output, (c) Lowered morale and decreased worker interest in the job, (d) Lowered worker efficiency.

Dr. Fisher found that a universal formula for maintaining a smooth order flow, could not be determined. No two warehouses have the same layout and they operate in different geographical areas serving different customers. He did recommend, however, that warehouses within the wholesale drug industry, in the interest of maintaining a smooth flow of orders should concentrate effort in the development of a flexible work force, adjusting work hours to flow, work simplification, and in the development of sales policies which would permit a more efficient handling of customers' orders.²

²Albert Benjamin Fisher, Jr., Warehouse Operations of Service Wholesale Drugists (Columbus: The Bureau of Business Research, College of Commerce and Administration, The Ohio State University, 1948) pp. 31-47.
Relationship of order flow to sales. It is characteristic of the work of salesmen that they should be future-oriented. They need to plan for future sales calls, and must continually analyze their territories and customers with a view of making better presentations during future sales calls. They need them to dwell upon past sales orders only to the extent that they can use such data to suggest and emphasize how a customer would be better served if he increased his purchases of like goods, or widened the range of his buying to include other goods offered by the business firm represented by the salesmen. Unless the job specifications and the nature of products sold require a salesman to set up the items sold or show customer how to adapt them to his production or sales efforts, the salesman will utilize his time and effort on future needs that could result in new orders. It has been the observation of the writer, based upon four years of intensive experience in procurement as an employee of the United States Department of Defense and the United States Atomic Energy Commission, that salesmen will try to avoid problems pertaining to past orders. If modifications in packaging, changes in shipping instructions, or changes in quantities are desired by the buyer, the salesman instrumental in placing the order will attempt to shift the negotiation to persons in the marketing or transportation departments of his firm. If he is well trained, he will produce the names, titles, addresses, and telephone numbers of each official in his firm who should be contacted for each problem area raised by the buyer. He will thereby carefully extricate himself from buyers' problems which have to do with past orders. It is desirable that he do so. While he is an agent for his employer, he is not
empowered to negotiate all changes in accepted orders that may be requested by buyers and it is generally desirable that he be concerned primarily with future needs of his customers.

The well trained salesmen, particularly those representing manufacturing or wholesale firms, are not as disinterested in the filling of orders to customers' satisfactions as the foregoing might indicate. They recognize that in the final analysis, a sale is incomplete until goods are delivered to buyer, put into use, and in some reasonable way fulfill expectations of buyer. Salesmen of industrial supplies may go so far as to state that sales of their goods are incomplete until they are actually used up. Proof of that they would say was in the fact that most of their orders were accepted with obsolescence clauses that permitted buyers to return goods for credit if they elected to do so. Sales personnel and warehouse personnel are in agreement in their dislike for returned goods. Sales personnel are therefore definitely interested in the proper filling of customers' orders and they are therefore interested in order flow. A major tactical weapon which a salesman may use effectively is the promise of quick delivery. If a selling firm fulfils the promises of its salesmen for quick deliveries, its operating procedures must provide for a speedy transmission of purchase orders, a filling of such orders without delay, and forwarding a shipment by a fast mode of transportation acceptable by the customer.

The relationship between orders and order flow is a definite one. In the first place, it is an order which triggers the flow of goods to a shipping department and causes the work of billing and record keeping to be carried out. A second relationship exists in the sequence of line
items on a purchase order, as these relate to the layout of inventories from which the order will be filled. This can be illustrated by a warehouse situation in which inventories are maintained for goods in one hundred class designations. In this example the spatial arrangement of these goods is in reverse numerical order with class 100 nearest the shipping department and class 1 being the most distant item. The spacing of the goods in this example is regular and even, with good class 50 located exactly half way between the shipping department and good class 1. In this simplified layout model, it would be desirable for orders from customers to be submitted in a numerical sequence starting with goods in the class 1 category, rather than by ordering by word descriptions alone. If all orders received called for line items which were listed by numerical classifications and such classes were entered on each order in a progressive sequence, the order flow would be simplified. If an order in a given instance called for items identified as classes 25, 30, 33, 41, 66, 78, 83, 92, and 100, the work of filling the order would commence at class 25, and the flow would be toward the shipping department. With the picking of good, class 100, the order would be ready for checking, packing, and forwarding. There is a definite weakness in this particular model; it is the lost time and unproductive movement of the equipment out to the point where the first item on an order is selected. The arrangement of goods in a somewhat circular pattern with both goods class 1, and goods class 100 adjacent to the shipping department, would be a better arrangement.

The layout and order flow arrangement envisioned in the foregoing would require the cooperation of the sales department which would be
enjoined to secure the cooperation of customers in purchase order submission. Efficiencies would be lost if line items as entered on purchase orders, did not agree with the physical layout of stock from which the orders were to be filled. This arrangement which is suggested as one means of securing efficiencies in order flow is not new and it is not an innovation. It is simply the adaptation of an order-filling arrangement which has been used in automated order-filling.

Observations made in an automated warehouse handling case lots of frozen foods, operated by the Abner Wolf Company in Detroit, indicated the essentiality of having customer-orders submitted so as to list items in the same sequential arrangement as they were stored in the warehouse. The Abner Wolf Company operated an automated frozen food warehouse to serve supermarkets of the Wrigley Company located in Southern Michigan. The orders received from supermarket managers were submitted on especially prepared forms that were fed into an electronic machine which punched a card for each line item. When ready to load out an order, the pertinent cards were fed into another electronic machine which sent impulses into the storage facility to release case lots of the quantity and description called for on each card. A conveyor system brought the goods to the shipping dock where they were loaded by hand into refrigerated highway trailers. A copy of the purchase order was used to check out each order and this was accomplished at the end of the conveyor. The checking of each order was simplified as items came out on the conveyor belt in exactly the same sequence as they appeared on the purchase order.

_USE OF PRE-PRINTED ORDER FORMS TO FACILITATE ORDER FLOW._ Not all
warehousing operations can be adapted to highly mechanized or automated operations. It is now well established that a system of automated materials handling requires three sets of conditions if it is to be installed to operate economically and efficiently. (a) High volume in the goods to be handled. (b) Steady volume in the goods to be handled. (c) Uniformity of packaging in the goods to be handled. Most warehousing operations at the present time cannot meet the requirements of those three conditions. The course of action which most warehousing executives need to follow to decrease operating costs or otherwise show greater efficiencies, is to make improvements within existing systems.

One practice which can coordinate purchase orders with storage layouts and thereby facilitate the work of filling orders, is to adopt procedures which require the use of pre-printed order forms. They can provide complete and accurate descriptions for each item ordered, a decrease in man-hours required to fill orders, and a listing of seller's entire line of goods is brought to the attention of salesman or customer each time an order is being prepared. 3

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The use of pre-printed order forms and the coordination of line items on such forms with stock layouts is an essential first step in the automation of warehouses. The cooperation of customers in this regard needs to be obtained before a high degree of mechanical handling in order-filling can be achieved. If a warehouse executive finds that he
cannot rearrange his inventory so that space locations for each item can be made to agree with the order in which items will be required by customers' purchase orders, his planning for an automated warehouse will be difficult.

Automation in order-filling reappraised.—Articles appear from time to time in the organized labor press, in the political press and even in the business press, which contain misleading statements concerning automation in materials handling. Statements appearing in Section 14-A of the Cincinnati Enquirer for Sunday, January 10, 1960, are illustrative. Under the caption, "Brewery Adopts Automation and Now It's 'Palletized'", appear these statements.

Palletizing is automation in its purest sense.
. . . . . And the worker involved. . . . . He pulls the switch.

The article in the above instance attempted to report the installation of a machine by a local brewery which was operated so as to place 42 cases of beer on a pallet where they could then be handled by a fork lift truck in one handling rather than in 42 separate handlings. Another example appeared in the Cincinnati Enquirer, Section C, for Sunday, June 26, 1960. The lead-in statement under the caption, "Automation Age - Alvey-Ferguson Teams With Colgate in Job", was made.

The worker in the warehouse feeds a punched card into the maw of an electronic device and far back in the warehouse, wheels begin to turn to deliver the shipment to the truck dock - all without labor.

There is something fanciful about press-button operations. A few years ago there was a flurry of news about press-button wars, and about the controls which had been instituted to insure that someone did not
press the wrong button. The idea that electronic devices and punched
cards could be geared up with mechanical handling equipment to select
and move goods without the use of human labor, has been rather widely
accepted. The installation of an automated or a highly mechanized ware­
house was news. The business firms making investments in such instal­
lations and the engineering firms as well as the technical firms which
developed and installed such systems, availed themselves of opportunities
to publicize their products and their work.

Some automated warehouse operations have now had five or more years
experience and certain results of that experience are being made known
in a limited way. A leading business weekly in a March, 1962 issue re­
ported that some of the drawbacks and problems which had appeared in
highly mechanized warehouse operations would include the following:

(1) Any warehouse relocation that might be required would be
difficult to make. Much of the equipment was too unwieldy to move.

(2) It takes time and the attention of specialists in getting
a system to working smoothly. It was reported that one company was
still "debugging" its punch-card order picker after five years oper­
tional experience with it.

(3) Gains from a reduction in the man-hours required to perform
some tasks may be offset by increased labor requirements for other tasks.
In one instance, 30 manual order pickers could be eliminated but 40
manual workers would be required to replenish stock in back of the
system.

(4) An installed system does not have flexibility for handling
different sizes and shapes. This is a significant problem as package sizes and shapes are constantly changing.


On a more positive side, the article cited in the foregoing reported that while automation was not a panacea for all physical distribution problems, it had been a factor in the development of some alternate handling systems. Automation has brought more attention to order-filling activities and as a result some new systems have come into existence which are not completely manual in their operation. An example was a warehouse of the Philadelphia Wholesale Drug Company. This warehouse, built at a cost of $1 million, can handle 40,000 items in a day. Stock pickers are used, but they are used in conjunction with I.B.M. cards. The cards are circulated slowly through the storage areas by a conveyor. Stock pickers, working in assigned stations examine the cards and withdraw from stock and place on a conveyor belt the items called for which are stored within their assigned stations. The Philadelphia Wholesale Drug Company reported that this system had provided for a 25 per cent reduction in its stock-picking worker force. Another Philadelphia Company, the Penn Fruit Company, has been using a similar system and was not interested in converting to automatic controls.

There is however, an indication in the periodical literature available pertaining to warehousing, that interest in automated operations
is increasing. Reasons for this increasing interest would include the following.  

(1) Pay scales for warehousemen are rising.

(2) Retailers, as well as wholesalers, desire to keep inventories low.

(3) Warehouse employees are usually not the most efficient and reliable workers.

(4) Land value and construction costs are increasing.

(5) The problems of distribution cause executives to seek a system that will solve all their problems.

(6) The generally rising costs which are considered to be distribution costs.


In the article containing the following reasons for interest in automation, the author presented some precautionary principles and advice for warehouse automation planners which included the following:  

(1) Know all you can about your firm's market forecasting, merchandising, and production before any planning for automation is begun.

(2) Draw plans for building after automated system has been designed: build over the system.

(3) Keep the system as simple as possible.

(4) Build on one level if at all possible.

(5) Make present system as efficient as possible before deciding to abandon it.
(6) Do not order an automated warehouse if it won't pay off in four years.

(7) Technical progress in the area is rapid: most systems as presently operated will be obsolete within five years.

There are no universal conclusions that can be reached in the reappraisal of automated order-filling, which could be applied to all warehouse operations. There are records of success in automated order flow and there are cases where investments in such installations have not provided expected returns. A review of available literature in the field of materials handling, indicates that some order-filling situations are adaptable to the installation of highly mechanized order picking equipment. A basic requirement for the success of such systems is a movement and volume sufficient for a steady operation of all electric and mechanical equipment. Secondly, the amortization of such installations should be provided for from savings achieved in the operation of such systems.


Other information can be found to indicate that some business firms are cutting order-filling costs by the modification of handling procedures and a better use of manually operated equipment. One warehouse reported an operating expense reduction of one day's expenses each week. This significant reduction in operating expenses was achieved primarily from the installation of pallet racks which permitted less handling of incoming goods but more importantly, provided a better utilization of
storage space and made all goods accessible for order picking.  

7"Stock Picking from Racks Cuts Waste Motion", Flow, February, 1958, p. 70.

The conclusions which can be drawn from pertinent literature indicates that the completely unmanned warehouse is still to be developed. Highly mechanized systems for order-picking operations can reduce handling costs and thereby make profit contributions in some business firms but may not do so in others. Prerequisites for such systems include, large volume, steady volume, package standardization with no package too large or too small, and a relatively stable market situation which will permit a steady and continuous operation of a system throughout the amortization period.

In a dynamic marketing situation, it is difficult to make determinations with respect to continued steadiness of demand for many products during a future period of four or five years. The warehouse and the order-filling activities of a firm are not separate entities which can be planned for or changed without a consideration of the marketing activities of the firm in total. The following statement is appropriate in this regard.

8... warehouse automation goes much deeper than mechanizing the manual retrieval, sorting, and dispatching of goods... you have to step back and rethink your whole concept of warehousing - what it is, after all, that you're trying to do in a warehouse - as it relates to your over-all cycle of business...
CHAPTER VIII
CLASSIFICATION, ARRANGEMENT, LOCATION,
AND IDENTIFICATION OF STORED ITEMS

Serving customers.—The modern warehouse is operated to receive goods and hold them until shipping instructions are received. In a commercial enterprise shipping instructions come along with a purchase order. It is a purchase order which lists the items wanted, the quantity of each, and the destination to which the items are to be shipped. The purchase order may designate the carrier to be used in making shipment, and the buyer may indicate a different destination for certain line items listed on his order. If the good will and continued patronage of a customer is to be maintained, care must be exercised in filling his orders to insure that he gets what he wants, when he wants it, and that it is forwarded to the point where he wants it. In actual practice, some reasonable variations in quantities, or even variations in qualities are made, but in most cases a seller is well advised to learn the wishes of the particular buyer before such changes are made.

In situations where a supplier serves a customer over a period of time, understandings develop concerning variations in purchase orders. Such understandings may be set forth as a condition in each purchase action, but more often they evolve and are not reduced to writing. The United States Department of Defense has used variations-in-quantities clauses as a standard condition in the local procurement of certain
hard goods. When such clauses are used the governmental agency expects vendors to use judgement in the count of items shipped. As an example, an order containing a variation-in-quantity clause allowing a 10 per cent deviation in the count of any line item, could permit a vendor to ship 32 oilers, spring bottom, half pint, meeting certain federal specifications, price $1.00 each, even though the order specified a quantity of 30 for that item. Such an increase in quantity would be considered within the terms of the purchase agreement, if there was some reasonable justification for it. A vendor in this instance could be justified in shipping 32 items instead of 30 because the oilers were packaged by the manufacturer in units of eight.

In view of the mutual dislike for broken containers which shipping departments of sellers and receiving departments of buyers have, the acceptability of a change of this kind is not difficult to understand. The buyer allowing for variations in quantities ordered does, however, expect vendors to apply reason in shipping a quantity other than that specified on his order. Reasonableness in this instance can be illustrated by assuming that the order containing a variation-in-quantity clause which permitted a vendor to ship 32 rather than 30 spring bottom oilers, contained a line item for 12 truck tires priced at $100.00 each. There would be no reasonable justification for the vendor to ship 13 tires, even though the additional tire would be within the 10 per cent variation stipulated in the purchase order.

In serving customers in the selection and forwarding of goods to fill their orders, some variations in quantities may be made for a reason other than that indicated above. A variation may sometimes be required
as a result of a difference between accounting practices of buyer and
seller. This could well be more of a problem in the future than it has
been in the past due primarily to spottiness in the increased usage of
electric accounting machines for procurement or warehouse inventory con­
trol. The traditional packaging of some goods has been in dozens or
multiples of dozens. It was not uncommon for small goods to be packaged
in a container of a dozen dozen units. The wholesale price for certain
small goods has been for a package containing a gross. Prices have
been established to reflect units of packaging and warehouse records
for incoming goods, balances on hand, and for quantities shipped have been
maintained accordingly.

Electric accounting machines, which are a part of any mechanized
handling or record-keeping system, are seemingly developing on a decimal
basis which considers units of ten to be a suitable divider. Where orders
appear with quantities listed in amounts that do not agree with the ac­
counting lines drawn by the seller, adjustments will be required. The
burden of adjustment is upon the seller.

Arrangement of stock and its relationship to work of receiving and
classification.-The concept of flow which is affecting the planning of
of warehouse operations for the future, implies a temporariness in the
storage of goods. The concept of dead storage is inappropriate in ware­
housing as contemplated by this study and report, although some market­
ing authorities with national reputations have continued to use the term.
The following is an example.1

As car-lot shipments are received in a modern warehouse,
they are unloaded by mechanical equipment and placed in
dead storage. Smaller amounts of each item are transferred
as needed to the assembly floor. The activity taking place on the assembly line is a pure example of assorting. To fill a customer's order is to assemble an assortment of goods as specified from the various supplies on the floor.


The opposite of dead is live and presumably a warehouse operation having dead storage would also have live storage if it were engaged in the day-to-day handling of in and out transactions. Dichotomous classifications are often misleading because they result in over-simplifications. A warehouse operation is no exception. Some goods are slow movers and some goods are fast movers, but in between there may be a number of other classifications which could be established according to rates of turnover. To indulge in a somewhat more involved simplification in a classification of goods according to the length of their warehouse stops, we might create the following classifications.

**Example of Turnover Classifications for Goods**

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<thead>
<tr>
<th>General Class Number</th>
<th>Word descriptions for sub-Classifications</th>
<th>Numerical designations used on Warehouse records</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. Slow</td>
<td>: Slow-slow</td>
<td>I-S-1</td>
</tr>
<tr>
<td></td>
<td>: Slow-medium</td>
<td>I-S-2</td>
</tr>
<tr>
<td></td>
<td>: Slow-fast</td>
<td>I-S-3</td>
</tr>
<tr>
<td>II. Medium</td>
<td>: Medium-slow</td>
<td>II-M-1</td>
</tr>
<tr>
<td></td>
<td>: Medium-medium</td>
<td>II-M-2</td>
</tr>
<tr>
<td></td>
<td>: Medium-fast</td>
<td>II-M-3</td>
</tr>
<tr>
<td>III. Fast</td>
<td>: Fast-slow</td>
<td>III-F-1</td>
</tr>
<tr>
<td></td>
<td>: Fast-medium</td>
<td>III-F-2</td>
</tr>
<tr>
<td></td>
<td>: Fast-fast</td>
<td>III-F-3</td>
</tr>
<tr>
<td>IV. Extra fast:</td>
<td>: In-outs</td>
<td>IV-X</td>
</tr>
<tr>
<td>Goods are received</td>
<td></td>
<td></td>
</tr>
<tr>
<td>and then reshipped</td>
<td></td>
<td></td>
</tr>
<tr>
<td>immediately</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
It should be a goal in planning for an efficient warehouse operation, to have goods diverted to storage to await shipping instructions or as part of a curing or ripening process required by the nature of the goods. The term, awaiting shipping instructions, is used broadly and would cover the reasons for storage listed elsewhere in this report.

Except for public warehouses which are operated to serve by renting storage facilities, warehouses do not provide for direct returns on investments. The operations contemplated in this study are those which provide the warehouse services needed by a firm. Warehouse services are needed by commercial as well as manufacturing firms. Such services when performed economically and efficiently, can contribute to the profit position of a firm. That contribution can be made through reductions in handling and storage expenses, but it can also result from a business firm being able to maintain and improve competitive position through its ability to select the proper goods and fill orders promptly.

The classifications provided for goods and their arrangement and location in storage can facilitate the work necessary in the identification of items to satisfy a customer's order. The beginning of efficiencies in the classification of goods occurs when warehouse management starts to plan for the handling of an incoming shipment. Planning here would require the cooperation of procurement supervisors and traffic management supervisors in providing warehouse management with information in advance so that plans for the receipt and placing of incoming items could be made prior to their delivery. The aim of planning in this instance would be to have the necessary equipment, materials, manpower,
and storage space in readiness so that a prompt and orderly receipt of the goods could be carried out.

Planning should insure that self-propelled trucks, lifts, conveyors, hampers, and any other equipment needed to handle a particular shipment, would be on hand or would be available for the handling of a particular shipment when it was due in. Planning here would also provide for the pallets, ropes, slings, tarpaulins, and any packing or wrapping materials that might be required. The manpower needed would be estimated according to tonnage of incoming shipment, assessment of unloading difficulties that might arise, distances the goods would be moved, and the kind of equipment that would be used.

A most important part of the planning which should be made for each incoming shipment is that which allocates space for the new goods. The instructions contained in the statement, "A place for everything and everything in its place," is appropriate advice for incoming goods as well as those already in storage. The receiving operation can bog down if employees moving new goods into storage do not have clear instructions for the deposit of their unit loads. Subsequent inefficiencies can result from inaccurate stock location records and the difficulties that will arise in selecting items to satisfy customers' requirements. Planning which determines stock locations for new goods in advance of their arrival, will also provide that the more valuable warehouse space will not be used to store goods of low economic value.

Warehouse planning work sheet. To facilitate planning for the handling of incoming shipments, work sheets could be designed and reproduced which could then be used to collect and record information
pertaining to each receipt of goods. Such printed forms would also serve as check lists to insure that a good planning effort was being made for each lot of goods. A warehouse planning work sheet that could be adapted to many receiving operations, could be drawn up along the following lines.

**ACME AUTOMOTIVE SUPPLY COMPANY**

**Warehouse Planning Work Sheet**

**Purchase Order or Contract Number Reference: ** A-345

<table>
<thead>
<tr>
<th>Supplier and Carrier Data</th>
<th>Kinds and Quantities</th>
<th>Physical and Movement Space Data</th>
<th>Assigned</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(1)  (2)  (3)  (4)  (5)  (6)  (7)  (8)  (9)  (10)

Supp- Line : Car-Kind : Quan-Turn- : Size & Units: Height: Slot
lier : item : item: of : ti-: over : number: per : of : number
: or con-: Due-: Gen- : Specific
: : Date:Class: : : : : : 

bide : 19-10: : : : : (27 : : 

In the work sheet designed as shown above, an automotive wholesale supply firm had planned to receive 1620 gallons of anti-freeze due in on September 10, 1962. The information posted in each column is the basic data needed for planning the receipt and storage of the shipment.
Information posted in columns (1) through (5) is obtainable from the procurement department, and from the traffic management department of the receiving firm. Information posted in column (6) was determined on the basis of turnover experience for anti-freeze of the general type and quality as that being procured under Purchase Order A-345. The turnover classification indicated (III-F-2), is in keeping with the example shown in the schedule on page 127 above. The numerical designation (III-F-2) indicates that the turnover expected of the shipment will be at the median of the general classification of "Fast". This determination as part of the planning accomplished before anti-freeze arrives, permits the assignment of storage space so as to minimize handling requirements. Columns (7), (8), and (9) are also posted with pre-determined information. Assume in the example that the warehouse of the Acme Automotive Supply Company uses pallets and pallet storage racks for anti-freeze, brake fluids, oils, and other items similarly containerized, and that the design and construction of the racks was made to handle standard size pallets of 40 inches by 40 inches. Purchase negotiations determined in this instance that the Prestone anti-freeze would be packaged in cartons and that each carton would contain five one-gallon units. Purchase negotiations also determined that the shipment would not be palletized by the supplier and therefore a quantity of pallets as well as manpower would be needed to palletize the shipment in the rail car as an initial step in the unloading work. The pallet storage racks which the company had available to receive this shipment, were made to receive 40 inch by 40 inch pallets with load heights up to 40 inches. As posted in column (7), a total of 12 pallets was required.
This was determined by considering the measurements of the packaging and the number of cartons which could be placed on one pallet. In the example being used the height of a pallet loaded could not exceed 40 inches, and a suitable load was then planned for a height of 37 inches. The planner had a cubic area of 40 inches by 40 inches by 40 inches within which unit loads could be stacked. Each pallet could accommodate 27 cartons or cases in three layers of 9 each. As there would be five one-gallon tins in each case, a total of 135 gallons could be moved and stored on each pallet. The information posted in column (10) was determined in advance of the due date for the shipment so that the space needed could be made ready to receive the 12 pallet loads. The numeral III indicates a storage area coordinated with turnover; an area used for fast-moving items. The number 46 indicates a specific location within that area.

The warehouse planning work sheet described in the foregoing can be adapted to most receiving situations. It provides for a listing of the major needs and determinations required in the receipt from carrier, physical movement, and placing of goods in storage. Such work sheets could be designed to provide other information, as for example certain inventory data. In addition to the information showing quantities due in (column (5) on the planning work sheet), additional columns could be provided to show quantities on hand, physical count of quantities actually received, and then a third additional column to provide for running balances. The United States Department of Defense has designed warehouse planning work sheets to include information referred to as "Retail Data". These data pertain to pertinent retail or issue
experiences during the preceding 90 days, and this information is posted
to show quantities. Such information has planning value as it shows the
number of items shipped during a 90 day period. When used along with
a total of the quantity on hand added to the quantity to be received,
the planner gains in immediate picture of current turnover for the
particular good. Judgement must, however, be applied and seasonal de-
mands must be understood before reclassifications for turnover and for
storage space assignments are made. The item of anti-freeze used in
the work sheet shown above would probably show very little shipping
activity for the 90 days preceding the due date of September 10, 1962.
This would not reflect the activity which an aggressive wholesaler
would obtain for this item in the 90 day period coming after September
10.

2U. S. Department of Defense, Storage and Materials Handling,
Department of the Army, Technical Manual TM 743-200 (Washington: U. S.

A planning work sheet could also be developed to provide estimates
for manpower, fork lift truck and other equipment requirements for handling a particular shipment. This could be done by warehouse supervisors
with time determinations being made largely upon the basis of experience.
It could be done more scientifically and more accurately on the basis
of time study analysis. When planning is extended to cover the manpower
and equipment requirements a smoother operation results and there is a
better utilization of manpower and equipment.

In developing a planning work sheet for the handling of incoming
shipments, as well as the development of procedures for other supply activities, the participation of other responsible personnel is required. In drafting a warehouse planning work sheet for use within a particular firm, the advice and cooperation of the following offices should be solicited: (a) Accounting, including inventory control. (b) Organization and procedures staff. (c) Personnel management, including time and duty analysis. (d) Procurement. (e) Production management, if manufacturing activities are involved. (f) Sales management. (g) Traffic management.

Arrangement of stored items.—In general, an efficient warehouse operation requires goods to be stored so as to minimize costs for physical movement; so as to provide prompt identification; so as to preserve inventory investments; so as to facilitate record-keeping; and so as to facilitate the work of marketing and transportation personnel. To meet those general requirements, a number of factors are to be considered in arranging for storage.

(1) Costs are involved in the physical movement of goods and therefore changes in storage space assignments should be made, insofar as possible, in the course of receiving shipments.

(2) Similarities in goods should be considered in determining storage arrangements. Goods may have similarities for a number of reasons. They may be similar according to the industry in which they were produced. Example, anything derived primarily from forest products would be placed in the same storage grouping. This could result in axe handles and turpentine sharing the same bin. Another similarity could be the uses to be served ultimately by the goods. This would bring
saw blades and steak knives into the grouping for cutting tools. Storage similarities could also be developed along customer lines; goods resold to retail hardware stores in one grouping; goods resold primarily to schools and other public institutions in another grouping, and so on. When marketing effort and sales force management are organized along customer lines, this arrangement has more merit than might first seem possible.

(3) Popularity of a good as indicated by its turnover is an important factor in determining storage arrangements. The very active goods should be stored as near to the receiving area and as near to the shipping area as storage facilities will permit.

(4) Storage facilities for most goods need to be arranged with flexibility in mind. This is the case as a volume handled in one good may decrease, while both volume and turnover for another good may increase. There is also the problem of providing for the efficient and economical handling of new items.

(5) Storage arrangements for some goods may be determined largely on the basis of the types of equipment available for their handling. Some light weight goods may be moved by elevator to a top floor, even though their turnover records indicate that they should be stored near the shipping department. A common storage area might be maintained for bulky cumbersome items which could be moved best by a gasoline powered crane truck, even though such goods were similar in no other way.

(6) Hazardous materials may require assembly and storage in storage areas affording the especial protection required. Flammable goods would be an example.
(7) Sensitive items require special storage controls. Some items have a high unit value in relation to their weight and size, high resale values, and are subject to pilferage. Cameras, jewelry, precision tools, and timepieces are examples. Such items may require storage in locations where storage is more rigidly controlled.

(8) Some items are perishable and will deteriorate unless certain temperature and other conditions are maintained. Frozen foods are examples. It is essential also that records maintained for such items and procedures for shipping provide that oldest goods be shipped first.

(9) As may be the case with chemicals and pharmaceuticals, different trade names may be used for items of the same analysis. This can require the storage and handling of such items under an arrangement somewhat like that of an apothecary. This could require special storage arrangements and especially trained personnel.

(10) Physical capacities and limitations of storage space, equipment, and manpower available must be considered. Storage is not always accomplished under optimum conditions and warehouse management must evaluate and assess the strengths and weaknesses of that which is available to carry out its responsibilities.

Commodity grouping and the slot system. The systems of storage in use in warehousing today can be divided into two basic systems, the commodity grouping system and the slot system. Both are widely used, although the use of the slot system is increasing.

Commodity grouping is the segregation and storage of items along the lines of a pre-determined commodity or family grouping. In a wholesale food warehouse this would provide for all cereal foods in one place,
all health and beauty aids in one place, all soups in one place, and so on. In practice, this system is somewhat difficult to manage, as each item has an assigned location within its group. As an example, a storage space for the soup commodity would provide space for Heinz tomato soup and certain space also for Campbell's tomato soup. When buyers decide to add a new dry soup as for example, Knorr's, the warehouse employees may have to improvise in placing this new item in storage.

The commodity grouping system creates problems when warehouse management attempts to follow a shipping policy of last in, first out. To carry out that policy, wholesale food distribution centers have sometimes found it necessary to maintain reserve storage for new shipments and to then remove such items to commodity storage when the older stock had been depleted. This system may also result in a poor utilization of storage space, as assigned spaces are held open if expected stock replenishment is delayed for any reason.

This system does, however, have certain advantages. Warehousing operations facilitate the serving of customers. When the relationship between a selling firm and its customers is regular and likely to continue, the seller can arrange his storage to correspond with his customers' orders. A case in point would be a wholesale grocery serving independent grocers. It is characteristic that independent grocers will generally list items on their orders according to the layout of goods in their particular stores. There is also a certain amount of similarity in the layouts of independent stores located in the same grocery wholesaling area. When those similarities prevail, the wholesaler serving such stores can arrange his commodity groupings in the same
general order as they appear on customers' purchase orders. The cus-
tomer would provide a continuous listing of his requirements for canned
vegetables for example, on his order. The order picker assembling that
order would find all canned vegetables located in one storage area, in
one continuous location. This system is basically a simple arrangement,
but yet it is difficult to modify and adjust to change.

One modification which food chains have used in their distribution
centers was the placing of goods with medium and slow turnover records
in commodity groups and then placing the fast-moving items along the
assembly line. Incoming goods would then be placed partly in storage
and partly in groupings along the assembly line. The arrangement of
the fast-moving items along the line where orders were assembled,
could be made in family groups to correspond to the arrangement of
the goods in storage.\footnote{William H. Mesarole, \textit{Streamlined Wholesale Grocery Warehouses},
U. S. Dept. of Commerce, Industrial Series No. 18 (Washington: U. S.
Government Printing Office, 1945), p. 36.}

The assembly line is an arrangement of the active stock
so that the order picker can assemble individual orders
conveniently, rapidly, and at the least expense. It
consists of a proportion of the entire stock, in quan-
tities suitable for the order-picking routine for a
"turnover" period. The assembly line is replenished
from the reserve stock as the active stock becomes de-
pleted so that there is always available on the line a
supply of all goods necessary to fill orders.

When an assembly line is being set up it is therefore
necessary to divide the inventory in two parts. The
larger part is put in reserves, which are compactly
stored. Actually the assembly line usually can be set
up on half or less of the floor space, and consequently
when the line is suitably arranged, the order-picking
walk can be relatively shorter than when orders are
picked from all stocks everywhere in the warehouse.
The commodity grouping arrangement differs from a slot system in that the latter provides a better utilization of storage space, is more easily adjusted to change, is easily geared to the controls and marketing analysis which can be provided by electric accounting machines, but requires better training for its operating personnel. In the physical handling and storage of goods, the major difference between the slot system and the older system is that goods are assigned and occupy locations known as slots and that the quantity of a particular variety of goods on hand may be divided up in two or more slots or locations. The assignment of goods to a storage space in the slot system is determined mainly on the basis of space utilization so as to minimize handling and other costs. A slot is not necessarily an especially designed storage rack or other installed equipment. A slot for warehousing purposes may be an area of floor space with a number stenciled on the floor; it may be an area between two building supports sometimes called a bay; or, it may be the storage space of one pallet rack. In view of the importance of physical distribution in our economy, the fact that slot systems may not require the installation of special storage racks or other expensive adaptations should be more widely disseminated in the marketing literature. Many storage operations not presently using the slot system should explore its possibilities. Literature reviewed in this study suggests that the basic principles of a slot system are not widely understood.

In adopting the slot system, all storage areas would be numbered systematically. Those numbers would remain constant and incoming shipments would be assigned storage space by a number. Subsequent shipments
of the same good could be assigned to a different slot number. In a 
warehouse handling green coffee in bags, one lot could be stored in slot 
1201, and another lot could be in slot 3526. Where the accounting system 
employed provides controls showing dates of acquisitions by slot number 
for each variety of goods handled, the work of selecting and shipping 
the oldest stock first is facilitated. The selection of items to fill 
a customer's order is not as complicated as a first look at the slot 
system might indicate. The systematic use of numbers is carried into 
groups which may contain any number of slots. A warehouse, for ex-
ample, with six bays connected in the center with unassigned space used 
for order assembly movement and other work, could have 1000 slot numbers 
assigned to each bay. The three bays on one side could have slots 
numbered from 1 to 999, from 3000 to 3999, and from 5000 to 5999. On 
the even-numbered side the slots in those three bays could be numbered 
2000 to 2999, 4000 to 4999, and from 6000 to 6999. By using Xerox copy-
ing equipment, or other office copiers, six copies of a customer's order 
could be made available so that selection of goods in all bays could be 
accomplished at the same time in filling a particular order. In some 
situations this arrangement would require a comparison of each order 
with record controls to identify each line item with the particular 
stock, identified by slot number, from which selection is to be made. 
Annotations indicating that information should be made on an order 
before it is reproduced. 4

4David Gardenier, "A Summary of the Slot System of Grocery Ware-
house Operation", I.S.M. Department of Education, Customer Administration 
Program. An article reprinted from The Voluntary and Cooperative Groups 
Magazine, courtesy of Cook Publications.
In the interest of achieving efficiencies in warehouse operations, Mr. William H. Meserole, President, Ballinger-Meserole Company of Philadelphia, has developed what he terms the ton-mile principle. This principle is based upon a finding of Mr. Meserole, that in the handling of processed foods, 20 per cent of the items carried will account for approximately 80 per cent of the movement. A first step in his approach then would be to determine the 20 per cent of a given stock which has the greatest turnover and consider such items first in the layout planning. The ton-mile principle in application is more specifically the location of goods in an order-picking sequence that takes into consideration their cost contributing characteristics of weight, bulk, and demand. The light, small, and slow-moving items are placed in storage spaces most distant from the receiving and shipping areas. The goods which have characteristics of being heavy, bulky, and fast-moving, are located at the end of the assembly line which is nearest the shipping dock. There is a weakness in this method which can cause damage to goods during internal movement. The light and small items are at the far end of the assembly line, which is the start of the line for order-picking purposes. The small and light weight items handled may not be palletized, they may be contained in packages of irregular shape, and the goods may be inherently fragile.

In the arrangement described above such goods would be the first items placed on the warehouse platform trailer or other equipment used to move the order for final checking and forwarding. Such items could be crushed or damaged in the process of order-filling by heavier goods which may be selected and added to fill an order. Training and the
use of special hampers or cartons should, however, delimit that risk.\footnote{William H. Meserole, "Slot Number Please!", I.B.M. Department of Education, Customer Administration Program. An article reprinted through courtesy of Wholesaler Grocer News.}

The 45 degree slot compared with the 90 degree slot. The inside of a modern warehouse shows stored goods built up on vertical lines and extended along horizontal lines. The inside of a well-managed warehouse which handles packaged goods, suggests a square world. Pallets are square or rectangular, and goods placed upon them are leveled off whenever the packaging will permit. There is a geometric pattern to the arrangement of aisles and their right angle intersections. When bins and pallet racks are installed, they are erected in a square and perpendicular way. In keeping with this square pattern it has been a general storage practice to continue the 90 degree arrangement in the placing of pallet loads. The right angle has been used whether the pallet loads were positioned in storage racks or placed on the floor. When so stored the operator of the fork lift truck must maneuver his vehicle into a position that is crosswise to the traffic aisle which is his roadway. Similar maneuvering is necessary when the truck is used to remove pallet loads from storage for shipping, or in the relocating of inventories. This takes time and from an observational viewpoint does not appear to be the most efficient arrangement.

The standard fork lift truck has been designed and constructed with its lifting attachment on the front and pointing in the same direction as the front wheels. This arrangement requires the operator
of this piece of equipment to position it directly in line with a pallet load which is to be moved and then move it toward the unit load about 36 inches after the lifting fork had been lined up with the pallet opening. Fork lift trucks of the usual design and having a 2000 pound capacity have required 9 foot aisles in order to handle loaded pallets at right angles. The use of so much space in the layout for aisles has prompted the positioning of pallet loads at a 45 degree angle in some warehouses. With this arrangement, fork lift trucks of the same size and capacity could handle loads in a 6 foot aisle.  


The use of 6 foot aisles to replace 9 foot aisles would seemingly result in a considerable saving of floor space in most warehouses. Warehouse managers using 6 foot aisles in conjunction with 45 degree stacking have found, however, that this arrangement creates other problems. The saving of a 3 foot strip running the length of each aisle is not a net gain of space. The unit loads, positioned in this way, create a saw-tooth line rather than a line flush with the aisle. This represents lost space, but the most significant loss is in the loss of pallet facings. Accessibility is important in the warehouse as it is in retailing. With the handling of more goods and wider ranges in the variety of items, arrangements which tend to decrease accessibility are usually not desirable. A study conducted by two officials of the Agricultural Marketing Service, United States Department of Agriculture,
found that in a storage space of 1408 square feet, the 90 degree placement of unit loads provided a better utilization. With pallets facing the aisle at the usual 90 degree angle, the space would accommodate 128 pallet loads arranged with 64 facings. A rearrangement of that space to 45 degree facings, reduced the storage space of that area to 110 pallet loads with 44 facings.\(^7\)


The major disadvantages in the 45 degree arrangement are in the loss of space, the requirement of one way traffic in the aisles, and in the irregular alignment of goods. A compromise arrangement permitting 90 degree facings, 6 foot aisles, and ease of truck handling can be had with the use of a sideloading type fork lift truck which can handle 40 inch by 32 inch pallets in 6 foot aisles. Warehouse managers considering the procurement of new equipment for their storage facilities and who need to gain space through a reduction in aisle widths, would be advised to consider a piece of equipment of this type. It must be pointed out, however, that pallets 40 inch by 32 inch are smaller than most in use today, and the unit loads handled would be less if an operation had previously used larger pallets of say 40 inch by 40 inch.

**Identification and selection of stored items.** The primary reason for the proper identification of stored items is in the need to fill customers' orders promptly with the goods desired and in the quantities desired. A second reason for proper identification is in the record
keeping required and the need to reconcile from time to time the results of physical inventory counts with record balances. A commercial firm must know what it has on hand and should have reasonably firm figures showing balances for each item in the inventory investment. Such information is needed for marketing management, for procurement management, for financial management, and for general management purposes. Manufacturing firms require similar information for much the same reasons.

For most warehouses during the next decade, the selection of items to fill orders and the identifications necessary in physical inventories will require manual inspections and human determinations. Personnel will continue to be an important part of the management mix of men, materials and machines, although the ratio of men to machines will certainly get smaller as technological advances continue. But the complete elimination of manpower in the identification and selection of goods is not now foreseeable, and so improvements in the accomplishment of that work can be had from developments that include personnel. Such developments would include the following.

(1) Selection and assimilation of personnel.

(2) Continuous training of personnel in which new products and new procedures would be explained.

(3) Personnel specialization when possible and when feasible. Making work assignments so as to use the interests and aptitudes of individual employees to the best advantage.

(4) Established procedures, with also the established practice of periodic review, and revision when needed.
(5) Use of stock number designations for popular and for standard items.

(6) Use of slot or other storage space numbering.

(7) Improving the quality of order-checking.

It is difficult to generalize with respect to the seven possible development areas listed above, and this is especially the case for those that deal directly with personnel. Specific training programs would need to be planned for specific situations. But one significant general suggestion would seem to be appropriate. It is the general need of warehouse employees to be assured that their work is important and that they are making contributions to the goal attainment efforts of their firm. This could be done as part of the continuous training program. In a warehouse serving a commercial firm, the cooperation of the sales manager could be solicited for the purpose of an occasional short talk as part of a training session. In such brief meetings, the marketing executive could stress the importance of warehouse activities in the attainment of marketing objectives. More specific information could be furnished from time to time by selected salesmen. They could build short talks around the relationship of a good order-filling performance to the success of customers in their territories, and such information could be spiced with actual experiences. In situations where the warehouses maintain stores to support manufacturing operations, the cooperation of production officials would be solicited.

Informative sessions which explain the involvement of warehousing with other activities of a business firm, can be of benefit for at least four reasons: (a) Positive effect upon morale (b) Warehouse employees
gain appreciation of the aims and purposes of their employer (c) Understanding can be gained that warehousing work is integrated with other activities (d) The importance of serving customers is stressed.

The best performance of an individual worker in the identification and selection of stored items may not be had unless he has technical knowledge necessary to make correct identifications and selections; has procedures which provide for orderly accomplishment of selection; has necessary tools and equipment for a profitable work performance; maintains some degree of positive morale.

All phases of work incident to the classification, arrangement, location, and identification of stored items are essential to the marketing success of any firm. Such work activities require managerial attention also because their performance is reflected in cost totals which appear on operating statements. Very few, if any, warehouse operations in our economy have no possibilities for improvement. Warehouse management needs to be forward looking, to keep up with change, and to plan innovations which can improve marketing effort. This is not to suggest that sweeping changes in order to effect a fast modernization will be profitable or desirable for all storage operations. All planned changes need to be considered carefully and evaluated against the expected results. The expected results must then be assessed in the light of warehouse goals as well as company objectives.
CHAPTER IX

POSSIBLE DEVELOPMENTS WHICH WILL AFFECT WAREHOUSING

Warehousing is affected by other developments and by leadership. The warehouse is not an operation that can be planned and set up for a continued performance of its activities without change. The need for the performance of its activities is derived from commercial and industrial opportunities which are in turn derived from demand. Demand is not a fixed matter, and with respect to a particular good needs to be assessed in terms of propensity it may have to increase or decline.

Attempts to assess demand and determine the actual effect it will have upon the sale of a particular firm’s goods is sometimes difficult to do. It is difficult because effective demand stems from the wants and needs of persons who are capable of choosing and making selections from a variety of goods and service offerings, and who are also in a position which allows them to obligate funds in exercising choice. This complicates the work of sales planning in a particular firm, as the exercise of choice may operate to shift an effective demand to goods offered by a competitor within the same industry. When the exercise of choice points the demand toward the offerings of other business firms, a firm finding its goods rejected must ascertain why others are more responsive to the demand. It is to be recognized also that all shifts in demand do not occur within the same industry. Buyers are
continually finding that wants and needs can be satisfied by goods produced in other industries. Clothing manufacturers, for example, have shifted a part of their demand for materials from natural fibers to man-made fibers coming originally from the chemical industry.

The need for warehousing is derived from demand. Adjustments made by selling firms to respond to demand may require changes in activities incident to the storage function. Other developments will have an effect upon warehouse management. To attempt to list all of them at this time would be futile if not impossible. The developments that will have an effect upon warehousing, are all the changes which may evolve in marketing. In a brief list under broad headings would be found the following areas of development which long range planning for warehouse operations would need to take into consideration:

1. State of the economy in general
2. Incidence and nature of existing demand
3. Future prospects of seller's industry as well as those of industries represented by customers
4. Changes in the institution of retailing
5. State and condition of the industrial arts as this may lead to new goods and improvements in old ones
6. Technological activities in materials handling, in electric record controls, and in any combination of the two
7. Warehousing customs of the particular seller's industry
8. Quality of marketing management in both the seller's and customers' industries
(9) Technological activities in the container and packaging industries

(10) Technological activities in transportation

(11) Supply and demand developments in world trade, including public policy in that regard.

It is a matter of record that changes have been occurring in all the foregoing. If recorded events and happenings are the stuff of history, and history is prologue, then executives responsible for long range planning need to understand the course of business history as this affects the attainment of objectives by their respective firms. It has been stated that great leaders were men who met the current problems of their time and were successful in most of those meetings. In order to do so, they had to maintain some alignment with the conditions of their times. The same can be applied to successful business leaders. History accords greatness to leaders who were associated with change. This is the case whether the leadership is in government, in industry, or in commerce. In the exercise of leadership to bring about change, the successful leader must view the general pattern of conditions which he desires to change as having two parts. There is first a set of conditions which he cannot change; he does not have the abilities, the resources, or the time to redirect them in any effective way. His energy and resources are then concentrated upon a second set of conditions. It is in this area that the successful leader makes changes which result in gains for his organization. His rating of success comes in time from the gains that he can put into the record rather than from the changes which he instituted to bring about the gains. The business leader needs to
recognize, understand, and distinguish the second set of conditions from those which he can do nothing about. By directing his energies and the resources made available to him, to a reasonably successful solution of the problems that arise within the scope of his responsibility, he helps to assure achievement of objectives.

The warehouse manager is a leader and must give direction to personnel of his organization to the end that effective results are obtained. Within the scope of his authority and responsibility he can institute a variety of changes in carrying out the work of receipt, storage, and issue of goods, and in the development of an organization to meet future needs in those areas. The warehouse manager is of course subject to the direction and quality of the leadership to which he reports. If his top management seems uninterested in the warehouse operation, he could quite easily accept this attitude as a directive to perform only a minimum of work. No requests for staff assistance in planning would be made and no budget proposals for new equipment would be submitted. The successful warehouse manager will of course follow a more positive course of action.

A concept which has provided one approach in the study of psychology has been termed the "black box". Researchers in keeping with this concept would be concerned only with stimulus and reaction. Their observations of an organism would be concerned with identification and recognition of stimuli and the reactions which resulted from each. What went on in the organism between a stimulus and the resultant reaction was considered a "black box" matter into which there was no absolute necessity for probing. The analogy can be drawn that a top
management that does not provide leadership, direction and support for its subordinate warehouse management, is operating in keeping with a "black box" concept. This would be the case where a management is concerned only that its warehouse operation be able to receive and store all procurement, and then be able to somehow find and draw out the goods required to fill customers' orders or production bills of materials. In such situations what went on within the warehouse beyond the receiving dock and the shipping dock would be a "black box" matter.

The "black box" concept in warehouse management is inconsistent with modern developments in business administration. Current organizational theory points up the need for each business firm to create structures and relationships in keeping with some clearly established objectives. A purpose of the structures and relationships is to effect an integrated performance of all necessary activities to the end that objectives are attained. Work activities performed within a warehouse are essential to any objectives of serving customers, and need to be fitted into the total management plan as the following statements imply.1

When you administer by objectives, you involve all the key people in your organization in the determination of objectives, in the working out of plans and policies, and in the formulation of detailed plans of operation.

. . . . .
Fixing your objectives is like identifying the North Star - you sight your compass on it and then use it as a means of getting back on the track when you tend to stray.

It is just as important to realize what objective-fixing is not. It is not as precise as a railroad timetable. It does not tell you how to deal with unforeseen contingencies such as depressions, the appearance of a new line of goods or a new competitor. In other words, clear
objectives are never a substitute for constant vigilance and constant thought and care. Objectives, like organization, are constantly in need of redefinition.


The developments of modern management stress the need to involve all key personnel in planning for the attainment of objectives, as well as in the subsequent steering of the firm's work activities. The warehouse manager is very much involved in both. He must plan for the handling and movement of the volume and variety in it that will be required for the attainment of objectives. As redeterminations must sometimes be made by management with respect to objectives, the warehouse operation needs to be flexible and capable of making the necessary adjustments.

In their efforts to emphasize total organization for the attainment of clearly established objectives, the management theorists have drawn attention to the importance of customer satisfaction. This has caused more consideration to center upon the goods involved; how they are made available and handled so as to pass into customers' possession.

Another development which appears to be having a more direct influence upon improving the organizational position of the warehouse is more technical in nature. Encouraged by the results of operations research in World War II shipping, some business firms have applied mathematical tools to business problems involving storage and inventory control.

Developments in organizational theory which embrace the warehouse activities, and the application of mathematics to inventory control and related problems, are placing the storage function under new light. Progressive managements recognize the importance of their warehouses in providing goods when needed, and they are also viewing new possibilities for cost reductions. All developments affecting future operations in warehousing, indicate that the receipt, storage, and issue of goods and materials call for a performance of activities that may not be left to chance. They must be planned for and carried out within the general planning of the firm.

Work in marketing and in related disciplines.-The need for industrial and commercial storage is as old as commerce. The requirement to store materials for productive purposes became a real need after the beginnings of commerce. Buildings to store things are not a new development. They have been a requirement since the dawn of civilization. The study of marketing by comparison is very young. The significant literature in marketing has been published within the last 40 years. The accomplishments of marketing scholars are especially noteworthy when measured against some of the old entrenched ideas that had to be refuted or down graded. As an example, there was Say's Law which held that production creates its own demand. If that were the case, the marketing effort essential to a progressive free enterprise economy would not have developed. Another example was the belief, sometimes attributed to Ralph Waldo Emerson, that a concentration upon quality in production would assure distribution; that customers would make a hardbeaten road to the house of a man who had better goods to sell.
The pioneers in marketing had to make a case for the distribution of goods. Business history can show innumerable examples of goods that failed to gain the customer support needed for their continued production. Many of those goods were not inferior in quality.

The case for marketing has been made and its position as a separate discipline is now well established. Laws passed by the Congress of the United States and by state governments have reflected a recognition of the importance of marketing. It is interesting to note, however, that marketing scholars have not shown a great exploratory interest in that phase of physical distribution which includes the activities of warehousing. This has been a part of the general lack of interest which academicians have shown for the subject of wholesaling. Marketing literature has provided only one textbook sufficiently definitive and suitable for advanced courses in the area of wholesaling. This becomes more surprising when it is found that compartmentalized interests do exist in the problems of inventory control, handling, and storage; at the present time they are increasing. Periodical literature and other published material reveal work in connection with warehousing problems in which approaches, utilizing techniques and tools of other disciplines have been made. The disciplines of accounting, architecture, economics, engineering, mathematics, and transportation may be mentioned in that regard. This can become a significant development when marketing men assemble, analyze, and evaluate so as to provide a continuing synthesis for the pertinent information that will be generated in other areas of specialization.

Cost reduction—Interest in reducing the costs of physical
distribution is not new. Buyers have long been concerned with the difference between what they pay for a good and what it costs a producer to make each unit of that good available at the end of his production line. The so-called marketing costs have been subject to much criticism and have been offered as evidence of inefficiencies in the distribution system. Marketing costs have not been fully understood and this is one reason for their unpopularity. Marketing cost can, however, become a popular subject for an executive who can offer methods and procedures for reductions. The popular side of marketing cost is still the cost reduction side.

A part of the total cost of distribution has been the expenses incurred for transportation. Sellers are well aware of customers' interest in landed cost and so pressures for reduction in shipping rates have come from two sides. A study of rates approved by the Interstate Commerce Commission will reflect some of the pressures that were applied to reduce rates for specific commodities and for specific classes of goods. A study of current activities in requests for rate changes would indicate the continuing interest in rate reductions. Quantities of goods, distances of their movement, and their classification for rate purposes must be considered when economies are sought in shipping. Storage facilities at both the point of origin and at destinations need also to be considered. This is a matter of concern in operations research and in linear programming. It has long been a matter considered in merchandising planning. What can be done in a warehouse is an important matter to be considered in planning for economical shipping.

The subject of cost reduction has singular appeal. It is
difficult to imagine a sales presentation for a piece of materials handling equipment that does not include a promise of cost reduction. Available literature pertaining to warehouse automation and mechanization indicates that the promise of cost reduction was an important factor when decisions were made to procure such systems. Quite often such promises were fulfilled. But it should be stressed that the procurement of labor-saving devices may not in itself reduce costs. Cost reductions in a warehouse result from a better performance of essential activities. The following statements made in June, 1958 by Dr. Herman C. Nolen, President, McKesson & Robbins, Inc., are appropriate in that regard.  

The wholesalers' adjustment to rising costs in distribution is less dramatic but, I believe, even more effective. Like all businessmen, wholesalers have a constant battle to keep their cost in line and I think they are doing a good job in pursuing the majority of the conventional methods of keeping down expenses, such as increasing merchandise turnover, eliminating waste, and the like. However, there are certain areas in cost cutting in which the wholesalers have made great progress in the last few years. One has been in the simplification of warehouse and office jobs. Wholesalers, as experts in distribution, have done an outstanding job in eliminating wasted motion and effort. For example, if you will pardon the reference to my own company, in the past three years we are handling one third more tonnage with 9 per cent fewer people in our offices and warehouses. In my opinion, that is quite an achievement in an industry that is not highly mechanized. That increase in production has been achieved largely by getting people to do their jobs better and not by the introduction of labor saving machinery.

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Developments in cost reduction indicate that the successful application of labor-saving equipment and the institution of new procedures must follow an evaluation of existing warehousing facilities. In studies conducted by marketing specialists in the United States Department of Agriculture, certain cost reduction determinations were made. 4

Case A.—The authors studied the warehouse operations of a grocery wholesaler who sponsored a voluntary group of retailers. His warehouse was a 2-floor building having approximately 40,000 square feet of storage space. His equipment for handling incoming and outgoing shipments consisted of 4-wheel hand trucks and a freight elevator. He rented additional storage space at a cost of $6,000 per year, an expense which could be eliminated with installation of a conveyor system. His business volume had grown steadily for several years.

Estimates indicated that the volume in this instance could be handled in a 1-floor warehouse having 30,000 square feet. It was further estimated that land and construction costs for this new building, including pallet racks, would amount to $220,000 which could be amortized for 20 years at 4.5 per cent interest. Two fork lift trucks would be required. These trucks and the necessary pallets would cost a total of $21,000 which depreciated over a 5-year period would result in an annual cost of $4,200. Other estimates were made and compared with existing warehouse costs as shown in Table 1.
TABLE 1.—A Comparison of Annual Warehousing Cost in a 40,000 square foot multi-story Warehouse with Estimated Cost in a New 1-floor Warehouse both with a Business Volume of $2.5 Million

<table>
<thead>
<tr>
<th>Annual expense item</th>
<th>Existing warehouse</th>
<th>New warehouse</th>
</tr>
</thead>
<tbody>
<tr>
<td>Facility cost</td>
<td>$6,000.00</td>
<td>$16,698.00</td>
</tr>
<tr>
<td>Equipment depreciation</td>
<td>$4,200.00</td>
<td>$4,200.00</td>
</tr>
<tr>
<td>Supervision</td>
<td>$6,500.00</td>
<td>$6,500.00</td>
</tr>
<tr>
<td>Insurance and taxes</td>
<td>$4,550.00</td>
<td>$4,510.00</td>
</tr>
<tr>
<td>Labor</td>
<td>$81,000.00</td>
<td>$40,500.00</td>
</tr>
<tr>
<td>Total expense</td>
<td>$98,050.00</td>
<td>$72,408.00</td>
</tr>
</tbody>
</table>

Estimates were also made in the situation identified as Case A to determine cost reductions that could be secured from the installation of a conveyor system in the existing 2-floor warehouse. Comparisons are shown in Table 2.

TABLE 2.—Estimated Annual Warehousing Cost Using Present Methods Compared with a Conveyor System in a 40,000 square foot 2-floor Warehouse both with a Business Volume of $2.5 Million

<table>
<thead>
<tr>
<th>Annual expense item</th>
<th>Present methods</th>
<th>Conveyor system</th>
</tr>
</thead>
<tbody>
<tr>
<td>Facility cost</td>
<td>$6,000.00</td>
<td>$19,955.00</td>
</tr>
<tr>
<td>Equipment depreciation</td>
<td>$4,200.00</td>
<td>$4,200.00</td>
</tr>
<tr>
<td>Supervision</td>
<td>$6,500.00</td>
<td>$6,500.00</td>
</tr>
<tr>
<td>Insurance and taxes</td>
<td>$4,550.00</td>
<td>$4,510.00</td>
</tr>
<tr>
<td>Labor</td>
<td>$81,000.00</td>
<td>$31,000.00</td>
</tr>
<tr>
<td>Total expense</td>
<td>$98,050.00</td>
<td>$69,250.00</td>
</tr>
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</table>

In the case history to which Table 2 pertains, the wholesaler was able to install a conveyor system for $19,955.00 ($636 below estimated cost), and with the institution of changes in work methods, secured an annual reduction in warehouse operating costs of more than $33,000.00.

Case B.—The warehouse here was one of a grocery wholesaler who sponsored a voluntary group of retailers consisting of some supermarkets.
and some smaller stores. He used warehouse space of approximately 47,000 square feet; a main warehouse with 32,000 square feet on 3 levels; and 15,000 square feet in three additional and separate buildings. This firm had an annual volume of $8 million. The business volume had been showing rapid growth and warehousing activities were performed on a 24-hour basis.

Land, railroad siding, construction, and installation of pallet racks for a new one floor warehouse suitable for this firm's volume would cost $525,000. At 4.5 per cent interest, amortization over a 20 year period would set up an annual cost of $39,850. A supply of pallets, 1 additional fork lift truck, 3 small tow tractors and other equipment needed would cost a total of $35,000 that could be set up on a 5-year depreciation schedule. An expense comparison of the proposed new facility with the existing warehouse is shown in Table 3.

TABLE 3.--A Comparison of Annual Warehousing Cost in a 47,000 square foot Multi-story Warehouse with Estimated Cost in a New 1-floor Warehouse with a Business Volume of $8 Million to be Handled in each

<table>
<thead>
<tr>
<th>Annual expense item</th>
<th>Existing warehouse</th>
<th>New warehouse</th>
</tr>
</thead>
<tbody>
<tr>
<td>Facility cost</td>
<td>$ 8,000.00</td>
<td>$39,850.00</td>
</tr>
<tr>
<td>Equipment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>depreciation</td>
<td>$0.00</td>
<td>$7,000.00</td>
</tr>
<tr>
<td>Insurance and taxes</td>
<td>$7,100.00</td>
<td>$4,500.00</td>
</tr>
<tr>
<td>Supervision</td>
<td>$6,500.00</td>
<td>$6,500.00</td>
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<tr>
<td>Labor</td>
<td>$88,452.00</td>
<td>$38,329.00</td>
</tr>
<tr>
<td><strong>Total expense</strong></td>
<td><strong>$110,052.00</strong></td>
<td><strong>$96,179.00</strong></td>
</tr>
</tbody>
</table>

It is to be noted that the most interesting comparison in Table 3 is in the item of labor. The wholesaler in this case decided to build the new warehouse and in addition to the promise of a labor cost reduction, his decision was influenced by the following factors: (a) New
warehouse could provide for handling of an increased volume of business. (b) It would eliminate need for smaller branch facilities and this would make for better control. (c) In new warehouse, efficiency of labor would increase as volume increased. (d) Additional space would be provided for frozen food. (e) Land site available might not be available at some future date. (f) New warehouse would give firm more prestige with customers and with the public.

Case C.—A third business situation studied was also that of a grocery wholesaler serving voluntary groups of retailers. The annual volume was approximately $17 million in dry groceries. Wholesaling operations were conducted in 5 multi-floor buildings located in a congested area, although a total of 140,000 square feet used for storage was in two of those buildings. The two storage buildings were joined by bridge plates between opposing doors at the first and second floor levels. Incoming merchandise was palletized and moved from rail cars and highway trailers by fork lift trucks. Outgoing merchandise was assembled on 4-wheel hand trucks. Three freight elevators were in operation for movement between floors. The firm had experienced a steady growth in its business.

Estimates for a new 1-floor warehouse for this operation was for 188,000 square feet of operating space, which could handle a volume up to $25 million. Land, construction, railroad siding, and installation of pallet racks would cost $1,250,000. That total included office space needed by the firm. Amortization of that investment over a 20-year period at 4.5 per cent would create an annual cost of $94,875. The new warehouse would require an additional investment of $65,650.00 for new equipment. On the basis of 5-year depreciation schedules, the annual
The cost for new equipment would be $13,130. An expense comparison of the proposed new warehouse with the existing warehouse facilities is shown in Table 4.

**TABLE 4.**—A Comparison of Annual Warehousing cost in a 140,000 square foot Multi-story Warehouse with Estimated Cost in a New 1-floor Warehouse with a Business Volume of $17 Million in Dry Groceries

<table>
<thead>
<tr>
<th>Annual expense item</th>
<th>Existing warehouse</th>
<th>New warehouse</th>
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<tbody>
<tr>
<td>Facility cost</td>
<td>$0.00</td>
<td>$94,875.00</td>
</tr>
<tr>
<td>Equipment depreciation</td>
<td>13,130.00</td>
<td></td>
</tr>
<tr>
<td>Insurance and taxes</td>
<td>27,600.00</td>
<td>27,485.00</td>
</tr>
<tr>
<td>Supervision</td>
<td>6,500.00</td>
<td>6,500.00</td>
</tr>
<tr>
<td>Labor</td>
<td>238,000.00</td>
<td>80,500.00</td>
</tr>
<tr>
<td><strong>Total expense</strong></td>
<td><strong>$272,100.00</strong></td>
<td><strong>$222,490.00</strong></td>
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The most interesting comparison in Table 4 above is in the item of labor, which suggests considerable labor inefficiency in the existing warehouse. The wholesaler in this case completed plans for construction of the new warehouse and decision to do so was influenced by the following reasons: (a) Reduced labor costs. (b) Long term potential annual savings. (c) Existing warehouse buildings would require increased maintenance costs in the future. (d) Overcrowded operating conditions would increase as volume increased. (e) Prospects of acquiring additional space in downtown area were not good. (f) At new site, space would be available for handling fresh fruit and vegetable needs of customers. (g) New facility would build company prestige with the trade and with the public.

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The goods handled in the studies identified as Cases A, B, and C, were largely dry groceries and the customers were independent grocers affiliated with the wholesaler in each case on a voluntary basis. Presumably there were no compelling reasons for these wholesalers to remain in old locations. As the authors did not go into the matter of delivery costs, it is assumed that they would not be significantly different in new locations. Studies of this kind need also to look more intently at the financial records of existing warehouses. Tables 1, 2, and 3, for example, show only facility costs of renting additional storage space. Table 4 shows zero dollars as the facility cost of existing warehouse. The data are not completely realistic in that regard. Even when existing investments in buildings are completely amortized, there is need to consider the economic matter of opportunity costs. A completely paid up investment in a building having a current market value of say $100,000, represents an annual opportunity cost when other investment possibilities are considered. The sum of $100,000 invested in 5 per cent bonds, would, for example, provide an annual return of $5,000. Planning involving new storage facilities should also consider the dispositions which could be made of old buildings and the capital they may provide.

Studies conducted by the Department of Agriculture, and by other governmental agencies, are important and they make valuable contributions to our store of marketing knowledge. A number of such studies have pointed the way toward cost reductions through work simplification and more efficient handling. Government policy will no doubt provide for a continuation of that research. Pertinent studies and reports
emanating from governmental sources can be of benefit to warehouse operators who wish to consider all cost reduction possibilities.

In general, benefits to commerce and industry made available by government-sponsored research are being distributed or made known by intermediaries. The results of such research are reported initially in marketing research reports, booklets, and monographs, printed and procurable from the United States Government Printing Office, Washington, D. C. Except for some direct mail advertising, a descriptive listing of the articles in the Marketing Information Guide, and occasional displays made by Field Offices of the United States Department of Commerce, the efforts to distribute such new information are not extensive. The efforts needed to make such research known and adaptable to specific business situations, is presently the work of others.

Some business firms, especially larger ones, maintain staff personnel who engage in the study of new business developments including those that pertain to physical distribution. They consider information coming from government as well as from industrial, commercial, and educational sources. Smaller firms usually do not have staff specialists of that kind. If the smaller firms learn of developments that could permit them to reduce handling and storage costs, they usually do so from some intermediate source. To fill the position of middleman in the channels of information, a number of specialized firms have come into existence or have expanded their efforts to include special distribution problems of clients. The Ballinger-Meserole Company in Philadelphia is an example. Other distributors of information pertaining to new developments are the sales departments of manufacturers that produce
materials handling equipment; they make use of selected information for obvious reasons. Trade associations, as for example the Wooden Pallet Manufacturers Association, make a distribution of selected data. Architectural-engineering firms also have made use of data pertaining to warehouse building changes.

Developments in warehousing at the present time, as indicated by pertinent information from a variety of sources, indicate that cost reductions will be secured from the following general areas:

1. More suitable locations, considering both the handling and merchandising requirements
2. More suitable buildings
3. Better balance in inventories
4. More attention to the application of machinery and machine-oriented procedures to existing handling problems
5. More attention to training of personnel
6. Improvement in record controls.

Cost increases.—It is common knowledge that costs have been rising. The cost of building equipment as well as that of both skilled and unskilled labor needed in construction have risen considerably since World War II. Operational costs have also risen. Pressures for price and wage increases come from a variety of sources, but exploration into such areas is not within the aims and purposes of this study. A tabulation of employment and earnings data compiled originally by the Bureau of Labor Statistics, United States Department of Labor, indicate wage increases in activities which include work in warehousing.
TABLE 5.—Average Weekly Earnings and Average Weekly Hours of Production Workers in two Selected Industries for the Years 1950 through 1961

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<tr>
<td>Motor</td>
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<tr>
<td>ation ($)</td>
<td>108.16</td>
<td>104.17</td>
<td>102.12</td>
<td>96.33</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
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<td>n/a</td>
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<tr>
<td>age (Hrs)</td>
<td>41.6</td>
<td>41.5</td>
<td>42.2</td>
<td>41.7</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>Whole-($)</td>
<td>93.56</td>
<td>91.13</td>
<td>90.27</td>
<td>87.02</td>
<td>84.42</td>
<td>81.20</td>
<td>77.55</td>
<td>73.93</td>
<td>71.69</td>
<td>67.80</td>
<td>64.31</td>
<td>60.36</td>
</tr>
<tr>
<td>sale</td>
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</tr>
<tr>
<td>Trade (Hrs)</td>
<td>40.5</td>
<td>40.5</td>
<td>40.3</td>
<td>40.1</td>
<td>40.2</td>
<td>40.4</td>
<td>40.6</td>
<td>40.4</td>
<td>40.5</td>
<td>40.6</td>
<td>40.7</td>
<td>40.7</td>
</tr>
</tbody>
</table>

Source: Pertinent issues of the Monthly Labor Review
As indicated in Table 5, compilations were not available for an industry termed, motor freight, transportation and storage for the years prior to 1958. The data for that industry from 1958 through 1961 do, however, show a steady rise in weekly earnings, with an eveness in the average number of hours worked each week. The wholesale trade figures of which annual averages were compiled for the years 1950 through 1961, show a progressive rise in weekly wages from $60.36 to $96.56. It is interesting to note that the average number of hours worked each week was remarkably even during that period.

These data indicate that the hourly rates have been rising for work which includes the performance of warehousing activities. This might seem to suggest that increasing productivity in the two industries had brought about a reduction in the number of employees. Data secured from the same source and recast in Table 6 will show, however, that employment in both industries has been rising steadily. This indicates that automation and mechanization have not operated to reduce the total number of persons employed in the two industries. In absolute figures the total number of persons at work in those two industries is increasing.

A steadiness in employment throughout a twelve month period is indicated by figures in Table 7.
TABLE 6.--Annual Average Number of Employees in non-agricultural Establishments in two Selected Industries During the Years 1950 through 1961, in thousands

<table>
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</tr>
</thead>
<tbody>
<tr>
<td>Motor Freight and Storage</td>
<td>875</td>
<td>874</td>
<td>848</td>
<td>793</td>
<td>812</td>
<td>804</td>
<td>763</td>
<td>720</td>
<td>724</td>
<td>699</td>
<td>676</td>
<td>584</td>
</tr>
<tr>
<td>Wholesale Trade</td>
<td>3008</td>
<td>3009</td>
<td>2941</td>
<td>3013</td>
<td>3065</td>
<td>3008</td>
<td>2856</td>
<td>2796</td>
<td>2782</td>
<td>2743</td>
<td>2655</td>
<td>2544</td>
</tr>
</tbody>
</table>

Source: Pertinent issues of the *Monthly Labor Review*
TABLE 7.--Employees in non-agricultural Establishments in two Selected Industries during the 12-month Period, February 1961 through January 1962 with Respect to a/ Number in Thousands b/ Average Weekly Earnings c/ Number of Hours Worked Weekly

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Motor Freight Transport and Storage</td>
<td>866.3</td>
<td>895.3</td>
<td>912.8</td>
<td>913.4</td>
<td>907.0</td>
<td>891.0</td>
<td>880.3</td>
<td>852.8</td>
<td>837.1</td>
<td>840.4</td>
<td>832.0</td>
<td></td>
</tr>
<tr>
<td>Freight</td>
<td>$ 108.79</td>
<td>111.72</td>
<td>111.04</td>
<td>111.67</td>
<td>111.19</td>
<td>108.42</td>
<td>109.30</td>
<td>106.55</td>
<td>104.45</td>
<td>103.53</td>
<td>103.63</td>
<td></td>
</tr>
<tr>
<td>Storage</td>
<td>40.9</td>
<td>42.0</td>
<td>41.9</td>
<td>42.3</td>
<td>42.1</td>
<td>42.6</td>
<td>41.7</td>
<td>42.2</td>
<td>41.3</td>
<td>40.8</td>
<td>40.6</td>
<td>40.8</td>
</tr>
<tr>
<td>Wholesale Trade</td>
<td>3026</td>
<td>3062</td>
<td>3051</td>
<td>3049</td>
<td>3035</td>
<td>3044</td>
<td>3013</td>
<td>2990</td>
<td>2959</td>
<td>2955</td>
<td>2964</td>
<td>2974</td>
</tr>
<tr>
<td>Freight</td>
<td>$ 94.54</td>
<td>95.47</td>
<td>95.00</td>
<td>94.60</td>
<td>94.77</td>
<td>93.79</td>
<td>94.42</td>
<td>94.19</td>
<td>92.69</td>
<td>92.69</td>
<td>91.66</td>
<td>91.43</td>
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<tr>
<td>Storage</td>
<td>40.4</td>
<td>40.8</td>
<td>40.6</td>
<td>40.6</td>
<td>40.5</td>
<td>40.6</td>
<td>40.7</td>
<td>40.6</td>
<td>40.3</td>
<td>40.3</td>
<td>40.2</td>
<td>40.1</td>
</tr>
</tbody>
</table>

Source: Monthly Labor Review, April 1962
In many warehouses, payroll costs represent the largest item of expense. This is especially true in storage facilities that have retained old methods and procedures. Warehouse wages are affected by the wage patterns in general. When wage increases are secured by the manufacturing employment in a given community, a pull is set into motion to raise wages in other employment. This has been a continuing problem faced by warehouse managements since World War II. This has made for increases in operational costs which many warehouse managers have found unavoidable. The best solution to that problem has been to make labor more productive through work procedural changes and the addition of labor-saving equipment. A consideration of new procedures and new equipment has frequently brought a recommendation for the construction of a new building to house a firm's warehousing operations.

Construction costs have risen sharply since World War II, as figures in Table 8 show. The Bureau of Labor Statistics estimated that the construction materials wholesale price index during 1960 was about 132 per cent based on a 100 per cent determination for the years 1947-1949. Total costs for construction, however, have increased at a sharper rate, and this has been due to wage increases in the construction trades, and increases in the procurement and leasing of construction equipment.
TABLE 8.—Building Cost Trends in Selected Years, 1946 to 1962 Based on an Index of 100 Established for the Year 1913

<table>
<thead>
<tr>
<th>Year</th>
<th>General Construction</th>
<th>Engineering</th>
<th>Composite Construction Cost, U. S. Dept. of Commerce</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Weighted Index</td>
<td>Weighted Index</td>
<td>Weighted Index</td>
</tr>
<tr>
<td>1946</td>
<td>346</td>
<td>262</td>
<td>269</td>
</tr>
<tr>
<td>1949</td>
<td>477</td>
<td>352</td>
<td>363</td>
</tr>
<tr>
<td>1955</td>
<td>660</td>
<td>469</td>
<td>440</td>
</tr>
<tr>
<td>1956</td>
<td>692</td>
<td>491</td>
<td>465</td>
</tr>
<tr>
<td>1957</td>
<td>724</td>
<td>509</td>
<td>482</td>
</tr>
<tr>
<td>1958</td>
<td>759</td>
<td>525</td>
<td>486</td>
</tr>
<tr>
<td>1959</td>
<td>797</td>
<td>548</td>
<td>496</td>
</tr>
<tr>
<td>1960</td>
<td>824</td>
<td>559</td>
<td>504</td>
</tr>
<tr>
<td>1961</td>
<td>847</td>
<td>568</td>
<td>511</td>
</tr>
<tr>
<td>1962</td>
<td>869 (1st 9 months)</td>
<td>578 (1st 9 months)</td>
<td>517 (1st 7 months)</td>
</tr>
</tbody>
</table>


A consideration of all trends for cost increases brings the conclusion that warehouses have been faced with steadily rising costs. Both labor and construction costs, including those for building modernization have risen sharply. The costs for replacing warehouse equipment have also increased, although it is difficult to make comparisons. A fork lift truck powered by storage batteries, capable of placing a 2500 pound load on a rack ten feet high will cost about $9700. ($5600. for truck, $3300. for two batteries, $800. for battery charger). A piece of equipment which will provide a similar work performance, but using LP gas fuel, can be purchased for about $4500. It is difficult to compare these two pieces of equipment with costs of prior years, as these trucks are relatively new in design and in operation. Warehouse supervisors
advise that the equipment available today is much more trouble free and more versatile than equipment produced several years ago.

Cost increases have been a spur to the development of warehousing operations that are more productive. When faced with rising costs for labor and for shelter that were unavoidable, business executives have looked into other areas in the interest of reducing costs. The result in some warehouses has been a better application of machinery, better utilization of facilities, and more production from each worker.

**Developments in world trade.** All news media tell repeatedly of the production and consumption problems of other countries of the world. The problems of new states now emerging in Africa and Asia are particularly acute. The countries of Latin America have long had production and distribution problems. Such countries need machinery to develop their own resources, and they need food and medicine. They need many items which American agriculture and industry can provide, and they also need instructional guidance in the adaptation of American machines, methods, and techniques to situations peculiar to their materials and resources. International trade is not new. The discovery of the Western Hemisphere in the fifteenth century was the result of a venture made in the interest of international trade.

Since World War II international trade has become more important as a matter to be spelled out in international alliances. The creation of the European Common Market is an example. The United States is interested in that development as it could become the most important market area in the world. Common markets may change the potentials for a
number of commodities and for certain classes of goods in both buying and selling.

The United States is interested in world trade for two reasons: the need to procure certain strategic materials from foreign sources, and the need to find outlets for certain of our industries which have capacities that exceed domestic requirements. The United States Department of State reported in February 1962 that our production needs for some twenty strategic minerals were being obtained from foreign sources. Industrial diamonds, tin, cobalt, mica, asbestos, chrome ore, and nickel are included in that list. Without the materials which are now procured from other countries, production of many items, including automobiles and electric appliances would not be possible.

From the standpoint of total employment, gross national product, and other economic barometers, the goods which we produce and sell to other countries are most important. The Department of State reports also that one dollar out of every twenty-five included in our gross national product comes from the sale of goods to foreign markets. More than half of our total production of such diverse products as fish oil, locomotives, tracklaying tractors, DDT, and industrial sewing machines, is exported for sale and use in other countries. Twenty per cent or more of our production of construction graders, molybdenum, civilian aircraft, rolling mill machine parts, sulfur, oilfield machinery, sardines, penicillin, lubricants, synthetic rubber, metal-cutting machine tools, harvesting combines, and textile machinery, is sold to markets in other countries.  

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5U. S. Department of State, Together We are Strong, publication
The items now being exported by American business firms to other countries consist largely of productive machinery, machinery for natural resource development, and materials for production. As those items come to be utilized in a production exceeding local market requirements, the importing countries will become exporting countries for some of their goods. This is of interest to marketing executives who plan for sales abroad, and it is of interest also to those marketing executives who plan for procurement abroad. In the conduct of business in keeping with both those interests a planning must be made for packaging, for unit loads, and for storage. Decisions must be made concerning the performance of those three functions and this should be done according to the pertinent marketing plans. The planning for sale of industrial sewing machines to Japan, an industrialized country, would be different from that of a similar sale to a business undertaking in the interior of Tanganyika. Decisions regarding packaging, unit loads, operational manuals, and spare parts, should be made with a good understanding of each customer's facilities and capacities. It is known, for example, that Japan has good facilities for unloading and dockside movement of shipments. It is known also that Japanese industry satisfies many spare part requirements by duplication in its own machine shops. Similar conditions do not prevail in countries still struggling to develop infant industries. It is firmly believed that continued developments and experience in world trade will prove the universality of the primary
service objective of providing customers with goods that will satisfy a want or a need, that will be priced in keeping with what customers are willing to pay, and will be delivered as customers want them.

World trade affects warehousing as goods require storage when being assembled for shipment. They may also require the application of special preservatives and the use of special packing materials. There is also a need to consider the storage and handling facilities available at destination points. The following advice for packaging in general, is even more important for goods being sold in foreign trade.6

A package is not complete until it is properly identified. This identification is intended to indicate the nature of the contents and to provide instructions for handling, warehousing, and shipping.


Warehousing consideration must also be given to goods in foreign trade which are being imported for sale in this country. This is especially true of consumer goods. This is actually a part of merchandising and the overall marketing planning of a business firm. Procurement should be made with an understanding of the retailing methods that will be employed in effecting final sale to consumers. If it is uneconomical to require the foreign production source to package goods so as to meet retailing needs, the buyer should plan and carry out a repackaging in his own warehouses. An example of this need was observed in a warehouse serving some seventy supermarkets in a retail chain. A considerable quantity of jackets and other inexpensive items of clothing had
been procured from a foreign production source. Purchase negotiations were not specific with regard to packaging and the goods were received in bales protected only by an outer wrapping of burlap. As a result, some of the goods when offered for sale were faded and discolored; all items were badly wrinkled and lacked the appeal necessary for impulse buying. Poor sizing was another condition of the lot. When efforts to move the goods by markdowns and the use of bargain tables were unsuccessful, the goods were ordered returned to the warehouse. The final disposition made of those goods is not known but an official stated that it would not be possible to avoid a monetary loss. The warehouse in this instance was not equipped to resize and renovate the goods for a second offering to the company's supermarket customers.

The impression was gained that company officials involved in that procurement and sales experience, had gained a retraining in three lessons: (a) Need to give procurement consideration to goods which will complement existing inventories and fit into established retailing methods. (b) Need to consider what can be done economically within the warehouse. (c) Need to consider the image which a firm maintains with the public. When a firm builds and maintains an image of quality at reasonable prices, repeated ventures in shoddy merchandise can destroy that image.

A final look at developments in world trade seems appropriate at this point with respect to the needs of marketing. There is a general presumption that the need to increase production is the major problem of all underdeveloped nations. The history of the United States has
shown a record of increasing productivity for a variety of goods, and also an increasing ability to find ways and means for distributing most of those increases. That particular history is frequently interpreted as an indication that other countries will follow the same course of economic development. When that interpretation is made the problems of distribution that may follow production successes are not recognized or anticipated. This point is supported in a case reported by an anthropologist.  

Economic adjustments are also often beyond the comprehension of such a primitive group. For example, an American Indian community was advised that one way to earn some money would be to make hay of the grasses growing in their locality; accordingly they labored successfully during the season, harvesting a large crop. Yet, when it came to finding a market, they failed. White men, they observed, did make a living by producing hay, but not being able to do it, they regarded themselves as inferior, entirely unable to live according to the standards of the new culture.


Most cultures of the world have problems of scarcity and so the problems of distribution do not arise until a surplus in some good is produced. So long as the machinery, equipment, and technical skills exported by the United States result only in production increases that are consumed in the country of production, international marketing problems will not be increased thereby. But it cannot be presumed that this will be the case. Entrepreneurial effort will seek out ways and means for utilizing productive capacity to the end that capital can be
gained for growth or other purposes. This will create marketing situations and the attendant problems of packaging, storing and handling. As this country continues to pursue a policy of exporting machinery and technical skills for increasing production, its position as leader of the free enterprise movement requires also the development of a policy for exporting the technical skill and equipment needed for marketing.

**Developments in the realm of speculation.**—In addition to the developments in the offing which can be identified with some positiveness, are others which at the moment can only be mentioned as speculation. Areas which could provide for drastic changes in the storage and handling of some goods would include the following.

1. New departures in the application of scientific knowledge to the preservation of perishable goods.
2. Development of equipment and procedures proving the practicability of an all-automatic warehouse for certain storage operations.
3. Increased use of gravity in moving packaged goods.
4. Increased use of air as a tool for movement of goods.
5. Simplification of electronic controls which might be made possible by discoveries coming out of space-travel research and other defense efforts.
6. Research and development in marketing and in engineering.

Scientific discoveries in the use of radiation, and in the use of anti-biotics have indicated the feasibility of preserving highly perishable foods through the use of these relatively new materials. Science has demonstrated that items as perishable as fresh meat can be preserved
for a number of days by the application of radiation or the application of anti-biotics so as to retard the development of bacteria. Such discoveries are presently in the realm of speculation insofar as they may be applied to items intended for human consumption. It is not known whether the human body could sustain without damage, a continued absorption of the anti-bacterial substances. There are also marketing drawbacks. Food so treated is said to have a flat taste and is less palatable than when preserved by traditional methods. Aside from the matter of taste is also the problem of public acceptance which would be required for marketing feasibility.

Developments indicating new possibilities for preserving perishable products are of interest to business executives concerned with long range planning for storage operations. If it would become practicable to preserve and market perishable goods so as to eliminate cold storage facilities, certain operations in food distribution would be greatly altered.

The all-automatic warehouse is not yet a reality and as far as this study has been able to reveal, none has passed the drawing board stage. For the many and varied kinds of warehousing requirements which continue to exist, it is not a likely development. Mr. William H. Meserole, an authority on warehousing, has estimated that such a warehouse is at least one generation away. The writer is of the opinion, based on a review of pertinent information, that something approaching an all-automatic warehouse for a very limited number of warehousing situations is less than a generation away. It can be envisioned that in highly stabilized situations, electronic controls can be paired with
precise handling equipment so as to handle both the incoming and outgoing goods. It is not foreseen, however, that such operations can be 100 per cent automatic. A development providing for about 90 per cent automatic handling would seem to be more in keeping with developments as they are now coming to be known. This would appear to be the case when it is recognized that a warehouse provides storage for goods received from a number of sources. The exercise of marketing management causes changes in the procurement base from time to time. Automation in a given warehouse operation requires a high degree of cooperation in relations with suppliers. It takes time to develop that cooperation and there may be a procurement need to secure goods from suppliers who do not consistently furnish goods in keeping with the precise requirements of buyer's automatic warehouse. Similar problems result from the efforts of sales management to locate and serve new customers. It may take some time to develop cooperation to the extent that new customers' orders will be geared to the precise impulse feeding required by automatic control.

A high degree of automation has been attained in manufacturing in the handling of liquids and other items that can be measured and poured into containers which are then closed, sealed, and moved by conveyors to storage and shipping locations. It is possible to continue the mechanized movement of goods up through the selection of cases and their placement upon pallets, as the writer has observed in a warehouse of the H. J. Heinz Company in Pittsburgh.

There are no great problems in the handling of fungible goods with a high degree of automation. This is especially true of goods which can
be pumped or moved by elevator buckets on an endless chain to a position of height from which they may then be metered and dropped through hoppers into containers. Grain elevators in the wheat belt as well as coal tip­ples in mining areas have proven the feasibility of such handling methods.

It seems entirely possible that a greater use of gravity will be made in the future in the handling of goods. Some speculation can be found that the first all-automatic warehouse will be constructed on an uneven land site so that gravity can provide the necessary movement. Presumably, level land could be used for the same purposes if some economical way could be found for spotting railroad cars and highway trailers for unloading at a height two or three floors greater than that of the shipping level. It has been observed that automated warehouses use gravity to get selected cases of goods onto conveyor belts. When electric impulses cause the momentary release of pawls that hold a good in place in its inclined slot, it is gravity that provides its movement for a few feet until it reaches the surface of a conveyor. As further study and application of automation principles are carried out, it seems quite likely that a further use of gravity will be made. In a sense, this is a return to the principle of chutes which wholesalers were using a generation or more ago.

The possibility for the increased use of air to move goods has no present support in warehousing literature. It is a speculation that the writer believes might be worth some engineering exploration. It would of course be unsuitable for most goods, but could perhaps be adapted to the handling of highly standardized containers of a cylindrical shape. As presently conceived, this would limit air as a propellant to move
goods to those packed in metal cans. The system would make the warehouse an installation of parallel tubes which could be made from a transparent plastic material. Some tubes would be of the proper inside diameter to receive cans of the number 1 size, some to receive the 2 1/2 size, some to receive number 5 cans, and so on. The tubes could be installed so as to gain some advantage from gravity. With air pressure, the tinned units could be made to slide into a loading position. If the system proved feasible in a test, further tests could be made of highway trailers similarly tubed so that connections could be made to load entirely by air. If tests proved this second step feasible, it would then be possible to use air in a similar way to unload each trailer at the reserve storage room of a supermarket, or at another warehouse similarly equipped. If a system of this kind could be employed it would provide savings in three ways. (a) A reduction in costs for warehouse labor. (b) A savings from the elimination of card board packaging. (c) A savings in the time and energy presently required to dispose of card board packaging after the unit containers have been removed.

At the present time a considerable amount of energy and national capital resources are being expended in space travel explorations and other defense efforts. The developments in heat treating, transistors, rocket fuel, storage batteries, and remote control systems have been significant. As further gains are made, many of the discoveries will be made known and available for civilian use. This could seemingly provide for some moves forward in mechanization, in data processing, and in electronic control systems. It seems entirely likely that the
government-sponsored research and testing will open up new possibilities for mechanization and controls for civilian application including warehousing activities.
CHAPTER X

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Summary.—Warehousing from a management viewpoint embraces the work activities incident to the performance of the storage function in a given enterprise. As it is not possible to eliminate storage in the economic activities that provide for production and distribution of goods, a continuing development is needed for procedures and equipment to facilitate the work of warehousing. Warehousing is essentially the work of organizing and the managing of business activities that include the following:

1. Receipt of goods from carrier.
2. Tally in of incoming goods.
3. Inspection of goods at time of receipt.
4. Assignment of incoming goods to specific storage locations.
5. Physical movement of goods to assigned storage spaces.
6. Maintenance of bin cards and other records used to keep itemized counts of goods on hand.
7. Handling of customers' orders and other authorizations for withdrawal and shipping.
8. Selection of goods for shipment.
9. Physical movement of goods for checking and assembly incident to shipping.
10. Turning shipments over to a carrier for forwarding.
(11) Maintaining commercial liaison with carriers used for incoming and outgoing goods.

(12) Maintaining internal relationships in the interest of coordinating the activities of warehousing with other activities within the business firm.

In some business literature, certain of the twelve business activities have been discussed as being a part of materials management. Some good arguments have been made for creating a materials manager position. The executive filling that position would have authority and responsibility for handling all incoming materials, all internal movement of materials in production, all movement of finished goods to storage, and all movement of finished goods from storage. Those who present the case for control and coordination of warehousing activities under a materials manager, have done so with a manufacturing activity in mind. Certain of the twelve essential activities could also be placed under an executive having responsibility for inventory control.

Whether all those activities are performed under the authority and supervision of a warehouse superintendent, or under some competent manager having another title, is not so important. It is important, however, for each business firm performing the storage function to provide for the planning, organization and control of those essential activities. The nature of work in a warehouse is such that one person should be given authority and responsibility for the management of work incident to the receipt, storage, and shipping of goods and materials. An organization for a given firm could place that authority and
responsibility under a vice president in charge of marketing. The direct supervision of the warehouse could then be placed under a warehouse manager who would report to the vice president. The need for competent line direction and supervision in the warehouse is well established.

There is a concept of flow which has affected executive thinking in distribution. This concept contains an idea of continual movement; goods would be stored only until shipping arrangements could be made or until routine matters were cleared with customers. This concept emphasizes movement rather than storage. It is an interesting thought and a desirable goal, and it has no doubt contributed to developments in the direction of automation in warehousing. For many firms and in many business situations it is not, however, a completely attainable goal. But the emphasis upon movement is properly placed, and responsible executives need to understand fully at all times the structure and nature of their turnover ratios. Efforts to step up turnover rates can be profitable, and opportunities for doing so should not go by default. The serious consideration of propositions to step up the physical distribution of goods, however, needs to be tempered with an understanding of the reasons for storage. Goods require storage for the following reasons:

1. Need to buy materials in advance of production.
2. Need to buy more than currently needed in order to gain economies in procurement.
3. Seasonalities of production.
4. Seasonalities of consumption.
(5) To have inventory quantities and ranges available to meet sales expectations.

(6) Assembly for shipping purposes.

(7) To stockpile for production or sales purposes, such items as may be expected to be in short supply at some future date.

(8) Public policy.

(9) For aging or curing purposes.

(10) To provide a reservoir for items as they become finished goods at the end of a production line. Except for job shop operations, most production in the United States is on the basis of some kind of a sales forecast. The reservoir may be provided by the producer and/or middlemen who distribute his goods.

The flow concept when properly interpreted and applied, considers the nature of the goods involved and the channel of distribution which can provide for their most efficient distribution. This is done in the interest of eliminating unnecessary handling and reducing the time involved between production and final use of a product. This concept has been in the pattern of thinking that has led some business executives to explore possibilities for machine handling of goods, and further to the adaptation of electric controls for such machines.

Warehousing is a part of the work necessary in physical distribution. As a subject of study it is to be placed in the field of marketing. While other disciplines make contributions to distribution knowledge, as for example that of economies in the development of theory, it is a primary responsibility of marketing scholars to develop marketing theory and to provide for the adaptation as well as the implementation of
all pertinent theory. Problems of physical distribution are within the province of marketing academicians.

The work of marketing scholars and others in the marketing discipline who have concentrated their efforts upon distribution problems has resulted in better economic understandings. Their contributions to total economic knowledge since World War I have been significant. Marketing professionals, however, have generally not shown strong exploratory interests in the phases of marketing work which can be considered under the heading of warehousing. This is believed to be a part of a general tendency to overlook the place of the wholesaler in the total distribution pattern. As a result, the literature which can presently be obtained and evaluated in the interest of warehousing is relatively limited. Business executives who share their ideas and experiences in publications have also shown more interest in other problem areas. The general paucity of warehousing literature can be attributed to a common lack of enthusiasm for the essential work performed between the receiving docks and the shipping docks of storage facilities.

There are a number of reasons for the lag in advancements to further the performance of warehousing work. There has been a general lack of executive and academic interest in storage operations that has resulted in a general lack of literature in warehousing subjects. The executive time that can be allocated to problem-solving is limited and other distribution matters have had precedence over those arising in storage facilities. Marketing executives have also had difficulty in justifying the expenditures that would be incurred if substantial improvements were undertaken. There have been difficulties in attracting,
maintaining, and developing the personnel needed to keep pace with available machine and procedural developments. Other inefficiencies in warehouse operations have resulted from marketing decisions that brought changes in inventories. Inventory changes have been necessary because of volume declines for some items, increased demand for others, introduction of new items, and package or container changes. There has also been a lack of communication between those who study warehousing problems with an engineering orientation, and business executives who have responsibilities for storage. Finally, and due largely to the fact that executives were generally unwilling to institute warehouse changes that would be reflected as increases in expenditures for warehouse operations, possibilities for using new equipment and procedures in materials handling have not been fully explored. While there have been significant developments in pallets and in the improvement of equipment to handle unit loads, technological advances in materials handling have not found a ready adaptation in many warehouses.

A historical comparison of advancements in manufacturing with developments in the storage and handling of goods in distribution, shows a more timely adoption of power in production. Factories have made a progressive utilization of power available through the employment of animals, water, controlled steam, internal combustion engines, and electricity. Power measured in terms of horsepower provided for the pressures and torque needed in fabrication, as well as for the movement of materials along production lines within a factory. The initial costs of providing for power and its adaptation to specific production needs required substantial investments in plant and equipment. This often
required long term capitalizations. But the long term cost advantages of machine power were evident to many forward looking factory managers, and as technological developments made power sources available the manufacturing industries increased their use of machines. The trend toward a greater use of power-driven machines and equipment did not, however, carry over as promptly into the storage operations.

Production shops increased their use of power for the primary purposes of fabrication. After power had been brought in and adapted to particular fabrication needs, it was not difficult to make further adaptations for purposes of moving materials in a production process. As the promise of a steady sales volume permitted the development of continuous manufacturing in some industries, the mechanized handling of finished goods from final inspection to storage and/or shipping was largely an extension of other production advances.

Except for power-driven conveyors which have been in use in some storage installations a generation or more, power usage in warehousing has had a slow development. While there has been a general lack of enthusiasm for the use of machine systems in the handling of goods within a warehouse, there are more specific reasons for the continued use of manpower in storage. There is first the problem of adapting power to the selection and movement of goods in different sizes, weights, and packaging. Secondly, there is the problem of intermittency; in some classes of goods, selections may be made daily, but in others the selections may be made at odd intervals. There are also problems of identification. Some authorizations for withdrawal, as for example purchase orders, require some kind of translation before selection can be made.
In many warehouses, particularly those operated in channels of distribution between producers and ultimate users, the need for trained personnel in the selection of goods has been a continuing one.

Storage in marketing cannot be avoided. It occurs in the gathering and assembly of the materials needed in production. It is also necessary in getting finished goods distributed to ultimate users. The need for storage facilities has grown with production successes. The history of warehousing has been one of adaptation. The storage facilities received the goods which had to be stored and took them into control. As the variety and characteristics of the goods changed, the facilities for controlling and preserving qualities in goods had to change. Warehousing facilities and procedures were altered to meet the requirements for storage of goods as these changed over time. The warehouse is a facilitating activity and in terms of physics is a driven force rather than a driving force. It supports both production and distribution activities and thereby facilitates the marketing of materials and finished goods. The nature of the work performed in warehousing is such that responsible executives must do much of their planning in the interest of adaptation rather than for innovation.

The history of warehousing is a record of adaptation. Storage buildings were adapted to the storage space needs of the business firms which they served. If expansion was necessary they built more floors when land restrictions did not permit horizontal extensions. As multi-floor buildings required a movement of goods between floors, the hoisting arrangements used on ships were adapted for that purpose. The interest today in single floor warehouses reflects an effort to gain
some of the economies which one-floor buildings have provided in con­

uous manufacturing. The developments in machinery and equipment for the

handling and movement of goods have had their origin in manufacturing.

This is understandable when it is recognized that business executives

look upon manufacturing as a profit making activity and one which could

therefore support technical research for process improvement. In con­

trast there has been a general tendency to view warehousing as a cost-

adding activity, and so comparable efforts to improve storage work activi­

ties have not been made. Some warehouses have, however, benefitted

indirectly from the technical research conducted for process improve­

ment. Materials handling equipment and techniques developed and tested

in manufacturing have been adapted for warehousing work. Power driven

conveyors and overhead mono-rails are examples. The fork lift truck

and the use of pallets evolved from skids and skid jacks. The fork

lift truck which can stack palletized unit loads up to a height of

20 feet is basically a portable hydraulic elevator. Electronic con­

trols were tested in other business operations before their adaptation

in warehousing.

There are certain major developments that can be detected in

current business literature and professional publications which in­

dicate some new directions in warehouse operation and management. In­

creasing interest and activity can be noted in the following areas.

(1) Increasing adaptation of machines for the handling of goods.

(2) Increasing adaptation of electronic devices for controlling

materials handling equipment and inventory counts.
(3) More application of mathematical procedures in determining optimum quantities for storage, for shipping, and for possession at predetermined points.

(4) Reappraisal of automation in warehousing.

(5) Increasing developments in marketing theory which bring the warehouse into a better focus. Examples, are the marketing concept, and the concept of value added in marketing.

(6) Developments reflected by writings in management theory. In presenting a case for the integrated management of all activities of the business firm, the activities incident to storage are brought into consideration.

(7) The treatment of inventories by the business press as an economic indicator, draws the attention of top management to inventory balances.

(8) Rediscovery of cost reduction advantages in one-floor warehouses.

(9) Significant increases in the use of pallets, unit loads, and fork lift truck usage since World War II.

(10) Possibilities for gaining better warehouse space utilization through installation of slot systems.

(11) Possibilities for using different shipping arrangements as these are being made available by common carriers. Containerized freight is an example.

(12) In general, the renewed interest in receiving, storing, and shipping, as activities which could provide for a reduction in distribution costs.
The need to perform warehousing activities is derived from the demand for goods. Demand is subject to change. It provides pressure for an increased distribution of some goods, and a decline in others. It also calls for changes in design and in quality from time to time.

Business decisions in distribution are made on the basis of some evaluation and assessment of demand. Such decisions affect the volume, quantities, varieties of goods, and even the customers served by a particular warehouse. As warehousing activities must be performed in conditions of constant change, the warehousing management must be sufficiently flexible to adapt to new directions and objectives of marketing management.

Conclusions.—The work performed in receiving, classifying, storing, selecting, and shipping of goods that will satisfy production or consumption needs is essential in any economic system. In a free enterprise system which depends very largely upon the free choice of goods as a marketing determinant, and in the final analysis as a production determinant, the efficient performance of warehousing activities is socially desirable. A system permitting freedom of choice is subject to change and requires the constant attention of responsible persons who understand the economics of marketing. Physical distribution involves the work of warehousing, and the total consideration of marketing understanding and development must therefore include the activities incident to the storage function. In the interest of continued efficiency in distribution, gains and improvements in the physical handling and storage of goods are necessary.

The activities performed in warehousing are essential and may not
be eliminated. They can be shifted within the channels of distribution, but the need for their performance continues. A large retailer may construct his own warehouse, as some have done, but in so doing he takes on the performance of wholesaling activities. He may or may not be able to perform these activities more economically. The search for operational economies and the desire to exercise more control over supply sources have led to a shifting of the place where warehousing activities are to be performed.

The efficient warehouse is one in which assigned activities are performed efficiently and economically. A summarization of the conditions which would be found in a warehouse meeting the tests for efficiency and economy, would include the following: (a) Line and staff relationships with personnel responsible for purchasing, production, marketing, inventory controls, traffic, personnel, and those concerned with organization and procedural studies. (b) Existence of preplanning for unloading shipments, assignments of storage space, order-filling, turnover of shipments to carriers, for training and retraining, and for coordination of re-warehousing with the in and out movement of goods. (c) Presence of current and active records showing efforts being made to decrease customer dissatisfaction resulting from bad shipments, coordinate storage and handling with turnover, achieve more effective control, and development of work standards and measurements for employee evaluation purposes. Records should also be available showing operational costs, capacities, and limits, for all equipment available for use by warehouse personnel. (d) Existence of storage and handling cost information for comparative purposes, and a record of success in some
cost reduction efforts. (e) Evidence of reasonable physical controls in keeping with inventory values, and evidence also of adequate internal controls. (f) An up-to-date organization chart showing the relationship of warehouse personnel to the organization of the firm. (g) Evidence that timely and pertinent warehousing information contained in reports and published literature is being brought to the attention of warehouse supervisors. (h) A warehouse operation that reflects an attitude of movement rather than one of storage.

A warehouse would not have the foregoing conditions unless its management had been integrated and coordinated with other purposeful activities of the firm. The conditions emphasize organization, coordination, cooperation, control, communication, cost, procedures, standards, continuing development, and the economic utilization of a firm's investment in its warehousing facilities and personnel. The conditions are not likely to prevail unless management provides for their institution and development.

It would seem that the starting point for any study aimed at improving the operations of a particular warehouse would be the clarification and positioning of the storage activities within the management of the firm. It is necessary to view the warehouse in its proper organizational frame before its services to the firm can be evaluated. It exists to serve the marketing activities of a firm. An organization provides for systematic operation and for the delegation of authority and responsibility. It should be planned to provide also for the economical utilization of investments in manpower, space, and equipment.
In a firm that engages in manufacturing, the warehouse serves also the production division of the firm. It is the organization, planned, charted, and carried out, that provides for the coordination necessary between warehouse management and the activities served. The importance of that coordination and control is reflected by recommendations of persons having knowledge of the subject, who would subordinate all physical movement to one official, a materials manager. The materials manager would have responsibility for purchasing, warehousing, and for traffic management. He would also have responsibility for all internal movements of goods and materials.

A warehouse organization requires manpower, suitable storage space, and equipment. Organization charts emphasize personnel and their line and staff relationships. The chart may show little or no information concerning the nature of the building facilities available for the performance of warehousing activities. While the quality and training of personnel making up the payroll charged to a warehouse are highly important to its operating success, the arrangement and quality of the storage facilities are also very important.

One of the significant developments since World War II has been the trend toward one-story buildings and the adaptation of materials handling procedures to that kind of structure. Because of construction site requirements, new warehouses with one level storage have been erected in suburban locations. Retail chains developed an early interest in one level operations and the trend, particularly in food distribution, was under way when commercial construction was curtailed during World War II. The one level operation attracted interest primarily because it
permitted the use of certain storage and handling techniques which did not appear to be possible in a multi-story building. A new name was coined for the one level storage innovation. It was called a "streamliner" or a "streamliner operation". The principal elements of a streamliner operation were said to be: (a) Emphasis upon turnover, (b) Use of one-story warehouse buildings, (c) Use of assembly line arrangement for selecting goods to fill orders, (d) Employment of a punch-card system to control inventories and facilitate a more speedy handling of customers' orders, (e) Use of skids or pallets, with use of skid jacks or fork trucks for their movement. The term "streamliner" became popular in the food distribution industry and up through World War II had such connotations as modern, up to date, efficient, and speedy service. The writer recalls a retail grocery store operated in downtown Columbus during World War II which bore the name "The Streamliner".

With the benefit of hindsight it can now be seen that the streamliner operations did not fulfill all the claims that adherents of the late 1930's and the early 1940's made for it. It did, however, draw attention to stock relocations so as to take advantage of fast turnover for some items. It also drew attention to the use of punch-cards, and to the use of pallets and fork lift trucks. As an innovation it helped pave the way for increased palletization and unit load handling after World War II. It is interesting to note that the first efforts to automate warehouse operations of wholesalers have been in one level buildings.

The one level warehouse provides for a better adaptation and use
of pallets, pallet racks, and fork lift trucks than can be had in multi-
story buildings. Comparative studies indicate that in some storage
operations, the horizontal movement of goods on one level can be made
more economically. The one level arrangement has gained economies in
a number of areas which would include the following:

(1) Being of more recent design and construction the one-floor
warehouse is more likely to be tailored more closely to the particular
inventory and handling needs.

(2) One level warehouses constructed in recent years are more
accessible for highway transportation. Suitable docks for loading and
unloading have facilitated the work of receiving and shipping by highway
transportation.

(3) Costs of elevator installation and maintenance have been re-
duced and in some instances eliminated.

(4) It is a matter of physics that the vertical movement of most
goods requires more energy.

(5) The one level is more adaptable to the innovations and im-
provements in self-propelled equipment. Stacking to a height of 20
feet is now possible.

(6) The one floor arrangement is more readily adaptable to new
ideas in pallets, pallet racks, and other work improvements in keeping
with the unit load principle. In some instances it has been possible
to procure goods on the basis of pallet loads.

(7) Reduction in payroll costs for labor.

(8) Better opportunities for storing goods according to their
turnover characteristics.
The one level warehouse offers certain advantages and for most warehousing situations today it is the most efficient arrangement. A business firm planning to build a new warehouse or modernize an old one, should certainly explore the possibilities of constructing a new building on another site. A warehouse is a special purpose building and each firm needs to consider its storage needs in the light of its objectives and future planning. For established firms the warehouse will usually require a new location if a decision is made to put operations on a one level basis. It is to be determined in each instance whether a new building at a new location would provide for better warehousing service or for economies in operation. Among the factors which a firm would need to consider would be found the following:

(1) Location of customers and their procurement pattern as shown by sales analysis.

(2) Procurement practices of customers with respect to submission of orders. If there is an established practice for customers to visit warehouse and inspect goods under display conditions, will the new location provide for the customer accessibility needed.

(3) Is the economic future of the firm and of its supporting customers, sufficient to justify a long term building debt. Twenty year amortization periods are common in new warehouse planning.

(4) Would the new location be accessible to present sources of supply, and to new sources which the firm plans to develop.

(5) Would the new location allow the firm to take advantage of new developments in transportation. If the new location cannot be reached by a railroad spur, some procurement and shipping advantages of
the future could be lost. If the new location would cause the firm to rely entirely upon highway transportation, drayage costs would be entailed if other modes of transportation were used.

(6) Can rush orders or other irregular shipments be handled economically from new location. To what extent has the firm made shipments of spare parts or other rush items by public highway bus service. Does the firm make use of air freight to satisfy the needs of some customers. What is the position of the new location from the standpoint of continuing shipments of that kind.

(7) It is sometimes the practice of wholesalers to round out customers' orders by engaging in a form of cooperative procurement with competitors and other wholesale supply sources. It would probably be necessary to discontinue such practices if the firm withdrew from the wholesaling district of a commercial city. The firm contemplating a move would need to decide whether the departure from practices of this kind would result in gains or losses, and to what extent.

(8) While it is perhaps a minor point, the new location must be evaluated with respect to maintaining the labor force. Most suburban distribution facilities have found it necessary to provide packing areas for employees automobiles, and some have found it necessary to establish and maintain cafeterias.

(9) A firm contemplating a move into a new warehouse would want to evaluate possibilities for improving handling and storage operations at established location. The addition of conveyors and other equipment might provide for satisfactory cost reductions.
(10) Delivery costs at new location should be estimated and compared with delivery costs from established location.

(11) Disposition possibilities for facilities at established location.

(12) Insurance and maintenance costs for new facility.

When a firm makes careful comparisons of its operational estimates for a proposed new warehouse with the cost experience and potential at an established location it may find the factors tipped in favor of a new building at a new location. If a firm decides to proceed with its planning for construction, the proposed site must be surveyed for drainage, availability of utilities required, zoning restrictions, railroad siding possibilities, traffic flow patterns in street approaches, taxes, fire protection, and police protection. At this point in the planning, most firms would find it desirable to obtain architectural or engineering services and advice. A construction firm with warehouse building experience may be able to provide the suggestions and advice needed in connection with designing and blue-printing. The construction literature as well as that pertaining to warehouse studies, however, make strong recommendations for the employment of industrial architects in the design and constructing of new warehouse facilities. The warehouse is a special purpose building and should in effect be erected over a well planned layout determined in consideration of present as well as future needs. The actual construction should not begin until planning has been completed for layout, classification of goods, equipment to be installed, and for the portable equipment to be used. The special abilities of
industrial architects can provide assurance that all needs made known to them will be considered.

A new warehouse is a part of a general plan to modernize and change storage and handling procedures. The new building can provide opportunities for definite changes in controls, procedures, techniques, and the equipment necessary to make the departures from old practices. The building should be carefully planned to facilitate the carrying out of the changes desired. An architect or a warehouse design specialist can be of valuable assistance in preparing a building plan that will accommodate the warehousing activities. He may also be able to suggest departures from traditional construction methods, and in the use of new construction materials. It was noted in Chapter IX that the construction materials wholesale price index during 1960 was about 132 per cent based on a 100 per cent determination for the years 1947-1949. Those compilations were made by the Bureau of Labor Statistics. As indicated in Table 8 in Chapter IX, the composite construction cost compiled by the United States Department of Commerce showed an index of 363 for 1949 and an index of 504 for 1960. The index used in that comparison was a construction cost of 100 per cent established for the year 1913. In a rough comparison, the composite construction costs during the period 1949 to 1960, rose by almost 140 per cent. This indicates that while costs for construction materials have been showing a steady rise, they have not risen as steeply as have total construction costs. This reflects the use of new materials and some change in manufacturing methods within the construction materials industry. Examples are new siding,
curtain wall panels, and the factory-assembly of some units which are then installed on the construction site.

The planning incident to new construction and the carry out of plans by some firms have drawn attention to possibilities for increasing mechanization and the installation of electronic controls. Some automated operations have been successful, and there are indications that the automation movement will gain more followers. At the present the movement is spotty rather than widespread, but knowledge gained from operational experiences and technological advances indicate further developments in adapting automation to physical distribution.

The adaptation of electronic controls to mechanical equipment so as to achieve a high degree of automatic handling requires certain conditions for an efficient and economic operation. On the basis of present developments in automation for physical distribution the following conditions are prerequisites:

(1) Large volume: a quantity of movement which will permit operation of the system at least one shift each day and preferably more.

(2) Steady volume: the handling requirements should allow for the operation of the entire system every day. Early experiences in automated warehouses showed Monday to be the most troublesome day of the week. This was especially the case when the system had been idle during the preceding Saturday and Sunday. It is also desirable that the volume be steady with respect to the total inventory. The equipment making mechanical selections under electronic controls are more efficient when used frequently. Failures in selection occur when a particular good has a slow movement or when it is called for intermittently.
(3) Package standardization: graduated differences in sizes, weights, and shapes of goods to be handled. While systems can conceivably be designed to handle both large and small items, their intermixing creates difficulties.

(4) Stable market situation that will allow for steady operation of system throughout an amortization period of 4 to 5 years.

(5) Cooperation of supply sources in packaging and in the furnishing of goods in quantities and in counts that can be best handled in feeding the system.

(6) Cooperation of customers in the listing arrangements of items and descriptions on purchase orders. Automatic systems are designed to handle numerical designations. Order filling would be simplified by a use of stock numbers to identify each item instead of descriptive listings.

Not all warehousing activities can create conditions that are presently necessary to assure the economical use of highly automated systems. Warehousing activities are performed by manufacturers' sales branches, by manufacturers at points of production, service wholesalers, chain store organizations, rack jobbers, commission merchants, and by other business institutions. They handle inventories that may not meet the requirements for automatic installations. Except for the warehouses operated and controlled by the manufacturers and by chain store organizations, they may not have the volume and package standardization necessary to provide for economical operation.

There is a need for the management of a business firm to consider whether its materials handling requirements are comparable to those in
continuous manufacturing, or more nearly like those in a job shop operation. The manufacturing firms which have developed advanced systems for the machine handling of materials are those that engage in continuous manufacturing. The job shops do not have the volume, the steadiness of volume, or the general conditions necessary to justify a high degree of automatic handling and control. Most of the warehouses in operation today have handling problems more nearly like those of a job shop in manufacturing.

Success in automation comes from the design and installation of a system tailored to meet the handling needs of a particular warehouse. A system that is successful in one warehouse may not be duplicated and installed in another with assurance of identical results.

The starting place for mechanization planning is a thorough analysis of the operation. This should precede all other planning. Planning executives need to attain a thorough understanding of the firm's objectives, marketing planning, volume, turnover characteristics of each class of good, and the improvements possible within present system. As the installation of machine-controlled handling equipment must necessarily set up operational rigidities, a firm planning for flexibility in its marketing efforts, would find the system too restrictive. There are automated warehouse facilities presently idle because competition forced the serving of customers from decentralized branch warehouse locations. A firm which plans to add new goods and different varieties during future operations, must take such planning into account when considering mechanized handling or automation.

Explorations in automation have permitted some firms to find ways
and means for improving existing facilities. As discussed in Chapter VII two firms in Philadelphia, both handling large volumes, have found that a manual selection of goods with use of punch-cards and conveyors could provide very satisfactory systems for filling customers' orders. Both systems provide for a marketing flexibility that would not be economically possible under more highly automated arrangements.

The equipment procured for warehouse use is important in efficiency considerations. To some extent, the sales departments of warehouse equipment manufacturers and their dealers have followed sales techniques of office machine salesmen. A salesman for a bookkeeping machine, for example, will stress the point that he is not selling a machine but is offering a bookkeeping system made possible by the machine. The machine is only an incidental tool; it is the system which the buyer needs. Salesmen representing dealers and makers of materials handling equipment have attempted to outline systems that their equipment make possible. They have done so with only a limited understanding of a particular customer's actual handling problems. In situations where the purchasing agent was unfamiliar with the specific warehouse needs, machines and handling systems have been obtained that did not result in operational economies.

A warehouse operation represents investments in building, installed equipment, portable equipment, manpower, and developed procedures. Efficiency in operations requires a planned employment of all parts of that investment. Efficiency in warehouse operations can assure profits, and it can also improve competitive positions in a good accurate and prompt filling of orders.
More specifically, the warehouse management should endeavor to reduce handling costs through space assignments that give precedence to fast-moving goods. This may be done by space controls, as for example a slot system, and the placement of goods in storage so as to reduce distances and unnecessary handling. In some situations a consideration of the 80 - 20 per cent principle has led to changes which resulted in savings. This principle holds generally that 80 per cent of the movement comes from 20 per cent of the inventory. When that is found to be the case, the more active goods can be assigned to storage spaces more accessible for receiving and shipping. The bulk of the inventory with respect to quantity, i.e., the 80 per cent which moves more slowly would be placed in the warehouse at points more distant. This principle certainly has merit, but it tends to suggest that most effort be concentrated on the 20 per cent fast-movers. While that may result in immediate economies, turnover evaluations and storage space assignments should give continuous consideration to all goods in the inventory.

The most important conclusion that can be drawn is that the warehouse should be planned, organized and controlled as an integrated activity of the firm.

Recommendations.— The following recommendations of a general nature are made:

(1) That more work be done to collect and evaluate information dealing with current problems and current developments in warehousing. A continuing synthesis of that information could provide for the
publication of timely articles that would contribute to the development of our distribution system.

(2) That warehousing studies on an industry to industry basis be considered by those who can recommend grants and otherwise encourage such research.

(3) That marketing professionals publish the warehousing information which they presently have.

(4) That an observation and study be made of the operational results of automation in warehousing.

(5) That efforts be made to arrange a professional conference for the purpose of discussing present and future developments in warehousing. Attendance and contributing information should be solicited from persons having knowledge of some phase of the subject. They may be found in commerce, industry, consulting firms, The United States Department of Agriculture, the United States Department of Commerce, electronic research, and in the academic disciplines of agricultural economics, industrial architecture, industrial engineering, mathematics, and marketing.

Operational recommendations are made that the management in each firm performing warehousing activities, plan and carry out an evaluation of operations through determinations in the following areas:

(1) A reappraisal of objectives of the firm with particular emphasis upon customers served and the marketing planning to serve other customers.

(2) A further evaluation of customers should be made from the
standpoint of sales analysis. Information should be compiled showing customers by some suitable classification, their locations, quantities procured by each, varieties procured by each, and any handling problems that may result from their orders.

(3) Ways and means of securing the cooperation and coordination of procurement, production, sales, accounting, personnel, traffic, and financial management in the interest of integrating warehouse activities with other activities of the firm.

(4) A classification of goods comprising the inventory starting with the industries and sources from which they are procured. Work here should provide also for the tabulation of information showing quantities usually received in each shipment and frequencies of deliveries. Such data can provide for planning in the interest of gaining efficiencies in the assignment and utilization of storage space.

(5) A determination of turnover rates for each class of goods as shown by inventory records, purchase orders, and shipping documents.

(6) A comparison of information made available in (4) and (5) with existing storage space assignments and handling practices. This should lead to the consideration of space assignments in keeping with turnover characteristics of each item. Goods may then be classified according to their turnover records and assigned to storage slots or numbered stations so as to decrease distances of movement and unnecessary handling.

(7) When studies and determinations made in the foregoing indicate that re-warehousing is in order, plan to carry out new space assignments with incoming shipments insofar as possible. This will
tend to hold down handling costs incident to the changes. The use of inventory controls for slot systems will minimize the problem of having some goods in one storage location and the more recent acquisitions of like items in another. There is one caution which should be raised in connection with storage reassignments in keeping with turnover. Some adjustments may be needed in the new layout as required to facilitate the work of filling customers' orders.

(8) The appointment of a committee made up of responsible executives to evaluate materials handling facilities and to consider recommendations for procurement of all new equipment

(9) The institution of a program for employee development. This would involve work standards, training and retraining.

(10) Any suggestions for automation or investments in highly mechanized systems should be preceded by a thorough analysis and understanding of existing warehouse methods. All possibilities for improving existing facilities, methods and procedures should first be explored.
APPENDIX

SELECTED GLOSSARY OF TERMS

Communication requires the use of terms and phrases. Uniform warehouse terminology is basic to the management of receiving, storing, and shipping operations. The terms defined as indicated in this selected glossary are widely used in warehousing literature and in business reports. The definitions were obtained from various sources, including government publications.

Aisle: Any passageway within a storage area.

Allocated space: Specific area in a warehouse designated for the storing of an incoming shipment.

Assignment of space: The designation of space within a warehouse for the storage of a particular class of goods.

Backorder: Action of shipper temporarily unable to ship all items called for on an order. Backorder annotations made on shipping papers indicates that shipper plans to forward such items in a subsequent shipment.

Bale: Compressed articles or materials assembled in a shaped unit and usually bound with cord or metal ties under tension.

Bay: Designated area within a section of a storage area, outlined by marking on columns or posts or floor. Normally a specific area within a section such as 20' x 20' squares.

Bill of lading: A document by which a transportation line acknowledges receipt of freight and contracts for its movement.
**Bin Storage**: Storage of parts, subassemblies, assemblies, or end items in bins so that an item may be withdrawn without breaking open a package containing a number of such items.

**Block**: Self-supporting stack of supplies, two or more units wide, two or more deep, and two or more high.

**Box car**: A fully inclosed freight car, usually with sliding doors on both sides.

**Box pallet**: A pallet framework back and sides, so constructed that several may be stacked, one upon another, without the weight being borne by the supplies, and only by the pallets.

**Bulk storage**: Warehouse storage of goods in large quantities, usually in original containers, as distinguished from bin storage.

**Caged storage**: Storage space segregated within a building and specially screened or barricaded to prevent pilferage, or to isolate dangerous materials.

**Carrier**: A railroad car, motor truck, ship, airplane, or other vehicle used for transport.

**Chute**: Usually an inclined trough, sometimes a tube, used to convey goods from an upper to a lower level.

**Common carrier**: A commercial transportation medium for delivery of goods from one destination to another. A transportation line engaged in the business of handling persons or goods for compensation and for all persons impartially.

**Conveyor**: A mechanical arrangement of belts, chains, or rollers designed to move goods. They are quite often power-driven, although gravity can be used for movements from higher to lower levels.
Container: A receptacle such as a bag, barrel, drum, box, crate or package used in storage or shipment of a good to unitize, provide protection from physical damage or contamination of the item.

Container marking: Numbers, nomenclature, or symbols stamped or painted on, or otherwise affixed to containers for identification.

Corner marker: Marker used at aisle intersections to prevent workers and equipment from bumping into the stacks.

Crate: A rigid shipping container of framed construction joined together with nails, bolts, or any equivalent method of fastening. The framework may or may not be enclosed with sheathing.

Critical items: Essential item which is in short supply or expected to be in short supply for an extended period.

Cross stacking: The placing of one layer of containers at right angles to those just below to increase the stability of the stack.

Cross tie: Cross layers of cartons as in cross stacking, except that only an occasional layer is crossed, and not every other one.

Deck boards: Top or bottom surface of a pallet.

Demurrage: An assessment against the shipper or consignee as a penalty for the detention of common carrier equipment beyond the period of free time allowed for loading or unloading.

Destination inspection: The inspection performed at the receiving point of the consignee of goods to ascertain whether the shipment is in conformance with purchase specifications.

Deterioration: Any impairment of quality, value, or usefulness. Includes damage caused by erosion, corrosion, combustion, and contamination.
**Drum**: Round metal or fiberboard container for liquids; or for solids. In this meaning, usually preceded by the quantity, as 5-gallon drum, 55-gallon drum.

**Dunnage**: Any material such as boards, planks, blocks, or metal bracing that is used in transportation and storage to support and secure goods, to protect them from damage or for convenience in handling.

**Dunnage in carloading**: Temporary blocking, flooring, or lining, racks, standards, strips, stakes, or similar bracing, or supports. Does not include excelsior, hay, sawdust, shavings, shredded paper, straw, packing cushions or pads, or similar packing materials.

**Electric accounting machine**: One of a series of electrically operated semi-automatic office machine used to maintain records.

**End item**: A final combination of a product, component part and/or material which is ready for its intended use.

**Equipment pool**: An area where equipment is centrally controlled and dispatched to particular areas or jobs when needed.

**Floor load rating**: Weight that can safely be supported by a floor, expressed in pounds per square foot of floor space.

**Gross weight**: The weight of a container plus its contents.

**Honeycombing**: The practice of storing and withdrawal of supplies in such a manner that the empty space resulting from withdrawals is not usable for the storage of additional items.

**Inventory**: A physical count of items located within an installation.

**Labor pool**: A centrally controlled group of workers who are assigned to particular jobs or areas when needed.
Lay out: The detailed, planned arrangement of space for storage, aisles or other necessary use.

Leaker: A can which through mechanical maladjustment or otherwise is not hermetically sealed, permitting air to enter and product to exude.

Less than carload: Is that weight which is less than the minimum required for the assessment of minimum carload rates.

Loading platform: A flat surface to facilitate loading, usually erected alongside a warehouse at the approximate level of a car or truck floor, sometimes of the portable trailer type.

Location audit: A verification of all of the data reflected on the location card.

Location survey: A survey conducted at predetermined intervals to ensure that the location of the goods is in agreement with the location shown on the locator card.

Locator system: A record which shows the exact location of items stored within a storage activity.

Lot: Specifically, a quantity of material all of which was manufactured, grown, or produced under identical conditions, and assigned an identifying lot number.

Less than truckload: Is that weight which is less than the minimum required for the assessment of minimum truck load rates.

Material handling: Internal movement of goods and supplies as distinguished from movement by common carrier or other transport carrier.

Net weight: The weight of the contents, not including the container.

Nomenclature: Set or system of names or titles given to items of material and equipment.
Nonperishables: Items which do not spoil or deteriorate readily.

Overseas pack: Package or method of packing designed to withstand handling as well as climatic conditions at destination.

Packaging: Application or use of appropriate wrappings, cushioning, interior containers and complete identification marking, up to but not including the exterior shipping container.

Packing: Application or use of exterior shipping containers and assembling of items or packages therein, together with necessary blocking, bracing or cushioning, weather-proofing exterior, strapping, and marking of shipping containers.

Palletizing: The placement and banding when necessary of units or shipping containers of goods on pallets.

Palletized unit load: Quantity of any item, packaged or unpackaged, which is arranged on a pallet in a specified manner and securely strapped or fastened thereto so that the whole is handled as a unit.

Paulin: Sheet of canvas or other materials usually treated to make it resistant to moisture and chemicals, used as a protective covering; tarpaulin.

Perishable: Items that deteriorate readily if not properly treated or refrigerated.

Planograph: A scale drawing of a storage area showing the lay out of the area, location of bulk, bin, rack and box pallet areas, aisles, assembly areas, walls, doorways, directions of storage, office space, wash rooms, and other support and operational areas.

Ramp: An inclined roadway which connects different levels. Ramps generally lead up from the ground to the loading platforms of the
warehouse so that equipment can be driven onto the platform; or from one floor level to another in a multi-story building.

**Rejection:** An action indicating nonacceptance of goods. In most cases a good is nonacceptable with regard to certain features with the understanding that upon correction the item may be resubmitted for inspection and acceptance.

**Requisition:** Request for goods or supplies, usually on a form furnished for that purpose.

**Retail bin area:** A room or area where retail quantities of goods, sometimes less than case lots, are stored and available for shipment.

**Rewarehousing:** Rearrangement of goods from one storage area to another within the same warehouse.

**Sensitive item:** An item that can be resold with little difficulty by persons who acquire it dishonestly. Such items are small in size and have relatively high unit values. They are subject to pilferage.

**Slot:** A specific storage space identified by a number.

**Slot system:** A system of warehouse space utilization which provides a numerical designation for each storage space. Movement in and out of that space is then controlled by use of the slot number. This system differs from the usual commodity grouping system in that like items may be placed in slots that are not adjoining.

**Space - assembly:** The area used for collecting and combining material components into units, kits, or assemblies.

**Space - box shop:** The area used for fabricating, manufacturing, assembly or repair of containers and storage aids.
Space - gross: Inside area between exterior walls, without deductions for fire walls and other structural losses.

Space - gross for storage: Is that amount of gross space for storage operations less those areas used for preservation and packaging, assembly, packing and crating, box shop, receiving, shipping, inspection and identification, offices, and other gross space used in support of storage functions.

Space - net storage: The floor area upon which bins are erected plus the floor area upon which material can be stored.

Space - packing and crating: Area used for the application of exterior shipping containers and the placing of the items or packages therein.

Space - preservation and packaging: The area used in processing, preservation and packaging of goods and similar protective measures taken to prevent deterioration during storage or shipment.

Space - receiving: The area used in checking, inspecting, preparing and directing goods (both new procurement and returns), to assigned storage spaces.

Space - shipping: The area used to assemble goods pending their loading for shipment, inspection, and identification.

Spare parts: Individual parts, subassemblies and assemblies for the maintenance or repair of equipment.

Spot: The placing of a truck or box car where it is required for loading or unloading.

Stringer: A piece of timber (usually 2" x 4") running the length of a pallet which supports the deck boards.
**Stack:** Collection or accumulation of goods arranged in an orderly and compact manner.

**Stock number:** Number assigned to an item, principally to identify it for storage and issue purposes.

**Tally in:** The process of recording, by appropriate marks, the number of containers or quantity of items received in a particular shipment.

**Tally out:** The process of preparing an itemized list of items included in a shipment.

**Tier:** A horizontal layer of a column, row or stack. Tiers are numbered in the order of their storing from the bottom up.

**Unit of issue:** In its special storage meaning, refers to the quantity of an item; as each, number, dozen, gallon, pair, pound, ream, set, yard. Usually termed "unit of issue" to distinguish from "unit price".
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I, George Lee Almond, was born near Bloomfield, Missouri, December 30, 1914. I received my secondary-school education in the public schools of Bloomfield, Missouri, and my undergraduate training at The Ohio State University, which granted me the Bachelor of Science degree in 1951.

From the same University, I received the Master of Arts degree in 1955. While in residence, I was research assistant to Professor David M. Harrison. During 1956 and 1957 I held a teaching assistantship in the Department of Business organization at The Ohio State University while completing residence requirements for the Doctor of Philosophy degree.

Non-academic employment has been in commerce and in the service of the federal government. Work experiences in the latter included staff and middle management assignments in the Department of Defense and in the Atomic Energy Commission.

I have held teaching appointments at Michigan State University and at the University of Rochester. Since September, 1959 I have been an assistant professor of marketing at the University of Cincinnati.