HANDLING GROCERIES FROM WAREHOUSE TO RETAIL STORE SHELVES

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Transportation and Facilities
Research Division
Agricultural Marketing Service

UNITED STATES DEPARTMENT
OF AGRICULTURE

PREFACE

This study of grocery handling in warehouses and retail stores is part of a broad program aimed at reducing the cost of marketing farm products. One phase of this research is the development of methods for increasing the efficiency of food wholesaling and retailing.

Increased efficiency results in better service or lower marketing costs, and savings will be reflected in lower consumer prices, in increased producer returns, or in both.

Management of American Stores Company, Philadelphia, Pa.; Giant Food Stores Inc., Washington, D. C.; The Kroger Co., Cincinnati, Ohio; Red Owl Stores, Inc., and Super Valu Stores, Hopkins, Minn., allowed researchers to use stores and warehouses as laboratories for this study. Personnel of these firms were helpful and cooperative. Credit is also due to Alan K. Greene, Transportation and Facilities Research Division, for his research on the multiforklift truck and to Extension Specialists in Food Distribution at the University of Delaware who assisted in the study.

This study was conducted under the general direction of R. W. Hoecker, Chief, Wholesaling and Retailing Research Branch, Transportation and Facilities Research Division, Agricultural Marketing Service.

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SUMMARY

Improved handling of groceries from the warehouse to the retail grocery store shelves offers the opportunity for substantial savings. An estimated five billion cases of grocery products are moved each year from warehouses into retail food stores. Handling time per case ranges from 3 to 6 man-minutes, depending on the method used. If this time were reduced by 1 minute and the time saved used effectively, an annual savings in food handling costs would total $160 million. 1/

Eight combinations of methods of handling groceries were studied. Costs ranged from $124.50 to $155.70 per thousand cases, a difference of 25 percent.

The eight systems were: (1) Merchandise assembled and shipped on pallets and priced in the storeroom; (2) merchandise assembled and shipped on pallets and priced at the store shelf; (3) merchandise handstacked in trailers and priced in the storeroom after receiving; (4) merchandise handstacked in trailers and priced at the store shelf; (5) merchandise loaded on trailers with a multiforklift truck and priced in the storeroom after receiving; (6) merchandise loaded with a multiforklift truck and priced at the shelf; (7) merchandise handstacked in trailers and priced as received; and (8) merchandise loaded with a multifork truck and priced as received.

Each phase of warehousing, trucking and store operations was studied. 2/ It was found that at the warehouse the tractor-train method of order assembly with multifork loading cost the least. But this method resulted in a loss of trailer capacity which increased transportation costs. To determine total costs, it is necessary to analyze the combined system being used.

Of the eight systems, loading by multifork, receiving by conveyor, and pricing at the shelf using 4-wheel stock trucks (Number 6) was the lowest cost system ($124.40 per thousand cases) when the warehouse was 30 miles from the retail store. Second lowest cost system ($125.90 per thousand) was handstacking in the delivery truck, receiving by conveyor and pricing at the shelf (Number 4).

1/ Based on estimated dry grocery sales of $24 billion, average case value of $5, and a wage rate of $2 per hour.

2/ This report does not include the shelf-stocking technique known as "tray pack," nor the use of gravity flow types of shelving.

The highest cost system for orders delivered 30 miles is the use of pallets for shipping, receiving and stocking (Number 2). Completely palletized handling from the warehouse slot to the store shelf has little application with the present scale of retail store operations. Except for shipments of less than 6 miles, shipping by pallet and receiving at the store by conveyor also has limited use and is more expensive than handstacking.

Relative costs of eight systems were different when the warehouse was a long distance from the retail store. For hauls of more than 78 miles, handstacking proved the lowest cost method.

While this study was in progress, U.S. Department of Agriculture researchers designed a new stamp set. This set reduced price-marking labor costs by $4.80 per thousand cases below those incurred with adjustable self-inking band stamps. The new set also cost less than the band stamps.

INTRODUCTION

This report presents costs of the functions performed in moving groceries from the warehouse to the retail store shelf and combines them in sequence. It also describes and evaluates some improved techniques and equipment for grocery handling. This research covers two basic systems, with variations, for moving merchandise from the warehouse slot to the retail store shelf. With one system, pallets are used to transport the merchandise; with the other, pallets are not used. When these two basic systems of shipping are combined with the various methods of handling merchandise at the store, eight overall systems result.

The study was designed to answer such questions as these: Does the time saved in shipping to and receiving at the store by pallets offset the loss of truck capacity and the additional time required to select and check palletized loads at the warehouse? How does the cost of palletized grocery handling compare with that of other systems of shipping, receiving, price-marking, and stocking? Some firms design their stores with receiving docks at truck bed height for unloading and with extra wide aisles so the shelves can be stocked directly from pallets: How are store costs affected? Can the efficiencies of unitized loading and unloading be combined without losing truck capacity and without increasing store handling costs? These factors have an important effect on operating costs and on store construction and design.

This study was confined to firms in which food distribution operations were integrated. Such firms handled 69 percent of the $55 billion estimated food store sales in 1959. 3/ They include voluntary-group and cooperative-group supermarkets, and those operated by corporate chain organizations. These operations are characterized by close working relationships between warehouses and supermarkets for such functions as group advertising, assistance in supervision and engineering, and assistance in unloading and receiving merchandise at the retail store.

3/ Mueller, R. W., Facts in Grocery Distribution. Progressive Grocer, April 1960, p. F. 7, 24 pp.

The time required to perform various store operations was determined by extensive motion-time studies in more than 50 retail stores of several regional and national food chains. Warehousing costs were based on detailed studies of operations in four warehouses. An analysis of trucking expenses, depreciation schedules, and operating methods was made to determine the shipping costs for several methods. These costs were based on using a 35-foot trailer to transport average loads to stores 15, 30, and 50 miles from the warehouse.

Production standards for warehousing and store operations, which include a 15 percent personal and fatigue allowance, were based on improved work methods developed through previous research in grocery handling. 4/ The jobs were divided into elements, and time to perform the elements was measured with a stopwatch or a constant-speed motion picture camera. The time for the various elements was then adjusted to reflect the speed of the average operator working at a normal pace and was applied at the frequency at which the element occurred. Labor costs are based on $2.50 per hour for warehousemen and truck drivers and $2 per hour for store personnel (with a 10-cent per hour premium for nightwork).

GROCERY HANDLING AT THE WAREHOUSE

Studies of alternative methods of grocery handling were made in four warehouses of different firms. In two of these warehouses comparable costs were developed for order assembly, checking, and truck loading, when the grocery cases were placed directly on the selector truck, and when they were placed on a pallet on the selector truck.

Order Assembly

In the newest warehouse, referred to as warehouse "A", the order selector used a battery-operated tow tractor to tow a train of four selector trucks. The grocery case could be placed on any one of the trucks.

When selecting cases from the warehouse slot, the order selector walked alongside the train and guided it with a radio control device attached to his waist. The warehouse had one-way aisles, thus eliminating cross-aisle travel. After he assembled the order, the selector towed the train to the shipping dock and positioned it for checking and truck loading. After disposing of the full train, he obtained empty trucks and returned to the selection area. When a pallet was used, he obtained the empty pallet at the shipping dock and placed it on the selector truck. This method is shown in figure 1.

4/ Bouma, J. C. "Methods of Increasing Productivity in Modern Grocery Warehouses," U. S. Dept. Agr. Mktg. Res. Rpt. 94, 30 pp., June 1955. Bouma, J. C., and Lundquist, A. L. "Grocery Warehouse Layout and Equipment for Maximum Productivity," U. S. Dept. Agr. Mktg. Res. Rpt. 348, 58 pp., July 1959. Harwell, E. M., and Shaffer, P. F. "Some Improved Methods of Handling Groceries In Self-Service Retail Food Stores," U. S. Dept. Agr. Mktg. Res. Rpt. 7, 118 pp. May 1952.

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Selecting a palletized order. The case may be placed on any one of four trucks in the tow train.

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While selecting the orders, the worker uses a radio control device at his waist to start, stop, and guide the trains. This order is not palletized.

Figure 1.--Order assembly in warehouse "A".

Part of warehouse "B" was arranged with U-shaped bays adjacent to an overhead towline. Here, merchandise was stored on pallet racks and in floor slots of varying depths. The order selector pushed a selector truck through the assembly area. When the truck was full, he attached it to the towline and it was automatically transported to the shipping dock. A towline operator removed the full trucks and attached empty trucks to the towline for use by the selector. When a pallet was used, it was obtained from a stack in the assembly area and placed on the selector truck by the selector (fig. 2).

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The order selector pulls a 4-wheel truck, with unpalletized order, through the selection area. When the truck is full, the selector attaches the hook to an overhead towline which automatically transports the truck to the shipping dock.

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When a pallet is used, it is placed on the selector truck.

Figure 2.--Order assembly in warehouse "B".

In both warehouses, palletized order assembly required more time than hand stacking the cases directly on the truck. This additional time was due to: (1) Obtaining and positioning the empty pallet on the selector truck; (2) stacking cases so they would not overhang the pallet; and (3) rehandling cases to form the case block. Additional time was also required when a lightweight case was set aside, then placed on top of the load, or a small case was used to fill a space in the load.

Order assembly costs were measured with and without the use of pallets in two warehouses. In warehouse "A", order assembly required 1.6 seconds, or 11 percent, more assembly time per case when orders were assembled on pallets. This difference totaled 27 man-minutes per thousand cases. In warehouse "B", additional time required to assemble orders on pallets totaled 2.9 seconds per case, or 48 additional man-minutes per thousand cases (table 1).

Table 1.--Labor time, cost per case, and productivity in assembling an order of groceries with and without the use of pallets in two warehouses

Element	Warehouse "A"		Warehouse "B"	
	With Pallet	Without Pallet	With Pallet	Without Pallet
	Seconds	Seconds	Seconds	Seconds
Obtain selector truck and pallet	.6	.2	1.1	.7
Travel, slot to slot	3.1	3.1	2.6	2.6
Select cases and position	6.2	5.5	11.1	10.0
Arrange cases	.4	.2	1.1	---
Miscellaneous elements	3.8	3.7	4.4	4.4
Towline	---	---	2.0	2.0
Total	14.1	12.7	22.3	19.7
15% personal and fatigue time	2.1	1.9	3.3	3.0
Standard time in seconds per case	16.2	14.6	25.6	22.7
Standard time in cases per man-hour	222	247	141	159
Labor cost: Cents per case @ $2.50 per hour	1.12¢	1.01¢	1.78¢	1.58¢

Order Checking

The kind and amount of order checking varies between companies. Some firms check assembled orders by commodity description, matching the invoice description with the case, to achieve a high degree of accuracy. Other firms count the pieces on the invoice and compare the total with the number of cases in the assembled order. If a discrepancy exists, the order is checked by commodity description. In some chainstores, orders are only spot checked, generally by piece count. The spot check includes orders assembled by new employees and those who are prone to make mistakes. These firms feel that more thorough checking is not warranted, since the merchandise is delivered to their own store. 5/ To determine the degree of order checking, the total cost of checking should be compared against the number of reported errors.

5/ The reliability of this method of checking was not studied. Studies were made in one warehouse where a 100-percent commodity check was used. Of 1,500,000 cases shipped by this warehouse over a 2-month period, 230 shortages and 130 overages were claimed when the orders were received at the store. It was felt that, since the tendency at store level was to claim shortages and overlook overages, the two figures probably average out. For additional information, see: Bouma, J. C. and Kriesberg, M. "Measures of Operating Efficiency In Wholesale Food Warehouses," U. S. Dept. Agr. Mktg. Res. Rpt. 399, 32 pp., May 1960.

A 30-percent commodity check was used in the two warehouses studied (table 2). Man-hour production for checking merchandise on selector trucks without pallets was over twice as great as checking palletized cases because orders were easier to check when they were on the trucks with the ends of cases clearly visible than on pallets with some cases hidden. Palletized cases were frequently moved to locate cases in the center of the pallet (fig. 3).

Table 2.--Productivity in checking orders assembled with and without pallets

	Standard time per case		Cases per man-hour	
	30% check	100% check	30% check	100% check
	Seconds	Seconds	Number	Number
With pallet	1.9	6.4	1886	566
Without pallet	.9	3.0	4000	1200

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Checking orders on selector trucks without pallets. When pallets are not used, the ends of the cases are clearly visible.

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When a pallet is used, the cases must often be shifted or removed to locate hidden cases for checking. This pallet has been properly blocked to facilitate loading into the trailer.

Figure 3.--Checking assembled orders.

Truck Loading

The grocery orders arrived at the loading dock on 4-wheel selector rucks.

Two methods of loading orders assembled on pallets, one method of hand-tacking, and a recently developed method of loading with the multiforklift ruck were studied.

In the first palletized method, the trailer load was partially topped off ith light, bulky items. This method was used when merchandise was received in tores on pallets and when the order was not a full trailer load. A low-mast ounterbalanced forklift truck removed the palletized orders from the selector ruck and loaded them into the trailer (fig. 4)

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Figure 4.--Using a low-mast forklift truck to load palletized orders into a trailer. The trailer floor must be strong enough to support the weight of the loaded forklift truck.

With the second method, the pallet loads were fully topped off (to the ceiling). In this instance, the order was received in the store by conveyors. 6/ The extent of top loading depends on the size of the order in relation to trailer capacity, length of haul, and method of store receiving.

In a few instances where the order size and length of haul were favorable, the pallets were not topped off.

With handstacking, orders assembled without pallets are pushed into the trailer and handstacked from the selector trucks (fig. 5).

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Figure 5.--Handstacking cases assembled without pallets. Cases are handstacked from the selector truck, which is pushed into the trailer.

With the newly developed multifork method, an average load of 35 cases is picked up from the selector truck on the shipping dock and positioned in the trailer in a manner similar to pallet loading. However, a pallet is not used. For this system, the selector truck must be modified to provide a slotted surface for the eight tines of the lift truck. One warehouse used a steel frame selector truck, 30 by 87 inches, on which 1/2" by 4" steel strips were welded to the frame 4" apart to provide entry for the fork (fig. 6).

6/ In all studies, one man did the entire loading. Based on previous studies, this is 33 percent more productive than a two-man crew. Bouma, J. C. "Methods of Increasing Productivity In Modern Grocery Warehouses," U. S. Dept. Agr. Mktg. Res. Rpt. 94, 30 pp., June 1955.

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A selector truck, used for multifork loading of unpalletized orders, showing grooves for the tines of the fork.

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The fork engages one-half of the load from the selector truck, then transports it into the trailer. The two outermost tines of the lift truck are slightly higher, causing the load to tilt inward.

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A scissors action mechanism pushes the cases from the fork onto the trailer floor.

Figure 6.--Loading unpalletized orders into the trailer.

When assembling cases, the order selector stacks two separate loads on each of one or more selector trucks. He tows the assembled order to the shipping dock and positions it for loading.

The multiforklift truck picks up a load and moves it into the trailer where it is lowered and pushed from the fork by a vertical metal plate attached to a scissors action mechanism. The two outermost tines of the fork are slightly higher than the others; thus the cases lean inward and the load is more stable. When this method is used, some cases are also handstacked in the trailer. The best man-hour production was achieved when the lift operator, rather than another employee, handstacked cases in the trailer.

The usual operating loads for a 35-foot trailer were:

Loading method	Cases
On pallets, with partial top-off	860
On pallets, with full top-off	1090
Multiforklift truck, with partial top-off	1105
Handstacked	1220

Labor costs for loading were lowest with partially topped-off pallets and highest when the handstacking method was used (table 3).

Table 3.--Labor costs for loading delivery trucks by four methods

Method of Loading	Standard time per case	Production per man-hour	Labor cost per 1,000 cases
	Seconds	Cases	Dollars
On pallets, with partial top-off	2.2	1622	1.52
Multiforklift truck, with partial top-off	2.4	1500	1.66
On pallets, with full top-off	3.8	952	2.62
Handstacked	6.3	571	4.35

Total Warehouse Costs

When the costs of order assembly, checking, and truck loading were totaled, the lowest cost system for these warehouse operations was with nonpallet order assembly, checking (30-percent commodity), and multifork loading. This system costs $13.90 per thousand cases. The next lowest cost system--selecting and checking orders on pallets and loading trailers, partially topped-off, with a regular forklift truck--cost $15.50 (table 4). The principal reason for this $1.60 difference is that multifork loading was about as fast as pallet loading yet did not add significant time for order assembly or checking.

Table 4.--Comparative labor and equipment costs per case for different systems of order assembly, checking, and loading

Operation	With pallets, some top load	With pallets, full top load	Without pallets, hand load	Without pallets, multi-fork 1/
	Seconds	Seconds	Seconds	Seconds
Order assembly	16.2	16.2	14.6	14.6
Commodity checking 2/	1.9	1.9	.9	.9
Truck loading	2.2	3.8	6.3	2.4
Total time per case	20.3	21.9	21.8	17.9
	Cents	Cents	Cents	Cents
Labor costs @ $2.50 per hour	1.41	1.52	1.51	1.24
Equipment costs 3/				
Order assembly	.12	.12	.11	.11
Loading	.02	.04	--	.04
Labor and equipment costs	1.55	1.68	1.62	1.39

1/ Order assembly and checking, with the multifork system, were studied in one firm. There was no measurable difference in the order assembly and checking time requirements.

2/ Based on a 30-percent sample check by description and case count.

3/ For comparative costs of grocery warehouse handling equipment, see: Bouma, J. C., and Lundquist, A. L. "Grocery Warehouse Layout and Equipment for Maximum Productivity," U. S. Dept. Agr. Mktg. Res. Rpt. 348, 58 pp., July 1959.

The fully topped-off pallet system was more costly than handstacking because the savings in truck loading time were more than offset by the time required for order selection and checking. Furthermore, some of these systems involved loss of delivery truck capacity (evaluated in the following section).

TRANSPORTATION TO THE RETAIL STORE

The second major cost in handling groceries is transportation expense. The principal factors affecting this expense are: The trailer capacity, length of haul, time for loading and unloading, equipment tieup time, the driver's time, and operating expenses.

Since the hourly charge for transportation equipment is affected by the length of time the equipment is used, records of over 200 tractor trailer units were examined to determine the average weekly equipment usage. The policies and procedures affecting the use of trucking fleets are fairly uniform among integrated wholesale-retail food distributors. However, some exceptions to this may be found in firms having unusually long delivery distances (400-500 miles) and those dropping loaded trailers at the supermarket.

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Delivery costs in this report were based on studies of internal operating data in seven warehouses of two firms. It appeared that these two firms did not materially differ from other firms and were achieving typical equipment utilization.

Maintenance costs were based on services provided in company-owned repair shops on their own equipment.

Trailer Capacity

All the methods of unitized loading, previously discussed, result in some loss of trailer capacity compared with the handstacking method. In this study the number of cases in the trailer for each method of loading was based on average operating loads of two firms over a 6-month period.

As previously indicated, the average operating loads for two firms using a 35-foot trailer were: 7/

Type of loading	Average operating load
On pallets, with partial top-off	860 cases
Multifork loading, with partial top-off	1105 cases
Handstacking	1220 cases

When 1,220 cases of average commodity mix were handstacked in the trailer, approximately 90 percent of the available space was utilized. When compared with average operating handstacked loads, the multifork method loses 9.4 percent, and loading out on partially topped-off pallets loses 29.5 percent (fig. 7). The principal difference in space loss between the multifork and the pallet method was the space occupied by the 16 pallets. Also, the pallets were top-loaded only to the extent that they could be easily unloaded with a pallet jack.

Determination of Delivery Costs

Any method of loading that results in fewer cases per trailer means more trips and higher delivery expense per case. Whether this added expense is significant depends on how much is saved at the warehouse through faster truck loading or at the store through faster receiving.

The following costs must be considered in evaluating the various systems in the delivery operation: (1) Equipment tieup costs at the warehouse, in transit, and at the store; (2) the driver's wage in transit; (3) variable expense per mile for gasoline, oil, tires, maintenance, insurance, licenses, and fees; and (4) fixed costs such as supervision, shortages, and damage.

7/ The trend in the warehouse-to-store shipments of grocery items is toward larger trailers. Most firms are now purchasing trailers between 35 and 40 feet long.

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When the load is handstacked, nearly all the trailer space is used.

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Pallet loading results in approximately 30 percent loss of trailer capacity.

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Pallets stacked to show the space occupied in a loaded trailer.

Figure 7.--Space utilization in trailers, with handstacking and pallet methods of loading.

The analysis was based on delivery operations in two firms. No imputed interest charge was made for capital invested in equipment because the firms studied did not make such charges directly to the delivery operation.

Equipment tieup costs.--To determine the depreciation of a tractor and trailer on an hourly basis, the average hours that the trailer fleet was in operation was divided into the annual depreciation charge. Trailers were used 36.8 hours per week; the depreciation charge was $1,800 annually or 90 cents per hour. Tractors were used 57.4 hours per week; the depreciation charge was $2,500 per unit annually, or 84 cents per hour (table 5).

Table 5.--Summary of delivery truck expenses

Expense item	Cost per hour	Cost per mile	Fixed cost per case
	Dollars	Dollars	Dollars
Tieup time			
Tractor	.84		
Trailer	.90		
Gas, oil, maintenance, insurance, and fees		.1688	
Driver's rate	2.50		
Supervision, shortages, and damage			.0067
Total per mile		.1688	
Total per hour	4.24		
Total fixed			.0067

Driver's wage.--The driver's wage was divided in two parts: The time for driving the truck to and from the store and the time for receiving merchandise at the store. Normally, the driver's wage in receiving at the retail store is also considered a part of the delivery expense. However, in this report it was charged to receiving, in order to pinpoint and compare receiving costs. An additional 30 minutes was charged to the driving time for each trip to cover such items as engaging and weighing the loaded trailer, parking, and delays at the store. The wage rate used was $2.50 per hour including fringe benefits. This was the typical wage rate in the firms studied.

Variable costs per mile.--The variable delivery costs are the expenses effected by the number of miles traveled. Insurance, licenses, and fees were also charged on a mileage basis. This category of charges, normally considered a fixed charge per operating unit, is treated as a variable expense to reflect a smaller number of trucks required when trailer capacity is used more efficiently. 8/

Fixed costs.--Each system of handling was charged the same amount for supervision, shortages, and damages.

8/ For an analysis of trucking expenses for individual units and the trucking fleet of a wholesale grocery company, see: Snitzler, J. R. "Improving the Truck Delivery Operations of a Wholesale Grocer," U. S. Dept. Agr. Mktg. Res. Rpt. 127, 51 pp., June 1956.

Comparative Delivery Costs for Five Systems

Delivery costs were determined by using shipments to 63 stores of one firm, and average operating loads as a basis for computing the number of trips, miles traveled, and other cost factors of alternative methods of loading, shipping, and store receiving. Delivery expenses were developed for five systems at 15-, 30-, and 50-mile distances from the warehouse.

The number of weekly trips for each system is the total number of grocery cases shipped to these 63 stores divided by the average operating load for the method of loading. The partially topped-off pallet method required 153.5 trips per week, the multifork 119.5, and handstacking 108.2 to deliver 132,000 cases.

Miles traveled were determined by multiplying the number of trips by the round trip distance from the warehouse; variable charges were applied to this mileage.

Time in transit was computed by dividing the miles traveled by the average miles per hour for a given distance from the warehouse. Thirty minutes were added to each trip for such elements as weighing the loaded trailer, parking, preparing to unload, and obtaining signatures for receipts at the store. Hourly cost of depreciation and the driver's hourly rate of pay were charged to this time. Depreciation was also charged for the trailer during loading at the warehouse and for the tractor and trailer during receiving at the store. Each system was charged the same amount for overages, shortages, damage, and administrative expense.

Delivery expenses were measured for the following five systems of loading delivery trucks at the warehouse and receiving at the retail store: System A, pallet loading with partial top-off and with merchandise received at the store on pallets and price-marked after receiving; System B, multifork loading with merchandise received on conveyor and price-marked as needed; System C, multifork loading with merchandise received on conveyor and price-marked at the store as received; System D, hand-loading with merchandise received on conveyor and price-marked as needed; and System E, hand-loading with merchandise received on conveyor and price-marked as received. Delivery expenses with these systems at 15, 30, and 50 miles from the warehouse are shown in table 6.

The lowest costs for delivery at 15, 30, and 50 miles from the warehouse were incurred by System D, handstacking in the trailer and receiving into the store by conveyor without price-marking. The next lowest cost system was System B, multifork loading with similar receiving at the store. The most costly was System A, shipping on partially topped-off pallets. Handstacking in the trailer means lower delivery cost because less space is lost in the trailer.

Total Costs for Warehousing and Transportation

The total costs for warehouse (order assembly, checking, and loading) and delivery systems depended in part on the delivery distance.

Table 6.--Delivery costs per case for transporting merchandise by five systems (A-E) from the warehouse to the retail store 15, 30, and 50 miles distant 1/

Distance from warehouse (miles)	Loaded and received on pallets; partial top-off; price-marked after received	Without pallets: Loaded in trailer with multifork; received by conveyor		Without pallets: Handstacked in trailer; received by conveyor	
		Price-marked as needed	Price-marked as received	Price-marked as needed	Price-marked as received
	A	B	C	D	E
	Cents	Cents	Cents	Cents	Cents
15	2.73	2.37	2.69	2.34	2.69
30	3.31	2.83	3.15	2.75	3.10
50	4.35	3.64	3.95	3.48	3.83

1/ For additional details, see appendix table 14.

At a distance of 6 miles from warehouse to store these total costs were the same for Systems A and D. At greater distances the palletized system was more costly. The truck driver's labor at the store was not included in these total costs, but was charged to store receiving. For Systems B and D the multifork system was less costly than handstacking, up to a distance of 78 miles from the warehouse. In both comparisons the cost of the unit-loading systems increased as the distance beyond the break-even point increased. 9/

It was assumed, in this study, that all loads were operating loads (the capacity of the trailer approximated the size of the order). In practice, many loads going out of the warehouse can be unit-loaded rather than handstacked to accomplish savings. For example, a 1,000-case order to be delivered 120 miles from the warehouse should be loaded with the multifork, rather than handstacked, because the total trailer capacity will not be used with either system and savings will be accomplished with unit loading.

Delivery expenses were not developed for the fully topped-off pallet method because the savings in truck loading at the warehouse were more than offset by higher costs of order assembly and checking.

GROCERY HANDLING AT THE RETAIL STORE

Approximately 60 percent of the cost of moving groceries from the warehouse slot to the store shelf is incurred at the retail store. When cases are received at the store, they are opened; the units are price-marked and handled individually in the stocking operation. A case that was 1 unit becomes 12, 24, or 48 units; thus, store handlings are more numerous than warehouse handlings.

9/ See appendix table 15.

In the following study of store operations all productivity and labor cost data are based on improved methods.

Backroom Layout

It is possible to use excellent work methods and equipment and still have a poor operation if the grocery storeroom does not have the proper layout. Whether groceries are received by conveyors or pallets, the layout will effect the time required for receiving and other operations (fig. 8). Unless the merchandise flows smoothly, without backtracking or bottlenecks, the layout is not right. For example the effectiveness of the conveyor is lost when an employee must walk a long distance between the conveyor and the point of storage.

BN-12101

A conveyor in the center of a storeroom requires two aisles, resulting in poor use of space. In addition, workers must cross over the conveyor when receiving and obtaining cases (see fig. 9).

BN-12102

A conveyor along the storeroom wall requires only one aisle; this arrangement is recommended for conveyor receiving in the long, narrow storeroom (see fig. 9).

Figure 8.--Storeroom arrangement for conveyor receiving.

A long rectangular storeroom with a conveyor along one wall is recommended for conveyor receiving. This type, as opposed to the L-shaped or square room with the conveyor bisecting the room, has the following advantages: (1) More precise commodity segregation; (2) more storage capacity; (3) eliminates crossing over the conveyor; (4) less receiving time; and (5) less time to locate and remove cases from storage.

The arrangement of storage space is as important as the shape of the storeroom. In one store, the storeroom was long and narrow, but the conveyor was 3 feet from one wall, and cases were stacked against this wall (fig. 9). Double rows of merchandise were located on the other side of the conveyor, perpendicular to it, with a 3-foot aisle between the conveyor and the end of the merchandise rows. Some of the rows were 8 feet high.

In the improved layout, the room was rearranged with the conveyor along one wall (fig. 9). Double-tiered stockracks were installed perpendicular to the opposite wall, with a 3-foot aisle between the stockracks and the conveyor. A shelf was mounted over the conveyor for small or lightweight items. This layout provided 23 percent more storage space, and the cases were more accessible.

Receiving

Previous studies showed that the productivity of conveyor receiving is superior to both the 2-wheel and the 4-wheel handtruck methods. This study compares conveyor receiving with pallet receiving.

The data includes time for the driver and for store employees in receiving, at their respective wage rates. No allowance was made in the receiving time for avoidable delays. These delays resulted from poor scheduling and crew organization rather than from the method of receiving. Merchandise was considered received when it had been: (1) Moved to the backroom, with the pallet method; (2) placed in segregated commodity stacks, with the conveyor receiving method; or (3) placed on the conveyor, en route to the pricing station, with the combined receiving and pricing operation.

Studies were made of three methods of receiving: Method A, merchandise received by pallet, price-marked after receiving; Method B, merchandise received by conveyor, price-marked as needed; and Method C, merchandise received by conveyor, price-marked as received (table 7).

With Method A, the merchandise was received by the truckdriver and one store employee using a pallet jack. The merchandise was pulled into the backroom and placed in temporary storage (fig. 10). This was the lowest cost method of receiving.

With palletized receiving, storage space at least equal to the size of the trailer must be provided for the loaded pallets (16 pallets in a 35-foot trailer) if merchandise is priced immediately after receiving or stored temporarily in the backroom and priced later. Handling groceries on pallets reduces storage requirements if the order is received after store hours and is moved direct to the sales area, or if racks are used for the storage of loaded pallets. However, reduced storage costs will then be offset, at least in part, by overtime wages or by additional handling and equipment costs if racks are used.

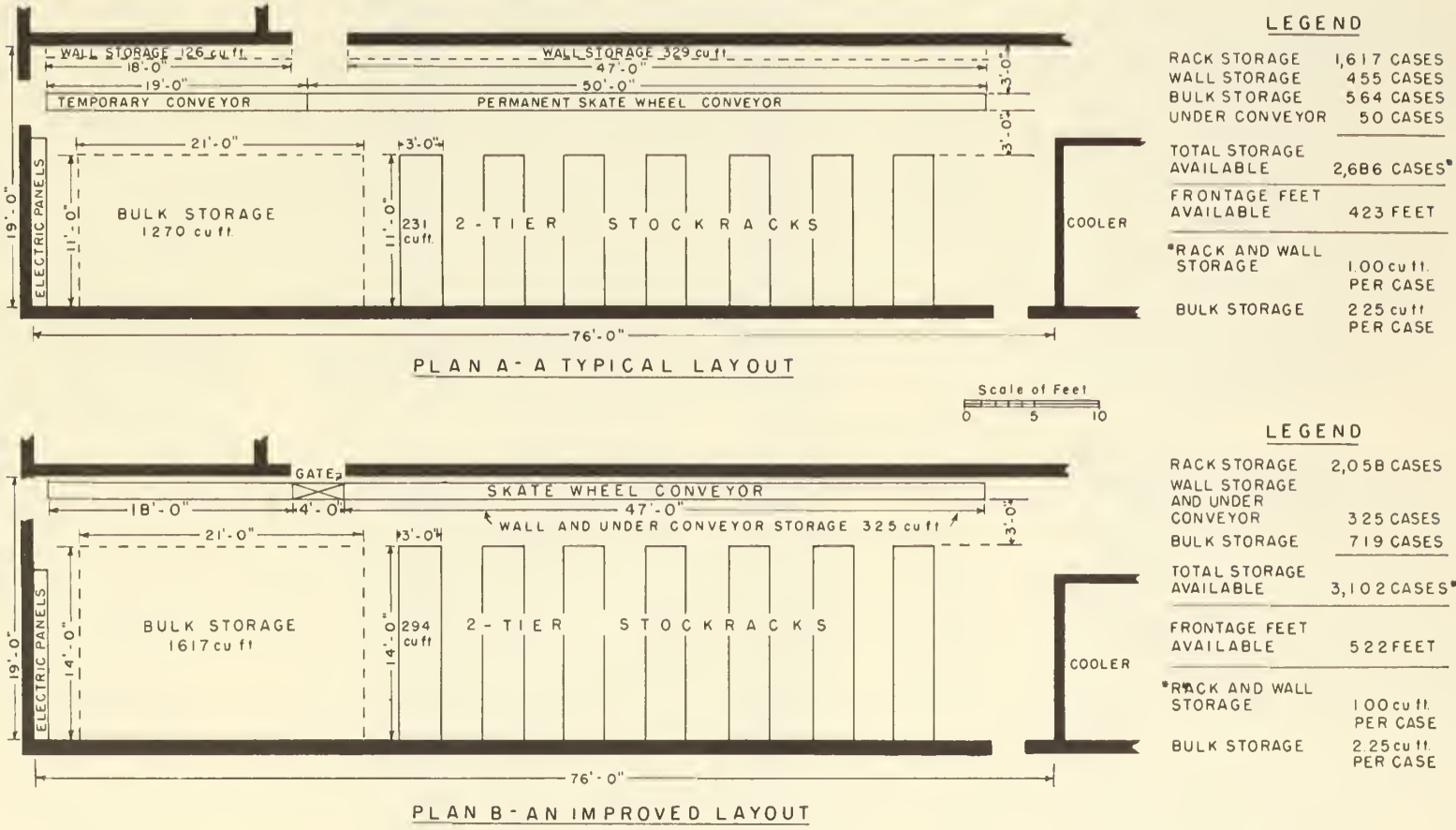

Figure 9.--Alternate layouts for rectangular storerooms.

Table 7.--Comparative time for labor and costs per case for three methods of receiving groceries at retail food stores

Method	Driver 1/		Store employees 2/		Total cost per case	
	Seconds	Cents	Seconds	Cents	Seconds	Cents
A: Pallet receiving (2 men), price-marked after receiving.....	3.7	.26	3.7	.21	7.4	.47
B: Conveyor receiving (3 men), price-marked as needed..	4.6	.32	9.3	.52	13.9	.84
C: Conveyor receiving price-marked as received 3/.....	11.7	.81	---	---	11.7	.81

1/ $2.50 per hour.
2/ $2.00 per hour.
3/ The costs of the combined conveyor receiving are understated since the store receiving costs include only the driver's time in receiving. This is an arbitrary break point; the other four men used in the operation are charged to price-marking.

Method B utilized the truckdriver and two store employees. The driver selected alternate cases from different merchandise categories and placed them on the conveyor in the trailer; two men in the storeroom removed the cases and placed them in segregated merchandise stacks or in a temporary location convenient to the conveyor. Temporary stacking is recommended only when most of the order is price-marked and placed on the shelves immediately after it is received.

With Method C, the typical crew consisted of the truckdriver and four store employees. The driver placed merchandise on the conveyor, the second man opened the case, the third placed the retail price on the face of the case, the fourth price-marked the merchandise, and the fifth placed merchandise in segregated commodity stacks or on a handtruck for stocking the shelves.

Price-Marking

When, where, how, and by whom price-marking is done varies among firms and also among units of the same firm. Cases can be price-marked at the warehouse or when they are received at the store; individual cans or packages can be price-marked as they are received at the store, in the backroom as needed, or at the shelf during the stocking operation. A band stamp or multi-impression stick stamps may be used to mark the prices on the individual units. Despite the development of these pricing tools, one may also find crayons being used in some stores.

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A manually operated pallet jack used for receiving at the store.

BN-12104

The loaded pallet is engaged and raised before it is moved.

BN-12105

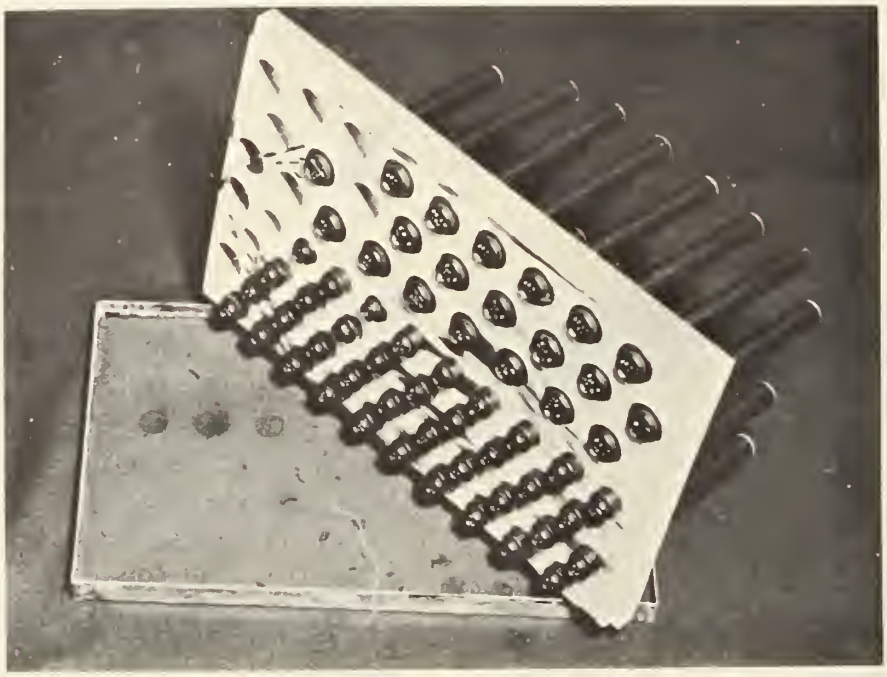
Two men are required to move one loaded pallet from the trailer.

BN-12106

Loaded pallets are placed in the storeroom.

Figure 10.--Receiving palletized merchandise at the retail store.

New stamp holder and stamps designed for price-marking.--During this study the researchers designed a new type of holder for the multi-impression stick-stamp set. The holder consists of a metal pan with 1/4-inch-thick foam rubber pad and a $1\frac{1}{2}$-inch-thick wooden stamp holder with tapered holes extending completely through it. The top edge of the holder is enclosed with $\frac{1}{2}$-inch aluminum molding to prevent warping. The sides of the holder rest on the edge of the pan, placing the base slightly above the inked pad so the holder will not become ink soaked. The stamps rest on the pad and are always wet, thus eliminating the necessity of inking the stamps before each use. The set is re-inked every 2 weeks (fig. 11).



BN-12107

Figure 11.--When this newly designed stamp set is in use, the tips of the stamps extending through the base will rest on the inked foam rubber pad in the tray.

The typical stamp set used by the cooperating firms had 106 multi-impression stick stamps. An analysis of warehouse movement and retail prices over a 12-month period showed that this set included 80 percent of the grocery prices used in the stores. Adjustable self-inking band stamps were used for the other 20 percent of the prices.

Based on the analysis of movement and retail prices, a new set of stick stamps was developed. This set had 59 stick stamps and included 85 percent of the prices used in the grocery department. The following prices were used in the newly designed stamp set: 10, 15, 17, 19, 20, 21, 23, 25, 27, 29, 30, 31, 33, 35, 37, 39, 41, 43, 45, 47, 49, 53, 55, 57, 59, 63, 65, 69, 75, 79, 85, 89, 95, 99; 2/19, 2/23, 2/25, 2/27, 2/29, 2/31, 2/33, 2/35, 2/37, 2/39, 2/41, 2/43, 2/45, 2/47, 2/49, (3/100, 4/100, 5/100, 6/100, 7/100, 8/100, 4/37, 6/57, 6/65, and 6/69) 10/

Because of the self-inking feature and few stamps, the improved stamp set reduced the time required for stamping the average case from 17.6 seconds for the typical large set to 15.5 seconds, a savings of $1.17 per thousand cases. When adjustable self-inking band stamps were used for all pricing, the newly designed set was substituted at a savings of 8.6 seconds per case or $4.80 per thousand cases.

In a store where 2,000 cases were price-marked each week, equipment cost per year for the newly designed stamps was $39.05, compared to $194 for the self-inking band stamps and $59.80 for the multi-impression stick-stamp set. Since the stamps in the improved set are always moist, the less frequently used stamps do not dry out as they do in the conventional set. Details of the labor and equipment costs are shown in appendix table 16.

Marking retail price on case.--The retail price of the individual items should be marked on the shipping case to eliminate searching through the price book when the items are price-marked for the shelves. This operation is not necessary when grocery items are price-marked at the shelf because the price can be taken from merchandise on the shelf.

In the combined receiving and price-marking operation, the typical practice is for one man in the crew to place the retail price on the face of the case as it is received. This method requires 12.0 seconds per case and causes delays for other members of the crew (fig. 12).

Studies were conducted to determine whether the cases could be marked with retail prices at the warehouse at lower cost than at the retail store. The logical time to mark the price on the case is when the order filler selects the case from the warehouse slot or places it on the selector truck (fig. 13). When he checks the item and the number of cases to pull, he also ascertains the price. When price changes are made, a warehouse employee should correct the price on the slot facing.

10/ Prices in parentheses reflect merchandising practices in one firm. Firms using different practices should determine the most frequently used prices for several months, and rank each price by the order of its importance. This determination can be easily made in firms using automatic tabulating equipment.

BN-12108

In this instance, the workers are kept busy by a steady flow of merchandise.

BN-12109

When merchandise is delayed, the price-marker (left) is idle while waiting for merchandise.

Figure 12.--Marking cases with retail prices in combined receiving and pricing operations at the store.

BN-12110

Figure 13.--Marking cases with retail prices during order assembly at the warehouse. Cases are immediately available to the pricer; hence fewer delays result for other members of the crew. This method is more efficient than pricing during the combined receiving and pricing operation.

If the face of the carton is exposed in the warehouse slot, the price should be written on the case before it is taken from the slot; otherwise, the case should be priced after it is placed on the selector truck. Marking the price on the case when it was placed on a pallet on the selector truck required 1.5 seconds longer than when the case was placed directly on the truck. Since only about 60 percent of the cases received at the warehouse were price-marked, this additional time averaged only 0.9 seconds more per case. In a warehouse shipping 100,000 cases per week, 25 hours could be saved in marking the cases if pallets were not used in assemblying orders. As shown in table 8, marking cases with retail prices at the store required over 7 seconds, or 0.34 cent per case, more than marking cases at the warehouse.

One company shipping 100,000 cases per week and price-marking cases as they were received at the store changed to warehouse pricing at a net savings of $12,500 a year.

Table 8.--Comparative time and labor cost for price-marking cases at retail store and warehouse 1/

Store receiving method	Pricing cases at the store 2/		Pricing cases at the warehouse 3/		Savings per 1,000 cases with warehouse pricing
	Seconds	Cents	Seconds	Cents	Dollars
By conveyor	12.0	0.67	4.8	0.33	3.40
By pallet	12.0	.67	5.7	.40	2.70

1/ Only 60 percent of the cases were price-marked at either location.
2/ Time required with combined receiving and price-marking, with store labor at $2 per hour.
3/ Warehouse labor at $2.50 per hour.

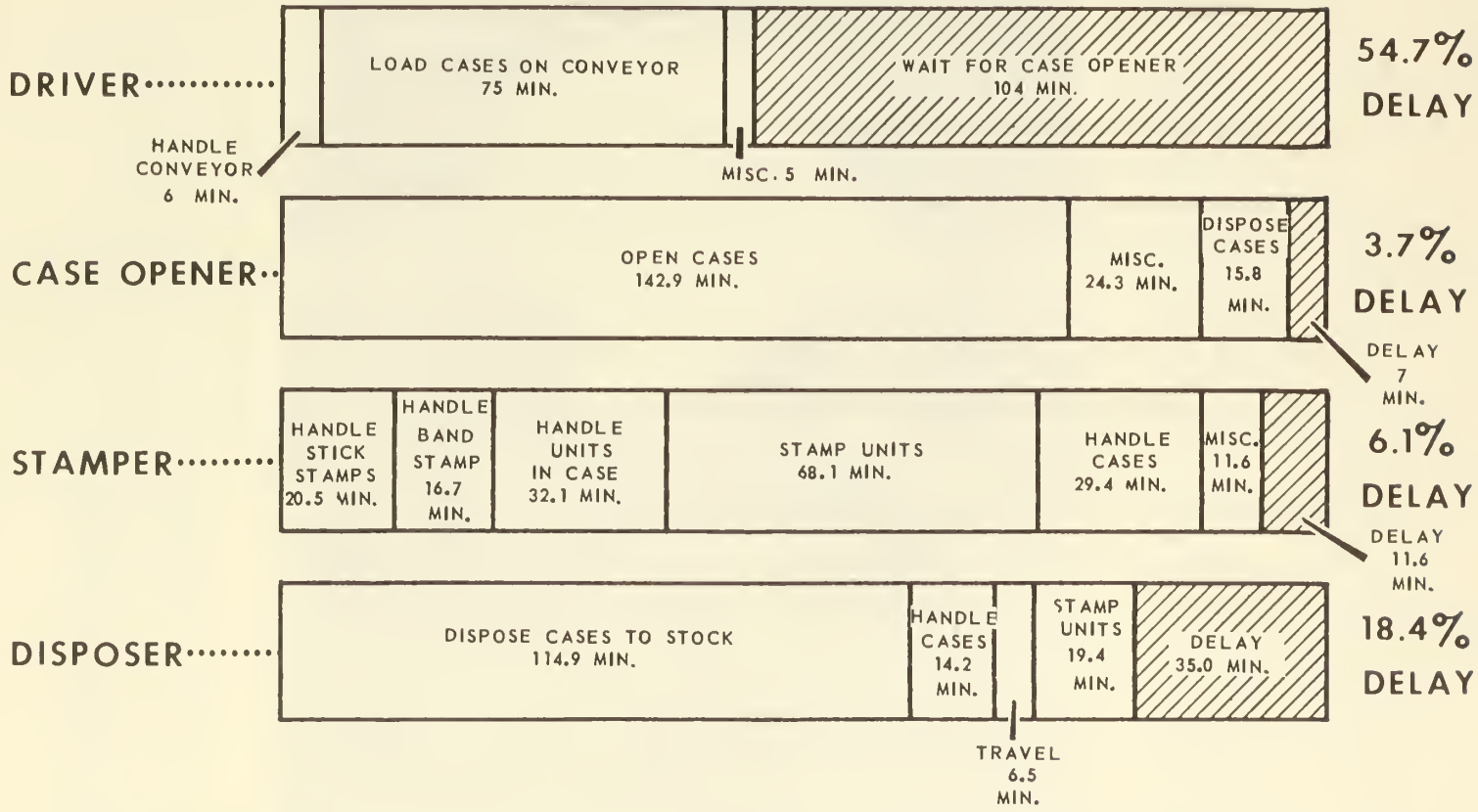
When price-marking is done in the backroom of the store, many operators combine receiving and price-marking operations to avoid extra handling in receiving, storing, and then obtaining cases for price-marking. This system can be used whether merchandise is received on pallets or by conveyor. The typical practice is for one man to place the retail price on the face of the shipping case as it moves to the area for price-marking the individual units in the case. When merchandise is received by pallet, the loaded pallets are parked in the backroom; the cases are then placed on the conveyor and price-marked if necessary.

About a third of the cases were not price-marked at either the warehouse or the store. Cases were not price-marked for such commodities as baby food and canned milk because the individual units were not price-marked in the retail store. The following items were excluded because they were marked at the shelf, and the price was obtained from shelf stock: Bleaches, cookies, housewares, cereals, paper products, sugar, flour, health and beauty items, extracts and spices, dessert products, cigarettes, and candy.

Price-marking individual items.--If the receiving and price-marking operations are combined, the case is opened and the individual units are price-marked before the case is placed in stock or on a stocktruck for display. There are many variations to this system; most of them require additional crew members for the pricing operation.

In these combined systems, many factors cause delays. Time required to open a case, stamp it, and place it in stock varies. Time required to remove the top of the case differs from time required to cut the case in half. Less time is required to stamp a 6-unit case than a 48-unit case. Using a band-stamp for the prices not in the stick-stamp set requires additional time. Marking several cases with the same price requires less time than changing stamps for different prices. The time required for placing cases on a stock truck near the conveyor differs from the time required to stack cases in bays. Only the driver and disposer are busy when items not to be price-marked are received. Sometimes the pricer cannot readily locate the price. The importance of each of these delays is shown in figure 14.

TIME UTILIZATION: FOUR-MAN CREW IN COMBINED CONVEYOR RECEIVING AND PRICE-MARKING OPERATIONS *



*TIME BASED ON RECEIVING 1,000 CASES, PRICE-MARKING ITEMS IN 600 OF THOSE CASES WHICH WERE RETAIL PRICE-MARKED AT THE WAREHOUSE.

U. S. DEPARTMENT OF AGRICULTURE NEG. 8397-61 (2) AGRICULTURAL MARKETING SERVICE

Figure 14.

A major problem of price-marking is stamping the units in the bottom layers of multilayer cases. This problem is readily solved at the lowest cost if a layer in the case is stamped at the shelf and then displayed. When units are price-marked in the backroom, the most widely used methods for 2-layer cases are: (1) Cut the case in half and stamp exposed units, and (2) remove lid and stamp top row, remove several units from the top layer to facilitate moving the remaining units, stamp the bottom row, and replace the units which were removed.

Costs of price-marking.--The two methods of price-marking that cost the least are pricing in the backroom using the half-case method (fig. 15) and pricing at the shelf from 4-wheel trucks in conjunction with stocking. Price-marking at the shelf from pallets is more costly than either of these methods (table 9).

BN-12111

Figure 15.--Price-marking in the grocery storeroom, using the half case method. This work surface is at a convenient height and the stamps readily accessible. When stamps are not in use, the inclined shelf is raised to a horizontal position to insure even distribution of ink in the stamp-set base.

Table 9.--Comparative labor costs per case for five methods of price-marking

Method	Time	Man-hour production	Cost 1/
	Seconds	Cases	Cents
Priced in backroom, as needed, half-case method 2/	36.1	100	2.08
Priced at shelf from handtruck	31.5	114	1.76
Priced at shelf from pallets 3/	40.4	89	2.36
Priced as received on conveyor 2/	44.2	81	2.46
Priced in backroom after received on pallets 2/	43.2	83	2.40

1/ Cost based on a wage rate of $2 per hour.
2/ Cost, based on price-marking 60 percent in the backroom and 40 percent at shelf, does not include the time or cost of pricing the case in the warehouse.
3/ Cost based on a wage rate of $2.10 per hour, allowing 10-cent premium pay for night work.

Price marking was more costly when it was combined with receiving than when the merchandise was price-marked, as needed, in the backroom or at the shelf because variations in the time required to do the different jobs caused delays for the crew and thus lowered production.

Combining price-marking with receiving cases on pallets cost less than price-marking items received on a conveyor, principally because the driver was at the store only long enough to discharge the pallets (table 10).

Table 10.--Costs for combined receiving and price-marking operations when cases are received on pallets and when received on conveyor (cases retail-priced at warehouse)

Operation	Time per case	Cost per case 1/
	Seconds	Cents
Receive on pallets, price-mark in backroom:		
Driver	3.7	0.26
Three store employees	32.8	1.82
Price-mark 40 percent (units) at shelf	10.4	.58
Price-mark case at warehouse	5.7	.40
Total per case	52.6	3.06
Receive on conveyor, price as received:		
Driver	11.8	.81
Three store employees	33.8	1.88
Price-mark 40 percent (units) at shelf	10.4	.58
Price-mark case at warehouse	4.8	.33
Total per case	60.8	3.60

1/ Driver at $2.50 per hour; store labor at $2 per hour.

Shelf Stocking

Some operators, who use pallets for shipping to and receiving at the retail store, price-mark in the backroom and then transport the cases to the sales floor on a stocking truck. Others move merchandise to the sales floor on pallets in order to take advantage of their greater capacity.

Using pallets increases the efficiency of moving the load to a specified area in the store. However, if pallets are used for shelf stocking during store hours, wider aisles are required for the passage of shopping carts, thereby increasing construction and operating costs. Day stocking with pallets requires a larger backroom, since the loaded pallets must be temporarily stored after receiving. Because of these considerations, and since many firms use pallet stocking after closing hours, the studies herein reported are for night stocking only. 11/ The improved stamp set, the perimeter storeroom, case support at the shelf, and good work methods were used in both the handtruck and pallet studies. 12/

Moving the case to the shelf location.--When merchandise was price-marked at the shelf, from a stocking truck, the clerk loaded cases from segregated merchandise stacks in the backroom and transported an average of 16 cases per load to the shelf. If merchandise was price-marked in the storeroom by the backroom stamper, the clerk merely exchanged an empty truck for a loaded one. At the shelf, the clerk pulled out the case supports in the section to be stocked, cut the cases either on the truck or the case support, price-marked the merchandise and placed it on the shelves.

When pallets were used, a pallet holding an average of 45 cases was transported from temporary storage in the backroom by two men using a manually operated pallet jack. Since one pallet could hold merchandise for several aisles, the pallet was parked at the end of the aisle; cases were sorted and then transported, on 2-wheel handtrucks, to the shelf location (fig. 16). High-platform handtrucks were used for case cutting and stamping (fig. 17). For stocking the shelves, cases were positioned either on the case support or on the floor. Paper goods and cereal were obtained directly from the pallet, one or two cases at a time, with the platform truck.

11/ The hourly premium for nightwork usually ranges from $0.10 per hour to time-and-a-half. This report uses a wage rate of $2 with a $0.10 premium, and no extra charge for supervision, for pallet stocking at night. The time to perform elements of the stocking operation is shown in seconds; costs are shown in cents per case. Each operator should substitute his own wage rates to determine his costs.

12/ The case support is a pullout shelf on which the case is positioned between the operator and the middle shelf. It will save $3.80 per thousand cases stocked. See: Harwell, E. M., and Shaffer, P. F. "Some Improved Methods of Handling Groceries In Self-Service Retail Food Stores," U. S. Dept. of Agr. Mktg. Res. Rpt. 7, 118 pp., May 1952, page 61.

BN-12112

Moving a loaded pallet from temporary storage in the backroom to the sales area.

BN-12113

Cases being sorted by aisle location for transporting with 2-wheel hand-trucks.

Figure 16.--Typical case handlings with pallet received merchandise.

BN-12114

Figure 17.--After cases are transported to the shelf location the merchandise is priced on the platform truck, then positioned on the pullout case support or the floor for shelving the units.

The two methods of moving unpriced merchandise to the shelf location; included the following elements:

Pallet method

1. Position pallet jack.
2. Jack up pallet.
3. Travel to sales floor.
4. Position and let down pallet.
5. Obtain cases and place them in stacks for 2-wheel handtrucks.
6. Engage stacks.
7. Transport cases to shelf location.
8. Unload cases at shelf.
9. Position case at shelf.
10. Return to stacks.

Stocking truck method

1. Obtain case from stock.
2. Load case on stocktruck.
3. Travel to shelf.
4. Position case at shelf.

The time required to perform the above steps was 28.9 seconds when using pallets and 18.6 seconds for the stocking truck. This saving of 10.3 seconds per case, or $6.01 per 1,000 cases, does not include the necessary rehandling of cases that could not be stocked and were returned to the storeroom.

Three trips were made to the backroom with the stocking truck to obtain the number of cases that could be transported with one trip by pallet. However, more time per case was required to move merchandise from the backroom to the salesroom shelf by pallet than by stocking truck because: (1) Sorting the mixed loads on the pallet and transporting them to the shelf required more time; (2) moving a full pallet to the sales floor required two men; (3) travel time per trip was slower with the pallet; and (4) extra time was needed to pick up the pallet and let it down.

Shelf stocking time requirements.--Exclusive of rehandling excess cases after stocking, the pallet method required 84.2 seconds per case and the handtruck 80.3 seconds to stock the shelf. The 3.9 seconds difference is due to more travel in the aisle to obtain cases (because of the large amount of assembled merchandise) and the handling of excess full and half cases not needed for the shelf.

Rehandling cases.--An important part of the hidden costs of grocery handling systems is due to the rehandling of cases.

If pallets are used for stocking, the amount of merchandise left on the sales floor after the shelves are stocked indicates the extent of case rehandling. In the pallet operation studied, 39 percent of the merchandise ordered (21 percent half cases and 18 percent full cases) remained on the sales floor after stocking. These cases were set aside during stocking, reloaded on pallets, and placed in storage in the storeroom. When needed for later stocking, they were removed from storage and moved to the floor on stocking trucks.

In the handtruck system, 15 percent of the half cases were not immediately needed for the shelf. The lower percentage is attributed to merchandise being requisitioned from the backroom close to the time it is needed at the shelf instead of 1 to 3 days in advance of shelf needs as is done with the pallet method. When the stocking truck is used, cases are cut in half before they are transported to the shelf. The only extra time required for them is the time to cut the case in half, return a half case to stock, and remove the half case from storage as needed later.

The pallet system required five times more rehandling than the handtruck method. Rehandling for palletized cases required 19.1 seconds per case compared to 3.6 seconds with the handtruck method, a difference of 15.5 seconds or $9.14 per thousand cases (table 11).

Table 11.--Comparative time and labor costs for rehandling cases with the pallet and handtruck method of stocking

Rehandling elements	Using pallets	Using handtrucks
	Seconds	Seconds
Assemble leftover cases at shelf	19.5	---
Cut case in half and return to stock 1/	---	4.6
Return cases from sales floor	9.2	---
Remove case from storeroom	8.7	2/ 6.4
Transport to shelf	5.2	---
Rehandle half case during stocking	13.8	12.7
Time per case to rehandle 100% of cases	56.4	23.7
Time adjusted for frequency of occurrence	19.1	3.6
Rehandling costs per 1,000 cases stocked	$11.14	$2.00

1/ "Cut case in half" represents the difference between time required to remove the top and to cut the case in half.

2/ Time for travel to the shelf has been previously charged to original handling.

Costs for Handtruck and Pallet Stocking

Pallet stocking required 34.2 seconds more per case, or $22.60 per thousand cases stocked, than the handtruck method (table 12). The following functions, of which rehandling is the most important, are the principal causes of the higher cost: (1) Transporting full cases from the storeroom to the shelf; (2) stocking merchandise at the shelf; and (3) rehandling full and half cases and handling trash.

Even if all rehandlings were eliminated from both systems, pallet stocking would still require 25 seconds more per case. Savings could be made at the store by receiving on pallets if a full pallet of like merchandise was received for a special display or a full pallet of one commodity was received and stored on the pallet. However, only large-volume stores move sufficient quantities to receive a full pallet of like merchandise.

If conveyor receiving were used for most of the load, and pallet receiving for the balance, a power booster would have to be installed on the conveyor. Otherwise, it would be difficult to utilize gravity in receiving because the dock would be at truck bed height for receiving a few pallets of merchandise.

Table 12.--Comparative time and labor costs per case for shelf stocking operations with pallets and 4-wheel stocking trucks 1/

Function	Pallets			4-wheel stocking truck		
	Percent occurrence	Seconds	Cents	Percent occurrence	Seconds	Cents
Travel to sales floor...	100.0	7.4	0.43	100.0	5.2	0.29
Remove cases from pallet, position them at shelf	85.0	13.0	.76	---	---	---
Remove cases from stock and load them on handtrucks	---	---	---	115.0	6.4	.36
Stock shelves	100.0	84.2	4.91	100.0	80.3	4.46
Handle trash	121.0	11.5	.67	115.0	5.5	.31
Assemble leftover cases	39.0	7.6	.44	---	---	---
Return leftovers to storage	39.0	3.6	.21	---	---	---
Remove leftovers from storage	39.0	3.4	.20	15.0	2/ 1.7	.09
Take leftovers to shelf with handtruck	28.5	1.6	.09	---	---	---
Rehandle half cases at shelf	21.0	2.9	.17	15.0	1.9	.11
Total per case		135.2	7.88		101.0	5.62

1/ Labor costs with pallets at $2.10 per hour, with stocking trucks at $2 per hour.

2/ Includes cutting 15 percent of the cases in half, placing them in stock, and obtaining them from stock.

SUMMARY OF COSTS FOR EIGHT SYSTEMS OF HANDLING

Costs were measured for eight systems of handling groceries from the warehouse slot to the retail store shelf (table 13). The systems are: (1) Merchandise assembled and shipped on pallets and priced in the storeroom; (2) merchandise assembled and shipped on pallets and priced at the store shelf; (3) merchandise handstacked in trailers and priced in the storeroom after receiving; (4) merchandise handstacked in trailers and priced at the store shelf; (5) merchandise loaded on trailers with a multiforklift truck and priced in the storeroom after receiving; (6) merchandise loaded with a multiforklift truck and priced at the shelf; (7) merchandise handstacked in trailers and priced as received; and (8) merchandise loaded with a multifork truck and priced as received.

Table 13.--Summary of costs for improved methods of handling groceries from warehouse selection through store shelf stocking by eight methods (30-mile radius from the warehouse)

System number and method	Operating trailer capacity	Order assembly, checking, and loading 1/	Transportation	Receiving	Price-marking	Shelf-stocking	Total cost per case	Cost per thousand cases
Separate receiving and price marking:	Cases	Cents	Cents	Cents	Cents	Cents	Cents	Dollars
1. Shipped on pallets, priced in storeroom 2/	860	3/ 1.95	3.31	0.47	2.40	5.62	13.75	137.50
2. Shipped on pallets, priced at shelf	860	1.55	3.31	0.47	2.36	7.88	15.57	155.70
3. Shipped handstacked, priced in storeroom	1,220	3/ 1.95	2.75	0.84	4/1.75	5.62	12.91	129.10
4. Shipped handstacked, priced at shelf	1,220	1.62	2.75	0.84	1.76	5.62	12.59	125.90
5. Shipped multifork, priced in storeroom	1,105	1.72	2.83	0.84	1.75	5.62	12.76	127.60
6. Shipped multifork, priced at shelf	1,105	1.39	2.83	0.84	1.76	5.62	12.44	124.40
Combined receiving and price marking:								
7. Shipped handstacked, priced as received 2/	1,220	1.95	3.10	0.81	2.46	5.62	13.94	139.40
8. Shipped multifork, priced as received 2/	1,105	1.72	3.15	0.81	2.46	5.62	13.76	137.60

1/ Total warehousing costs include the placing of the retail price on the outside of the case for all systems except those where pricing is performed at the shelf.

2/ With multiple man crews.

3/ Warehousing costs for systems 1 and 3 are the same when the costs of price-marking cases are included.

4/ This cost differs from the cost shown in table 9 because the cost of placing the retail price on the outside of the case is included in warehousing cost in this table.

Of the eight systems, number 6 (loading by multifork, receiving by conveyor, and pricing at the shelf using 4-wheel stocking trucks) is the lowest cost system at 30 miles from the warehouse; the cost is $124.40 per thousand cases. At the same distance, the number 4 system (handstacking at the warehouse, receiving by conveyor, and pricing at the shelf) would cost $125.90 per thousand cases, or $1.50 more than the number 6 system. The next lowest cost combination, number 5 (the same system as number 6, except that pricing is done in the backroom at a fixed workplace fed by a conveyor) costs $127.60 per thousand cases. The cost for system 3 (handstacked shipping and storeroom pricing) is $129.10 per thousand cases, or $3.20 more than system 4 (pricing at the shelf). The highest cost system, number 2 (using pallet for shipping, receiving, and stocking) costs $155.70 per thousand cases, or $31.30 more than number 6 system.

The three systems requiring multiple-man crews, number 1 (pallet shipped and received), number 7 (handstacked and conveyor received), and number 8 (loaded with multifork and priced as received), cost about the same, $137.50, $139.40, and $137.60, respectively, per thousand cases. They cost from $13 to $15 more per thousand cases than the number 6 method. Multifork handling is less costly than pallet handling at the warehouse because the costs of palletized order assembly and checking offset some of the savings in truck loading. Because more trucking capacity is lost with pallet shipping, additional savings are accomplished with the multifork method.

For orders shipped the distance at which transportation costs offset the savings of unitized loading and for shorter distances, the lowest cost handling system, number 6, uses unitized loading at the warehouse.

On the basis of data in this study, warehouses shipping most of their orders up to 78 miles from the warehouse should load delivery trucks with the multifork, and warehouses shipping most of their orders over that distance should use system number 4 and handstack orders in the trailer. 13/ Since the break-even distance for unitized loading will vary from one company to another, depending on warehousing and delivery costs, each firm should substitute its own costs to determine the break-even point.

Shipping by pallet and receiving at the store by conveyor has a limited use and is more expensive than handstacking for distances over 6 miles from the warehouse. Completely palletized handling from the warehouse slot to the store shelf also has little application with the present scale of retail store operations.

13/ See appendix table 15 for computation of the 78-mile break-even distance for multifork loading.

APPENDIX

Table 14.--A comparison of weekly delivery expense for shipping dry groceries to 63 stores at 15-, 30-, and 50-mile distances from the warehouse with 5 methods of loading and receiving at the store using a tractor and 35-foot trailer 1/

Method of shipping and store receiving	Trips per week 2/	Miles per week 3/	Transit time 4/	Variable trucking expense 5/	Driver's cost 6/	Tieup time 7/	Other fixed charges 8/	Total expense 9/	Cost per case 10/
	Trips	Miles	Hours	Dollars	Dollars	Dollars	Dollars	Dollars	Cents
Shipped by partially topped-off pallets and received on pallets--860 cases per trip									
15-mile radius at 15 m.p.h.	153.5	4,605	307.0	777.32	959.38	972.51	888.36	3,597.57	2.73
30-mile radius at 30 m.p.h.	153.5	9,210	307.0	1,554.65	959.38	972.51	888.36	4,374.90	3.31
50-mile radius at 40 m.p.h.	153.5	15,350	383.8	2,591.08	1,151.38	1,105.62	888.36	5,736.54	4.35
Multifork loading, conveyor receiving, price-marked as needed--1,105 cases per trip									
15-mile radius at 15 m.p.h.	119.5	3,585	239.0	605.15	746.88	893.78	888.36	3,134.17	2.37
30-mile radius at 30 m.p.h.	119.5	7,170	239.0	1,210.30	746.88	893.78	888.36	3,739.32	2.83
50-mile radius at 40 m.p.h.	119.5	11,950	298.8	2,017.16	896.38	997.83	888.36	4,799.73	3.64
Multifork loading, conveyor receiving, combined with price-marking--1,105 cases per trip									
15-mile radius at 15 m.p.h.	119.5	3,585	239.0	605.15	746.88	1,313.54	888.36	3,553.54	2.69
30-mile radius at 30 m.p.h.	119.5	7,170	239.0	1,210.30	746.88	1,313.54	888.36	4,159.08	3.15
50-mile radius at 40 m.p.h.	119.5	11,950	298.8	2,017.16	896.38	1,417.59	888.36	5,219.49	3.95
Handstacking, conveyor receiving, price-marked as needed--1,220 cases per trip									
15-mile radius at 15 m.p.h.	108.2	3,246	216.4	547.92	676.25	973.33	888.36	3,085.86	2.34
30-mile radius at 30 m.p.h.	108.2	6,492	216.4	1,095.85	676.25	973.33	888.36	3,633.79	2.75
50-mile radius at 40 m.p.h.	108.2	10,820	270.5	1,826.42	811.50	1,067.46	888.36	4,593.74	3.48
Handstacking, conveyor receiving combined with price-marking--1,220 cases per trip									
15-mile radius at 15 m.p.h.	108.2	3,246	216.4	547.92	676.25	1,432.69	888.36	3,545.22	2.69
30-mile radius at 30 m.p.h.	108.2	6,492	216.4	1,095.85	676.25	1,432.69	888.36	4,093.15	3.10
50-mile radius at 40 m.p.h.	108.2	10,820	270.5	1,826.42	811.50	1,526.82	888.36	5,053.10	3.83

Note: See footnotes on following page.

Footnotes for Table 14.

1/ Based on total weekly receipts by 63 stores (132,000 cases) divided by the trailer capacity for the method of loading. Weekly orders ranged from 401 to 4,582 cases. Average weekly receipts were 2,097 cases per store.

2/ Average trailerload divided into weekly shipments.

3/ Trips per week times average distance to and from the warehouse.

4/ Based on estimated speeds given.

5/ Gas, oil, maintenance, insurance, licenses, fees, and other expenses that vary with the miles traveled -- 16.88 cents per mile.

6/ Computed at $2.50 per hour. Time in transit plus 30 minutes per trip for engaging tractor, weighing at the warehouse, miscellaneous elements, and delays at the store.

7/ The value of tieup time was computed by taking the total number of hours worked by the truckdrivers and dividing by (1) the number of tractors -- 57.4 hours per week, (2) the number of trailers -- 38.6 hours per week. These hours were divided into the annual depreciation rate of $2,500 for tractors and $1,800 for trailers. The depreciation then charged was $0.90 per hour for trailers and $0.84 per hour for tractors. Depreciation was charged against the trailer only during loading and against the tractor and trailer during transit and receiving; an additional 30 minutes per trip was allowed for miscellaneous elements. The following tieup times were used:

Truck loading	
With partially topped-off pallets	0.036 min. per case or 79.2 hours
With multifork	0.040 min. per case or 88.0 hours
With handstacking (one man)	0.105 min. per case or 231.0 hours
Store receiving	
By pallet	0.061 min. per case or 134.2 hours
By conveyor	0.077 min. per case or 169.4 hours
By conveyor combined with price-marking	0.197 min. per case or 433.4 hours

8/ Supervision, overages, shortages, damage, and administrative expense -- 0.673 cents per case or $888.36 per week.

9/ Does not include the driver's time at the store. This time is charged to receiving, to compare different receiving methods.

10/ Total cost divided by weekly movement of 132,000 cases. To compare cost in dollars per thousand cases, move decimal point one place to the right.

Table 15.--Determination of break-even distance with alternative shipping methods

General Formula: Warehousing cost + miscellaneous driver cost + driver cost in transit + variable costs + value of tieup time + fixed costs = Cost for system.

Warehousing cost includes costs for order assembly, checking, and loading.

Miscellaneous driver cost includes trips per week, times 30-minute delay allowance, times driver pay.

Driver cost in transit includes trips per week, times average distance divided by miles per hour, times driver pay.

Variable costs include variable costs per mile, times miles traveled.

Value of tieup time includes the time at the dock, in transit, in receiving, and 30 minutes per trip for tractor and trailer.

Fixed costs include supervisory and other fixed costs.

Break-even distances were computed from costs obtained from a company that cooperated in this study. These costs, based on shipping 132,000 cases per week and separate conveyor receiving at the store, are:

	Handstacking (108.2 trips)	Multifork (119.5 trips)	Pallets (153.5 trips)
Order assembly, checking, and loading 1/	$2,217.60	$1,834.80	$2,046.00
Tieup time ($0.90 per hr. for trailer, $0.84 for tractor) 2/			
Dock	208.08	79.29	71.37
Transit (varies)	--	--	--
Store	294.93	294.93	294.93
30-minute allowance per trip	94.31	104.05	136.07
Driver cost per hour	2.50	2.50	2.50
Variable costs per mile	.1688	.1688	.1688

1/ See table 4.
2/ See footnote 7, table 14, for details of tieup time.

Handstacking compared with multifork loads (suburban and rural driving conditions and separate conveyor receiving)

D = Distance to and from warehouse

1. Handstacking:

$$\frac{\text{Whse. cost}}{2{,}217.60} + \frac{\text{Misc. driver cost}}{(108.2 \text{ trips} \times .5 \text{ hrs.} \times \$2.50)} + \frac{\text{Driver cost in transit}}{\frac{(108.2D \times \$2.50)}{(40 \text{ m.p.h.})}} + \frac{\text{Variable costs}}{(108.2 \times .1688D)} + \frac{\text{Value of tieup time}}{208.08 + \frac{(108.2D \times 1.74)}{(40 \text{ m.p.h.})}} + \frac{\text{Fixed costs}}{94.31} =$$

(continued on following page)

Handstacking compared with multifork loads (suburban and rural driving conditions and separate conveyor receiving)

D = Distance to and from warehouse

1. (Continued from preceding page)

Multifork loading:

$$\frac{\text{Whse. cost}}{1{,}834.80} + \frac{\text{Misc. driver cost}}{(119.5 \text{ trips} \times .5 \text{ hrs.} \times \$2.50)} + \frac{\text{Driver cost in transit}}{\frac{(119.5D \times \$2.50)}{(40 \text{ m.p.h.})}} + \frac{\text{Variable costs}}{(119.5 \times .1688D)} + \frac{\text{Value of tieup time}}{79.29 + \frac{(119.5D \times 1.74)}{(40 \text{ m.p.h.})}} + \frac{\text{Fixed costs}}{104.05}$$

2. $2217.60 + 135.25 + \frac{270.50D}{40} + 18.26D + 208.08 + \frac{188.27D}{40} + 94.31 = 1{,}834.80 + 149.38 + \frac{298.75D}{40} + 20.17D + 79.29 + \frac{207.93D}{40} + 104.05$

3. $\frac{270.50D}{40} + 18.26D + \frac{188.27D}{40} - \frac{298.75D}{40} - 20.17D - \frac{207.93D}{40} = 1{,}834.80 + 149.38 + 79.29 + 104.05 - 2217.60 - 135.38 - 208.08 - 94.31$

4. $-\frac{47.91D}{40} - 1.91D = -487.85$

5. $\frac{47.91D}{40} = 487.85 - 1.91D$

6. $47.91D = 40\ (487.85 - 1.91D)$

7. $47.91D = 19{,}514 - 76.4D$

8. $124.31D = 19{,}514$

9. D = 156.98 miles to and from the warehouse; within a radius of 78.5 miles from the warehouse, multifork loading is more efficient than handstacking.

Handstacking compared with partly topped-off pallets (city and suburban driving conditions and separate conveyor receiving)

1. Handstacking:

$$\frac{\text{Whse. cost}}{2{,}217.60} + \frac{\text{Misc. driver cost}}{(108.2 \text{ trips} \times .5 \text{ hours} \times \$2.50)} + \frac{\text{Driver cost in transit}}{\frac{(108.2D \times \$2.50)}{(20 \text{ m.p.h.})}} + \frac{\text{Variable costs}}{(108.2 \times .1688D)} + \frac{\text{Value of tieup time}}{208.08 + \frac{(108.2D \times 1.74)}{(20 \text{ m.p.h.})}} + \frac{\text{Fixed costs}}{94.31} =$$

Partly topped-off pallets:

$$\frac{\text{Whse. cost}}{2{,}046} + \frac{\text{Misc. driver cost}}{(153.5 \text{ trips} \times .5 \text{ hrs.} \times \$2.50)} + \frac{\text{Driver cost in transit}}{\frac{(153.5D \times \$2.50)}{(20 \text{ m.p.h.})}} + \frac{\text{Variable costs}}{(153.5 \times .1688D)} + \frac{\text{Value of tieup time}}{71.37 + \frac{(153.5D \times 1.74)}{(20 \text{ m.p.h.})}} + \frac{\text{Fixed costs}}{136.07}$$

Table 15.--Determination of break-even distance with alternative shipping methods

General Formula: Warehousing cost + miscellaneous driver cost + driver cost in transit + variable costs + value of tieup time + fixed costs = Cost for system.

Warehousing cost includes costs for order assembly, checking, and loading.

Miscellaneous driver cost includes trips per week, times 30-minute delay allowance, times driver pay.

Driver cost in transit includes trips per week, times average distance divided by miles per hour, times driver pay.

Variable costs include variable costs per mile, times miles traveled.

Value of tieup time includes the time at the dock, in transit, in receiving, and 30 minutes per trip for tractor and trailer.

Fixed costs include supervisory and other fixed costs.

Break-even distances were computed from costs obtained from a company that cooperated in this study. These costs, based on shipping 132,000 cases per week and separate conveyor receiving at the store, are:

	Handstacking (108.2 trips)	Multifork (119.5 trips)	Pallets (153.5 trips)
Order assembly, checking, and loading 1/	$2,217.60	$1,834.80	$2,046.00
Tieup time ($0.90 per hr. for trailer, $0.84 for tractor) 2/			
Dock	208.08	79.29	71.37
Transit (varies)	--	--	--
Store	294.93	294.93	294.93
30-minute allowance per trip	94.31	104.05	136.07
Driver cost per hour	2.50	2.50	2.50
Variable costs per mile	.1688	.1688	.1688

1/ See table 4.
2/ See footnote 7, table 14, for details of tieup time.

Handstacking compared with multifork loads (suburban and rural driving conditions and separate conveyor receiving)

D = Distance to and from warehouse

1. Handstacking:

$$\underset{2,217.60}{\text{Whse. cost}} + \underset{(108.2 \text{ trips} \times .5 \text{ hrs.} \times \$2.50)}{\text{Misc. driver cost}} + \underset{(40 \text{ m.p.h.})}{\frac{(108.2D \times \$2.50)}{}} \text{ Driver cost in transit} + \underset{(108.2 \times .1688D)}{\text{Variable costs}} + \underset{208.08}{\text{Value of tieup time}} + \underset{(40 \text{ m.p.h.})}{\frac{(108.2D \times 1.74)}{}} + \underset{94.31}{\text{Fixed costs}} =$$

Handstacking compared with multifork loads (suburban and rural driving conditions and separate conveyor receiving)

D = Distance to and from warehouse

1. (Continued from preceding page)

Multifork loading:

$$\frac{\text{Whse. cost}}{1{,}834.80} + \frac{\text{Misc. driver cost}}{(119.5 \text{ trips} \times .5 \text{ hrs.} \times \$2.50)} + \frac{\text{Driver cost in transit}}{\frac{(119.5D \times \$2.50)}{(40 \text{ m.p.h.})}} + \frac{\text{Variable costs}}{(119.5 \times .1688D)} + \frac{\text{Value of tieup time}}{79.29 + \frac{(119.5D \times 1.74)}{(40 \text{ m.p.h.})}} + \frac{\text{Fixed costs}}{104.05}$$

2. $2217.60 + 135.25 + \frac{270.50D}{40} + 18.26D + 208.08 + \frac{188.27D}{40} + 94.31 = 1{,}834.80 + 149.38 + \frac{298.75D}{40} + 20.17D + 79.29 + \frac{207.93D}{40} + 104.05$

3. $\frac{270.50D}{40} + 18.26D + \frac{188.27D}{40} - \frac{298.75D}{40} - 20.17D - \frac{207.93D}{40} = 1{,}834.80 + 149.38 + 79.29 + 104.05 - 2217.60 - 135.38 - 208.08 - 94.31$

4. $-\frac{47.91D}{40} - 1.91D = -487.85$

5. $\frac{47.91D}{40} = 487.85 - 1.91D$

6. $47.91D = 40\ (487.85 - 1.91D)$

7. $47.91D = 19{,}514 - 76.4D$

8. $124.31D = 19{,}514$

9. D = 156.98 miles to and from the warehouse; within a radius of 78.5 miles from the warehouse, multifork loading is more efficient than handstacking.

Handstacking compared with partly topped-off pallets (city and suburban driving conditions and separate conveyor receiving)

1. Handstacking:

$$\frac{\text{Whse. cost}}{2{,}217.60} + \frac{\text{Misc. driver cost}}{(108.2 \text{ trips} \times .5 \text{ hours} \times \$2.50)} + \frac{\text{Driver cost in transit}}{\frac{(108.2D \times \$2.50)}{(20 \text{ m.p.h.})}} + \frac{\text{Variable costs}}{(108.2 \times .1688D)} + \frac{\text{Value of tieup time}}{208.08 + \frac{(108.2D \times 1.74)}{(20 \text{ m.p.h.})}} + \frac{\text{Fixed costs}}{94.31} =$$

Partly topped-off pallets:

$$\frac{\text{Whse. cost}}{2{,}046} + \frac{\text{Misc. driver cost}}{(153.5 \text{ trips} \times .5 \text{ hrs.} \times \$2.50)} + \frac{\text{Driver cost in transit}}{\frac{(153.5D \times \$2.50)}{(20 \text{ m.p.h.})}} + \frac{\text{Variable costs}}{(153.5 \times .1688D)} + \frac{\text{Value of tieup time}}{71.37 + \frac{(153.5D \times 1.74)}{(20 \text{ m.p.h.})}} + \frac{\text{Fixed costs}}{136.07}$$

Table 15.--Determination of break-even distance with alternative shipping methods (continued)

Handstacking compared with partly topped-off pallets (city and suburban driving conditions and separate conveyor receiving)

D = Distance to and from warehouse

2. $2{,}217.6 + 135.25 + \frac{270.50D}{20} + 18.26D + 208.08 + \frac{188.27D}{20} + 94.31 = 2{,}046 + 191.88 + \frac{383.75D}{20} + 25.91D + 71.37 + \frac{267.10D}{20} + 136.07$

3. $\frac{270.50D}{20} + 18.26D + \frac{188.27D}{20} - \frac{383.75D}{20} - 25.91D - \frac{267.10D}{20} = 2{,}046 + 191.88 + 71.37 + 136.07 - 2{,}217.6 - 135.25 - 208.08 - 94.31$

4. $-7.65D - \frac{192.08D}{20} = -209.93$

5. $\frac{192.08D}{20} = 209.93 - 7.65D$

6. $192.08D = 20(209.93 - 7.65D)$

7. $192.08D = 4{,}198.6 - 153D$

8. $345.08D = 4{,}198.6$

9. D = 12.16 miles to and from the warehouse; within a radius of 6.08 miles from the warehouse, using partly topped-off pallets is more efficient than handstacking.

Description	Band type adjustable self-inking stamp			Typical porous-tip stick-type stamp			Improved stick-type stamp		
	Percent occurence	Seconds	Dollars	Percent occurence	Seconds	Dollars	Percent occurence	Seconds	Dollars
Labor									
Obtain, adjust, and dispose band stamp	100	11.6		20	2.3		15	1.7	
Stamp merchandise									
Stick-type stamp	--	--		80	7.8		85	8.3	
Band stamp	100	12.5		20	2.5		15	1.9	
Change and ink stamps	--	--		80	5.0		85	3.6	
Total labor @ $2 per hour		24.1	0.0133		17.6	0.0098		15.5	0.0086
Annual labor cost for 2,000 cases per week			1,383.20			1,019.20			894.40
	Number			Number			Number		
Equipment									
Band stamps @ $6	8		48.00	4		24.00	4		24.00
Single-price stick stamp @ 35¢	--		--	118		41.30	70		24.50
Multiple-price stick stamp @ 45¢	--		--	94		42.30	48		21.60
Stamp-set base	--		--	2		12.00	2		8.00
Total initial cost of equipment			1/ 48.00			2/ 119.60			2/ 78.10
Annual equipment cost			194.00			59.80			39.05
Total annual cost			1,577.20			1,079.00			933.45

1/ Stamps replaced 3 times per year.
2/ Stamps replaced every 2 years.

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