APPLE HANDLING METHODS and EQUIPMENT in Pacific Northwest Packing and Storage Houses

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It is planned to publish the data from the report submitted by the Washington State Apple Commission, in fulfillment of its contract obligation, in five separate publications. This report covering "Apple Handling Methods and Equipment in Pacific Northwest Packing and Storage Houses" is the first to be published. Other reports are expected to cover: (1) Innovations in apple handling methods and equipment; (2) handling empty containers; (3) utilization of space in cold storage rooms; and (4) plant-wide materials-handling costs.

After these reports are issued, a summary report is planned. Some of the results of this research are available now in "summary" form in the Department of Agriculture film "Apple Handling Methods."

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HANDLING COSTS CAN BE REDUCED

Marketing the products of the Nation's farms, ranches, and groves requires the physical handling and the movement of millions of tons of commodities each year. Some of these products are handled as many as 25 or 30 times between producer and consumer. These operations require thousands of workers and millions of man-hours of labor. Currently the labor required for marketing some products exceeds that necessary to produce them. This emphasizes the importance of the efficient use of manpower.

This report is one of a series designed to guide operators of apple and other fruit packing and storage houses in reducing labor required for various physical handling and warehouse operations. It outlines some of the methods by which labor can be made more productive. Although it evaluates methods and equipment used for handling boxes of apples in Pacific Northwest apple houses and appraises some of the methods and equipment developed during the research in that area, the results should be applicable to commercial fruit packing and storage houses in all areas.

Because the report is intended as a manual or guide for plant managers and other supervisory workers, the methods, type of equipment used, and conditions influencing their use are described in some detail. In connection with the selection of methods, the cost data shown include only the costs of productive labor and equipment. Therefore, they cannot properly be used as a basis for comparison with actual plant costs for performing handling operations or for budgetary purposes.

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SUMMARY

The research which is the basis for this report was conducted in Washington State, which annually markets about one-third of the national supply of fresh apples. Each year more than 40 million boxes of unpacked apples are moved from orchards into the State's 252 packing and storage houses, which pack out about 27 million boxes. Exclusive of packing-line operations, each box of fruit is handled from 25 to 30 times during its movement into, within, and out of the storage house, and during an average season the total number of individual box handlings required approximates 500 million. To do this work during the peak season, when apples are being received and shipped at the same time, apple houses employ from 5 to 60 workers per 8- or 9-hour shift. This does not include workers in packing-line operations.

In addition to their concern over large and increasing labor costs, plant operators also are concerned over the availability of the needed number of workers for performing warehousing operations by more conventional methods, particularly during the harvest season when plants compete with growers for labor. Another concern is the amount of storage life lost by fruit because of relatively slow rates of receiving at the plants by the older and more widely used methods. Directly associated with loss of storage life is the amount of bruising and other damage caused by rough and excessive handling.

To assist plant operators in meeting these problems, research was undertaken: (1) To determine, under variable conditions of significance to the industry, the comparative efficiency of various types and combinations of types of materials-handling equipment currently used in Washington State apple houses for performing the different handling or warehousing operations and to evaluate current methods of using these types of equipment, (2) to develop and test improved methods for using present equipment, (3) to introduce and test, under actual operating conditions in apple houses, some new types of equipment not in current use in Washington State plants, and (4) to develop and test new or improved types of equipment where needed to increase the efficiency with which specific operations are performed.

In Washington State plants, apples usually are: (1) Unloaded from road trucks or orchard trailers and placed in storage, (2) moved from storage to the dumper at the head of the packing line, (3) moved from the stamping or marking station at the end of the packing line back to storage, and (4) moved out of storage and loaded into refrigerator cars or road trucks. Relatively small volumes of apples are: (1) Unloaded from road trucks and orchard trailers and moved directly to the packing line, and (2) moved from the packing line to refrigerator cars and trucks for loading out. In the first two of these cycles or groups of operations, unpacked apples are handled and stored in standard northwest apple boxes having inside dimensions of $10\frac{1}{2}$ by $11\frac{1}{2}$ by 18 inches, or in field crates of comparable size, which when filled loose weigh roughly 35 pounds.

In the last two cycles of operations, packed apples are handled in the same standard boxes or in fiberboard cartons. The carton used for tray-pack fruit has inside dimensions of 11-3/4 by 12-1/8 by 19-7/8 inches. The weight of a packed standard box is 50 pounds.

Six principal types and combinations of types of materials-handling equipment are used in Washington State apple houses: (1) Clamp-type 2-wheel hand trucks alone, (2) clamp-type 2-wheel hand trucks and belt conveyors, (3) clamp-type 2-wheel hand trucks and floor chain conveyors, (4) clamp-type 2-wheel hand trucks and elevators, (5) industrial clamp-type trucks, and (6) industrial fork-lift trucks and pallets. Other types of equipment used in certain cycles of operations are gravity-type roller conveyors, stackmakers, stackbreakers, pallet transfer dollies, and low-lift pallet transporters.

By use of clamp-type 2-wheel hand trucks, 6-high stacks of boxes of unpacked fruit are handled as unit loads. As packed boxes are handled and stored on their sides, unit loads of these boxes sometimes are reduced to 5 boxes. This method of handling, in conjunction with which boxes above the original 5- or 6-high stacks in storage were manually high-piled and broken out of high piles, led to the development of a portable mechanical lift or high-piler which, since the completion of this research, has become a major type of equipment used in Washington State plants.

Industrial clamp-type lift trucks handle either 24 or 36 boxes of unpacked fruit as unit loads in 6-box high-stacks and tier 12 boxes high. Dunnage strips are used between loads in the stack. Packed boxes of apples are handled in 20- and 30-box unit loads of 5-box-high stacks. This type of powered lift truck is being used in a number of older houses.

Industrial fork-lift truck and pallet use is confined to newer houses designed for use of this equipment. Pallet loads of 36 or 48 boxes are handled. Pallet loads generally are tiered 3 loads high (18 boxes).

Gravity-type roller conveyor sections are used in belt conveyor plants for unloading fruit from trucks and trailers and in nearly all plants for segregating packed boxes of fruit en route from the packing line to storage.

Time studies of operations performed by use of various methods and types of equipment in selected plants provide data on the elapsed times required, or the rates of performing the cycles of operations that are not paced by the packing line, and the total labor and equipment requirements in terms of specified outputs. Time studies also show the frequency and duration of delays and wait time occurring by use of different methods and provide the basis for developing improved methods. Data on labor and equipment requirements obtained through time studies, wage rates based on 1951-52 levels, and estimates of per hour equipment costs based on assumed annual hours of use, are used to compute total labor and equipment costs for the various cycles of operations by use of different methods and types of equipment. Management and facility costs are not included.

"Current" wage rates are an average of wage rates paid during the 1951-52 season in Washington State apple houses. These rates are $1.15 per hour for unskilled labor and $1.30 per hour for semiskilled or "key" workers such as industrial truck operators. To show cost relationships if wage rates should increase further, "assumed" wage rates provide an increase of 25 cents per hour in "current" wage rates for both unskilled and semiskilled workers. Total labor and equipment costs have been recomputed on the basis of "assumed" rates.

Equipment costs include the costs of both ownership and operation, prorated on a per-hour basis. Ownership or fixed costs, which include interest, taxes, insurance premiums, and depreciation, are prorated on the basis of assumed annual hours of use in apple packing and storage houses. Operating or variable costs include inspection, servicing, maintenance, repairs, overhaul, and energy. Equipment cost estimates range from 2.4 cents per hour for clamp-type 2-wheel hand trucks to $3.21 per hour for freight elevators. Industrial truck costs range from $1.42 per hour for a 1,000-pound (24 box) capacity electric clamp-type truck to $2.28 per hour for a 4,000-pound (48 box) capacity electric fork-lift truck. Pallet costs are estimated on the basis of the time they are involved in handling operations rather than on storage time.

Unloading and Moving Apples into Storage

Seven combinations of types of materials-handling equipment are used for unloading boxes of unpacked fruit from road trucks and orchard trailers, transporting the fruit from the transportation equipment to storage points, and stacking in storage: (1) Clamp-type 2-wheel hand trucks, (2) belt conveyors and clamp-type 2-wheel hand trucks, (3) floor chain conveyors and clamp-type 2-wheel hand trucks, (4) belt conveyors, stackmakers, floor chain conveyors, and clamp-type 2-wheel hand trucks, (5) elevators and clamp-type 2-wheel hand trucks, (6) industrial fork-lift trucks and pallets, and (7) industrial clamp-type lift trucks. A number of different methods are used in connection with each equipment combination. Variations in methods principally are in crew sizes and in the use of temporary banks or blocks to break the sequence of operations in a cycle. In analyzing methods for receiving apples into storage, a standard transportation distance of 100 feet is used. When temporary banks are used, transportation distances are increased to allow for movement into and out of the banks.

When 48-box pallet loads are built on road trucks in the orchard and these loads are removed from the road trucks at the plant and placed on an apron for later movement to storage, the labor required by use of fork-lift trucks to unload and place 1,000 boxes of fruit in storage is 0.96 of a man-hour. Pallet loads are stacked 3 high, or 18 boxes high. Labor and equipment costs when this method is used are $3.95 per 1,000 boxes. When apples are moved directly from the road truck to storage, costs are increased $0.10 per 1,000 boxes.

Industrial clamp trucks also are relatively efficient for receiving fruit from road trucks. The lowest cost method, using the 24-box-capacity truck, involves the use of clamp-type 2-wheel hand trucks to move 6-high stacks of boxes from the road truck bed to the receiving platform, where four of the stacks are picked up by the industrial truck, which transports them to and stacks them 12 boxes high in storage. Labor requirements per 1,000 boxes by this method are 2.86 man-hours. Labor and equipment costs are $5.72 per 1,000 boxes.

The highest cost method of receiving fruit and placing it in storage is by use of elevators and clamp-type 2-wheel hand trucks. Fruit is manually high-piled above the 6-high stacks handled by hand trucks. Use of a method that involves only one elevator requires 11.92 man-hours of labor per 1,000 boxes to receive into storage, including manual high-piling in 12-box-high stacks. Labor and equipment costs for handling this volume are $18.71. When fruit is mechanically high-piled, these costs are reduced to $16.33 per 1,000 boxes.

Belt-conveyor and hand-truck methods, plus manual high-piling, used in about 47 percent of the Washington State plants, also are relatively high-cost methods. By one of these method, which involves a 10-man crew, 10.10 man-hours of labor per 1,000 boxes are required to unload, move to storage, and manually high-pile 12 boxes high. Labor and equipment costs are $12.54. These costs are reduced to $9.66 per 1,000 boxes when one worker and the portable mechanical lift are substituted for four workers manually high-piling.

Rates of receiving also are an important measure of the desirability of different equipment combinations and methods. When 48-box pallet loads are received and moved directly to storage, a 2-man crew with an industrial fork-lift truck can receive 8,600 boxes of fruit during an 8-hour day. However, when boxes must be palletized at the plant, the rate drops to 2,300 boxes. Industrial clamp trucks of 24-box capacity, when used by a 2-man crew, receive about 4,600 boxes per day, which is in line with receiving rates for other types of equipment. Floor chain conveyors and hand trucks used by an 8-man crew permit the highest receiving rate of the more conventional types of equipment, 6,300 boxes per 8-hour day.

When fruit is received at the plant on orchard trailers, labor and equipment costs per 1,000 boxes range from $3.58, when 24-box industrial clamp trucks are used, to $20.14 for hand trucks and elevators. Industrial fork-lift trucks also are relatively efficient. Costs for unloading when boxes arrive partially palletized are $3.81 per 1,000 boxes.

When boxes are unloaded from orchard trailers, receiving rates are somewhat slower than when received from road trucks. The highest rate of 8,000 boxes per 8-hour day is by use of industrial fork-lift trucks and pallets. This rate is attained only when boxes are completely palletized in the orchard. When none of the boxes are palletized, the rate drops to 3,200 boxes. Belt conveyors and hand trucks are relatively slow, and with them and a 5-man crew, only 3,400 boxes can be received per 8-hour day.

Unloading and Moving Apples to the Packing Line

With belt conveyor and hand truck methods, five fewer handlings are required when fruit is unloaded and moved directly to the packing line than when fruit is moved to storage and later moved to the line. However, most plants prefer not to pack fruit as received warm from the orchard.

The operations involved in unloading fruit and moving it directly to the dumper at the packing line are paced by the rate of the line, usually 300 boxes per hour. However, to release road trucks as soon as possible, all methods make use of temporary banks near the dumper to break the sequence of operations and permit road trucks to be unloaded at normal rates. The same combinations of equipment are used for this cycle of operations that are used for receiving into storage. Gravity-type roller conveyors also are used for unloading from orchard trailers and moving to the packing line when the distance is not too great. Except for the gravity-type conveyor method, the transportation distance from the road truck or orchard trailer to the dumper has been standardized, for purposes of analysis, at 70 feet.

Of the methods used for unloading from road trucks and moving to the packing line, the method requiring the least labor and incurring the lowest labor and equipment costs is that using industrial fork-lift trucks handling 48-box pallet loads which were built on the road truck in the orchard. Labor requirements are 1.21 man-hours per 1,000 boxes. Labor and equipment costs are $4.78 per 1,000 boxes. Industrial clamp trucks are not relatively as efficient for use in this group of operations as in receiving into storage. Costs by this equipment are among the highest at $7.75 per 1,000 boxes.

Because of the relatively short distance involved and low equipment costs, 2-wheel hand trucks are more efficient for this cycle of operations than other more widely used types of equipment. Costs by use of hand trucks are $6.28 per 1,000 boxes.

Fruit can be unloaded from orchard trailers and moved 50 feet to the packing line by use of gravity roller conveyors at a total cost for labor and equipment of $2.60 per 1,000 boxes. For this method, equipment costs are low and wait time, inherent in most other methods, is eliminated. The conveyor lines serve as accumulators or banks of supply. When hand trucks alone are used for unloading from orchard trailers, labor and equipment costs are higher than for unloading from road trucks, $8.23 per 1,000 boxes as compared with $6.28. Industrial fork-lift trucks, handling 48-box pallet loads built after arrival of the truck at the plant, incur costs of $6.02 per 1,000 boxes.

Moving Apples from Storage to the Packing Line

The operations required in breaking out boxes of unpacked fruit from storage stacks and moving them to the packing line also are paced by the rate of about 300 boxes per hour at which fruit is run through the line. All methods and types of equipment used for performing this group of operations involve the use either of temporary banks or blocks near the dumper, or accumulators which break the interdependence of operations performed in direct sequence and minimize wait time. Transportation distances are standardized at 190 feet for analytical purposes.

Only 0.67 of a man-hour of labor is required to break out and move 1,000 boxes of apples to the packing line in 48-box pallet loads by use of an industrial fork-lift truck when an accumulator, consisting of 30 feet of gravity-type roller conveyor, is used at the dumper. However, if the truck and operator must remain on duty full time to move pallet loads of apples to the dumper as they are required, labor is increased to 3.33 man-hours per 1,000 boxes and the truck is required for the same period. Labor and equipment costs per 1,000 boxes by use of the first method are $4.06. By use of the latter method, costs are increased to $13.27. The 24-box industrial clamp truck is almost as efficient when used with a floor chain conveyor accumulator at the dumper. Costs are $4.53 per 1,000 boxes.

When 500 of each 1,000 boxes moved to the line are manually broken out of 12-box-high stacks, the highest cost method is by use of hand trucks and a single elevator. Labor and equipment costs are $21.08 per 1,000 boxes. Substitution of the mechanical break-out method for the manual method does not materially reduce these costs.

Among the more conventional types of equipment, the combination of equipment in which the high-piler is used for breaking out boxes from 12-high stacks, and floor chain conveyors and hand trucks are used for transporting, incurs the lowest costs. By use of this combination of equipment, labor and equipment costs are $8.33 per 1,000 boxes. This method eliminates one worker from the usual 3-man crew and uses the floor chain conveyor as an accumulator.

Moving Apples from the Packing Line to Storage

In moving fruit from the packing line back to storage, six basic types and combinations of types of equipment are used. They are: (1) Clamp-type 2-wheel hand trucks and gravity roller conveyors, (2) belt conveyors, clamp-type 2-wheel hand trucks, and gravity roller conveyors, (3) elevators, clamp-type 2-wheel hand trucks, and gravity roller conveyors, (4) industrial fork-lift trucks, pallets, and gravity roller conveyors, (5) low-lift pallet transporter, industrial fork-lift truck, pallets, and gravity roller conveyors, and (6) industrial clamp-type lift trucks and gravity roller conveyors.

After boxes have been packed, the practice is to handle them on their sides. This is necessary with bulge-packed fruit because stacking the boxes one on top of the other, right side up, would result in much bruised fruit. However, since the width of the standard box is 1 inch greater than the height and because of the increased weight of packed boxes, they generally are handled in 5-high stacks instead of the 6-high stacks used when handling loose fruit. This stacking height is followed when apples are handled with industrial equipment as well as clamp-type 2-wheel hand trucks.

In performing the sequence of operations in taking the boxes from the packing line back to storage, it is necessary to segregate the fruit by grade, size, and variety. This segregation is usually done in a special area. Boxes are conveyed to this area and the worker doing the segregation picks up each box manually off a gravity conveyor, which serves as an accumulator, and places the packed boxes in appropriate stacks or unit loads. The rate at which this work can be performed is geared to the production rate of the packing line, which is about 210 packed boxes per hour. As a result, the segregator must wait for work during much of the day.

For purposes of comparing the different methods of performing this cycle of operations, the following assumptions are made: (1) One 15-foot section of gravity roller conveyor for segregation is included in all operations, and (2) transportation distance is standardized at 160 feet, or a total of 175 feet.

Labor requirements for the different methods ranged from a low of 5.43 man-hours per 1,000 packed boxes by the fork-lift truck and pallet method to 19.04 man-hours per 1,000 packed boxes by both clamp-type 2-wheel hand truck method and elevator and clamp-type 2-wheel hand truck method. The belt conveyor and clamp-type 2-wheel hand truck method required 14.28 man-hours, whereas the industrial clamp-type lift truck and low-lift pallet transporter, fork-lift truck, and pallets took respectively 6.31 and 6.22 man-hours per 1,000 packed boxes.

The lowest cost--$9.41 per 1,000 packed boxes--for equipment and labor combined--was obtained with the industrial fork-lift truck and pallets. The costs for the industrial clamp-type lift truck almost equaled this, being only $0.47 higher. The highest cost method involves use of the elevator in combination with the clamp-type 2-wheel hand truck. Costs with this method amounted to $32.25 per 1,000 boxes; almost three and one-half times the cost of the most efficient method. Total costs for the clamp-type 2-wheel hand truck method were $22.43 per 1,000 boxes, for the belt conveyor and clamp-type 2-wheel hand truck method, $20.79, and for the low-lift pallet transporter, fork-lift truck, and pallets, $12.71.

Moving Apples Out of Storage and Loading Out

The cycle of operations involved in moving packed boxes of apples from storage and loading them out into refrigerated railroad cars was performed with nine different types and combinations of types of equipment. These include: (1) Clamp-type 2-wheel hand trucks, (2) belt conveyors, gravity roller conveyors, and clamp-type 2-wheel hand trucks, (3) floor chain conveyors and clamp-type 2-wheel hand trucks, (4) elevators and clamp-type 2-wheel hand trucks, (5) industrial fork-lift truck and pallets, (6) industrial fork-lift truck, pallets, belt conveyors, and gravity roller conveyors, (7) industrial fork-lift truck, pallets, and pallet dolly, (8) industrial fork-lift truck, low-lift pallet transporter, pallets, belt conveyors, and gravity roller conveyors, and (9) industrial clamp-type lift truck, belt conveyors, and gravity roller conveyors.

Refrigerated railroad cars usually are loaded with 798 standard boxes before being moved to a consuming area or in-transit storage. However, some cars are loaded with 756 boxes and others with 840 boxes. The 798-box load is used for comparative purposes. In the cycle of operations in placing these loads in refrigerator cars, it is necessary that: (1) The load be blocked out, (2) load be manifested for shipment, (3) boxes be moved from storage point to the railroad car, (4) boxes be stowed, (5) boxes be stripped for stability in transit, and (6) boxes be braced on either side of the doorway or filled in solid to keep the load from shifting. Occasionally, it is necessary that boxes, not already labeled, be labeled in the car during the loading.

For comparative purposes, it is assumed for all methods that: (1) The fruit is blocked out and ready to bring to the car so that the carloading crew will not be delayed by the crew bringing up the fruit, and (2) the fruit is assumed to be moved a distance of 110 feet from storage to car.

When industrial fork-lift truck, pallets, belt conveyor, and gravity roller conveyor were used for this cycle of operation the lowest labor requirements--7.40 man-hours per 1,000 boxes--were obtained. This method was followed closely by all other methods which employed industrial fork-lift trucks or industrial clamp-type lift trucks. Labor for these methods ranged from 7.69 man-hours per 1,000 packed boxes to 8.68 man-hours. The elevator and clamp-type 2-wheel hand truck method was the least efficient--requiring 13.40 man-hours per 1,000 packed boxes.

Costs for both labor and equipment combined varied only $7.40 per 1,000 packed boxes. The clamp-type 2-wheel hand truck method had the lowest cost, $13.37 per 1,000 packed boxes, whereas the elevator and clamp-type 2-wheel hand truck method showed the highest cost, $20.77. The rest of the methods, with one exception which showed a cost of $17, fell into a very narrow range between the two extremes mentioned.

The loading out of refrigerated highway trucks is quite similar to that of refrigerated railroad cars. Loads vary a great deal, much more than with railroad cars, ranging from 600 to 800 standard boxes. Blocking out fruit as well as other operations are essentially the same, except that no stripping or bracing needs to be done.

Moving packed boxes of apples from storage and loading out highway truck was performed by the following: (1) Clamp-type 2-wheel hand trucks, (2) belt conveyor and clamp-type 2-wheel hand trucks, and (3) industrial fork-lift truck and pallet dolly. Transportation distance from blocking out point to highway truck was standardized at 130 feet.

Of these methods, the industrial truck required the least amount of labor, 5.51 man-hours per 1,000 packed boxes. The clamp-type 2-wheel hand truck was next with 9.83 man-hours, and the belt conveyor and clamp-type 2-wheel hand truck was highest with 11.73 man-hours. Because of the high equipment costs for the industrial fork-lift truck, the clamp-type 2-wheel hand truck was the lowest cost method--$11.42 per 1,000 packed boxes.

Moving Apples from the Packing Line and Loading Out

Moving apples directly from the packing line and loading them directly into refrigerated railroad cars or highway trucks is not a practice commonly followed in Washington State. However, when it is done two methods are used: (1) Move the fruit through a segregation area, and set aside in a block-out area the boxes which are to be loaded, and (2) move part of the flow of fruit from the packing line into the carrier.

The common practice is to follow the first method; that is, to run the fruit through the segregation area and select the sizes needed for the load. These boxes are moved to the blocking-out area and the rest are sent to storage. The labor involved in this method is no different from that in regular carloading when the fruit is moved from storage.

In using the latter method, the rate of loading is geared to the rate of the packing line, which is about 210 packed boxes per hour. Depending on the sizes and grades called for in the manifest, it would require 4 to 8 hours of elapsed time to load a 798-box car.

This method requires 5.88 man-hours per 1,000 packed boxes and a total labor and equipment cost of $10.90 per 1,000 boxes. The labor requirements are low but elapsed time is high. However, one advantage is that one handling operation, moving the packed fruit back to storage, is eliminated.

Moving Apples Into, Within, and Out of Storage Houses

Labor and equipment costs per 1,000 boxes for performing all four of the cycles of operations required in receiving from road trucks, moving fruit through the plant, and loading into refrigerator cars, when both packed and unpacked boxes of fruit are stored by common and improved methods, by use of the five principal types or combinations of types of equipment are:

Type of equipment and method:	Costs	
	Common method	Improved method
	Dollars	Dollars
Clamp-type 2-wheel hand trucks	56.03	48.94
Belt conveyors and clamp-type 2-wheel hand trucks	60.28	50.23
Floor chain conveyors and clamp-type 2-wheel hand trucks (belt conveyors and hand trucks are used for moving packed boxes to storage)	54.62	46.56
Industrial clamp-type lift trucks--24-box capacity	37.75	35.55
Industrial fork-lift trucks and 48-box pallets	31.99	31.89

When apples are moved directly to the packing line from road trucks, moved from packing line to storage, and then loaded into railroad cars the labor and equipment costs per 1,000 boxes for the three cycles of operations are:

Type of equipment and method:	Costs
	Dollars
Clamp-type 2-wheel hand trucks	39.30
Belt conveyors and clamp-type 2-wheel hand trucks	36.56
Floor chain conveyors and clamp-type 2-wheel hand trucks (belt conveyors and hand trucks are used for moving packed boxes to storage)	36.85
Industrial clamp-type lift trucks--24-box capacity	32.50
Industrial fork-lift trucks and 48-box pallets	28.66

APPLE HANDLING METHODS AND EQUIPMENT IN PACIFIC NORTHWEST PACKING AND STORAGE HOUSES

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INTRODUCTION

Marketing the Nation's apple crop involves the physical handling each year of millions of boxes of fruit. In the marketing channel these handling operations begin when the fruit leaves the orchard and end when it leaves the retail store. Between these stages of the marketing channel for fresh apples, each box of fruit is handled from 25 to 30 times, the exact number depending on the methods of handling used and the kinds of facilities through which it is moved. These handlings occur in transporting fruit from the orchard to the plant, in the storage and packing plant, in transporting fruit from producing areas to consuming centers, in the terminal markets, in transporting fruit from the wholesale market to retail outlets, and in the retail stores. A relatively large number of these handlings take place in packing and storage houses. In these facilities, handlings are necessary in receiving fruit from the orchard and placing it in storage, moving unpacked boxes of fruit from the storage room to the packing line, moving packed boxes from the packing line to storage, and finally moving packed boxes out of storage and loading into refrigerator cars and motortrucks. These handlings do not include dumping, cleaning, sorting, sizing, packing, lidding, and other operations in the packing line.

The total work involved annually in apple-handling operations in producing areas throughout the United States can be indicated by the size of the job in Washington State, which markets about one-third of the national supply of fresh apples. Each season in that State more than 40 million boxes of apples are moved from the orchards, placed in storage in packing houses, and later moved out of storage to the packing line. Most of the 27 million boxes of fruit packed out from this volume goes back into storage and later is moved out of storage and loaded out for shipment to terminal markets. During each of these four cycles or groups of operations in the plant, each box is handled from one to three times, depending on the types of materials-handling equipment used. Thus,

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in a typical season the total number of individual box handlings, excluding operations in the packing line, approximates 500 million.

To perform these physical-handling operations, each of the 252 packing and storage plants operating in the State during the 1950-51 season employed, at the peak of their operations (the period when fruit was being received, stored, packed, and shipped), from 5 to 60 workers per 8- or 9-hour shift. Workers employed for packing-line operations were in addition to these numbers. Of the total labor, other than office workers, employed in these plants, it is estimated that roughly 40 percent is used for performing materials-handling or warehousing operations and 60 percent for packing line operations.

However, the total of wages paid to this labor, which is one of the largest items in the cost of marketing apples, is not the only problem in connection with handling operations that concerns plant operators. Plant-handling operations, particularly during the harvest season, must proceed with dispatch since the market quality of apples is affected adversely if the fruit remains in the orchard for any substantial time after it is picked. For each day apples remain in the orchard after they are picked, or remain in the open at usual orchard temperatures, 10 days of storage life is lost. For this reason, during the period when apples are being received at the plant, plant operators may be more interested in reducing the elapsed time of receiving than they are in increasing the efficiency of operations. The addition of crews at the plant to increase the rate of receiving operations means that plants are in competition with orchards for the labor needed to pick fruit at its proper stage of maturity.

The necessity for obtaining adequate labor at the proper time for harvesting apples is indicated by the fact that Delicious varieties, which account for roughly 60 percent of the total tonnage in Washington State, should be picked and moved into storage within a 10-day period to retain the potential storage life of the fruit. If the full storage life is not retained, the Delicious will not keep for the late marketing season and may become unsalable.

Even when apples are harvested at the proper stage of maturity and moved promptly into storage, maintenance of quality is an important consideration in handling and storage operations. Each of the 10 or 15 separate handlings of a box of apples causes some bruising or other damage to the fruit. Research by the Washington State Apple Commission, in which shock recorders were placed in boxes of fruit, showed that when boxes of fruit are handled individually, by use of most methods, they nearly always receive a serious impact that bruises some of the fruit. By reducing the number of handlings, through adoption of the unit-load principle and improving or simplifying work methods, much of the fruit quality lost through bruising and other injuries can be retained. 1/

1/ H. T. and S. Office Report No. 211, "Investigation of Apple Bruising," Bureau of Plant Industry, Soils, and Agricultural Engineering, USDA, Wenatchee, Wash., 1948-49.

Although it might appear that the large, and increasing, costs of materials handling in apple-packing and storage houses by use of current methods, and the resultant loss of quality, would force adoption of improved methods, this has not been the case, since the type of box, method of refrigeration, plant design and layout, type of packing layout, type of packing equipment, and fruit-handling practices, in most cases, have evolved a somewhat integrated system. The industry has been tooled up in this specialized way for 20 or 30 years, making it difficult to initiate a change in one operation without changing the entire system. Few private firms in the apple industry, where the size of the individual business is relatively small, are in position to finance research needed to develop improved methods and equipment and to measure the comparative costs of various methods and innovations on an industry-wide basis.

Objectives of the Research

The research which is the basis for this report was undertaken to find ways, on an industry-wide basis, for increasing the productivity of labor employed in apple-packing and storage houses for performing fruit handling operations, thus making possible increases in the rates for performing critical operations during harvest periods, and reductions in total labor costs. Since one of the ways for making labor more productive is by reducing the number of times individual boxes of fruit are handled, the research also was aimed at maintaining fruit quality.

The specific objectives of this research were: (1) To determine, under variable conditions of significance to the industry, the comparative efficiency of various types and combinations of types of materials-handling equipment currently used in Washington State apple houses for performing the different handling or warehousing operations and to evaluate current methods of using these types of equipment, (2) to develop and test improved methods for using present equipment, (3) to introduce and test, under actual operating conditions in apple houses, some of the new types of equipment not in current use in Washington State plants, and (4) to develop and test new or improved types of equipment where needed to increase the efficiency with which specific operations are performed.

Although this research was conducted in Washington State, where a relatively large number of types of materials-handling equipment was available for study in apple packing and storage houses under a wide variety of conditions that affect the efficiency with which handling operations are performed, the data developed should have applicability to commercial (non-farm) apple houses in other areas. With interpolations, these data also may be applicable to operations in farm storage houses, which usually are of smaller capacity than commercial houses.

Research Methods and Techniques

Materials-handling research was conducted in apple packing and storage houses selected to provide coverage of all basic types of equipment that were currently in use and all significant variables that affect the use of the equipment. Included among these variables are: (1) The layout and design of the plant, (2) types of packages handled, and (3) types and sizes of trucks, trailers, and refrigerator cars from which apples are unloaded or into which they are loaded. Variables in plant layout and design include such factors as: (1) The number of floors on which or between which apples are handled (single story versus multistory handling); (2) the dimensions of the plant, which affect in-plant transportation distances; (3) ceiling heights of storage rooms, which govern stacking heights; (4) number and spacing of columns; (5) surface of floors over which equipment is operated; (6) height and width of platforms, and (7) height and width of doors.

To obtain data on these variables, which would provide a basis for selecting plants for case studies, a survey was conducted of a sample of plants, using the following procedure:

> On the basis of plant layout and design and types or combinations of types of equipment used in performing materials-handling operations, preliminary observations and secondary information indicated that there are five different types of commercial apple packing and storage plants in the State of Washington. To determine the significant variables that should be considered in materials-handling research, it was proposed to sample at the following rates:

Number of plants of given type in population	Number to be included in sample
12 or fewer	all
13 - 15	12
16 - 20	14
21 - 25	17
26 - 30	19
31 - 35	20
36 - 40	22
41 - 45	23
46 - 50	24
more than 50	25

> In the event that more than five basic types of plants were discovered, it was decided that these would be included in the survey and sampled at the same rate as indicated above.

This survey corroborated preliminary observations with respect to the five basic types of plants and showed that a sixth type existed. It also provided data on variables applicable to each of the six types which were needed in selecting case study plants.

Time studies of fruit-handling operations, as performed by various methods, were made in selected plants to: (1) Determine the elapsed time required, (2) determine the total man-hours of labor required and the total machine-hours of equipment use required, (3) determine where delays, wait time, and other unproductive time occurred during the performance of the operation, and (4) develop improved methods for performing the operation.

Elapsed times were determined as a basis for comparing the speeds or rates at which given operations are performed by various methods--a factor that is highly important in receiving fruit at the storage plant during the harvest season. Elapsed times also provide a basis for computing total labor and equipment inputs. These input data were computed as a basis for comparing the relative efficiency of methods for performing the same operation.

A determination of the sequence and magnitude of delays, wait time, and other unproductive time, in part, provided the basis for developing improved methods in which either the same types of equipment are used or in which new types are introduced.

Time studies were conducted in accordance with approved techniques by use of stop watches. As a means of obtaining comparability of data from time study observations, four men spent an initial period working together during which special emphasis was given to the rates at which workers performed. Estimates of these rates were used as a basis for leveling time study data in terms of a "normal" rate. Extraneous factors were eliminated in making time studies so as to avoid the effect of disruptions to work procedures. As many as 15 different time study observations were made of some methods for performing warehouse operations. Data from these studies were frequently checked for reliability. 2/

The costs of ownership and operation of various types of materials-handling equipment, which have been used for computing total equipment costs for performing handling operations, were obtained through accounting analyses made in selected plants and through cost records maintained on special forms by cooperating plant operators. Other data were obtained through surveys of equipment manufacturers, insurance companies, and tax officials.

Data on prevailing wage rates in Washington State apple plants during the 1951-52 season, which have been used for computing total labor costs for performing handling operations, were obtained through interviews with plant managers, labor union officials, and others.

2/ Standard error of the mean was used most commonly.

In the sections of the report that follow, labor and equipment costs for performing various fruit-handling operations by use of specified methods and types of equipment have been computed. These costs provide a basis for comparing the relative efficiency of different methods and types of equipment under variable conditions. They were computed because valid comparisons cannot be made solely on the basis of physical labor and equipment inputs. That is, man-hours of labor and machine-hours of equipment use cannot be totaled as a basis for making comparisons. Nor can valid comparisons be made solely on the basis of labor requirements, unless equipment costs are constant.

Labor costs shown in these computations are based on the productive labor required to perform the operation, plus the amount of idle time inherent in the method. The amount of time lost by workers in moving from one job to another, waiting for trucks to arrive for unloading, and other idle time not inherent in the method, is not included in these costs. Since nonproductive time may, in some instances, account for as much as 50 percent of the total man-hours of labor employed in a plant, the inclusion of unproductive time, not inherent in the method, would destroy the cost relationships.

Moreover, because of the variability of management and facility costs between plants of the same capacity and output, these costs have not been included in the costs shown for performing fruit-handling operations by use of different methods and types of equipment. Therefore, the cost data shown do not reflect total costs to the plant and should not be used by plant managers for budgetary purposes. However, in plants that allocate labor and equipment costs to various operations, these costs might serve as desirable goals to be attained in achieving cost reductions.

Principal Types of Materials-Handling Equipment Used

One of the principal types of fruit-handling equipment used in Washington State apple houses is the clamp-type 2-wheel hand truck with a stevedore frame (fig. 1). Instead of using a stevedore lip as a means of supporting the boxes, the clamp truck has two arms which grasp the boxes and clamp in from the sides when motivated by a foot-operated lever. These arms have a sharp blade or prong on their inside edge which jabs into the end of the box or slips underneath the edges of the box ends (fig. 2). With this type of hand truck, six boxes usually are handled as a unit load. Occasionally seven or even eight boxes of unpacked fruit are handled per load, but when packed fruit is being handled the load may be limited to five boxes.

Belt conveyors used in the Washington State apple houses usually are constructed of wood or metal frames, with wood or steel rollers, over which 12- to 14-inch belts are pulled to provide the conveying surface.

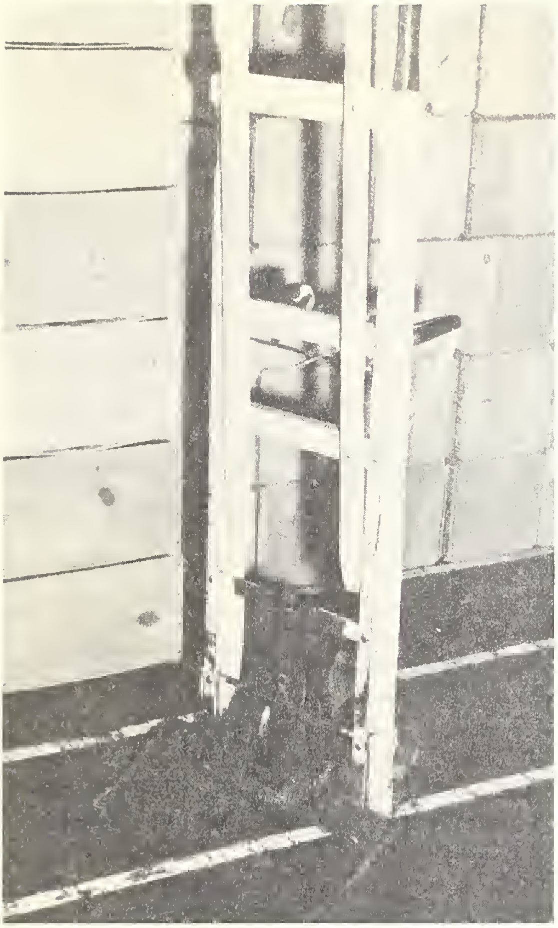

Figure 1.--Clamp-type 2-wheel hand truck.

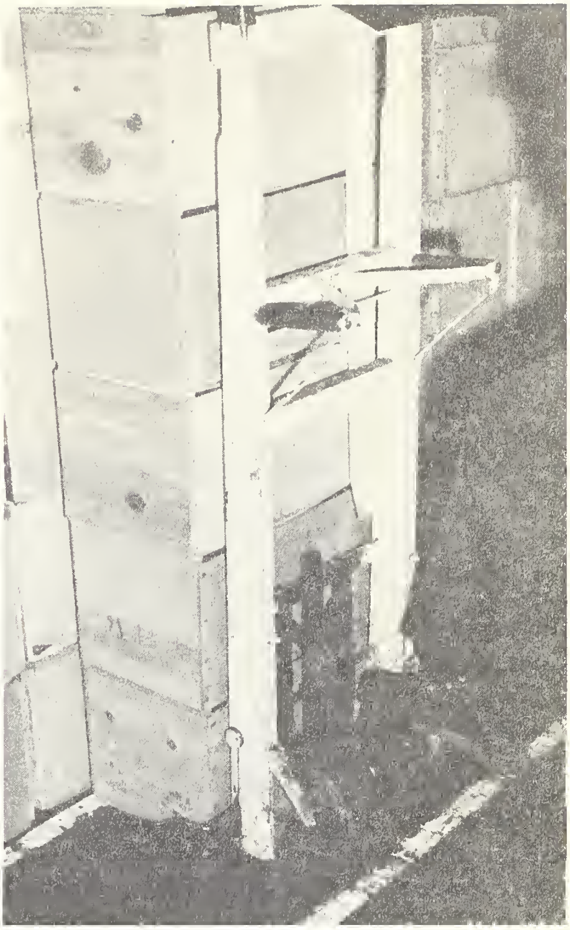

Figure 2.--Clamping onto a stack of boxes with a hand truck.

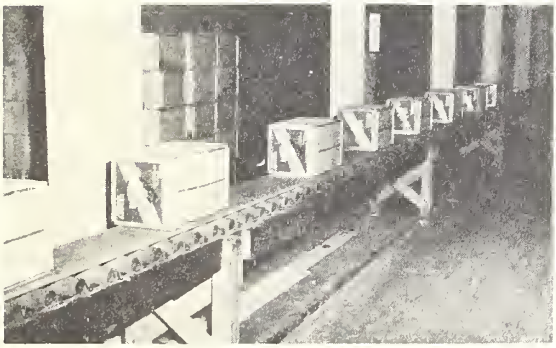

Figure 3.--Belt conveyor carrying boxes of apples.

These conveyors are built in sections that vary considerably in length, depending on the layout of the plant and the capacity of the motors used (fig. 3).

A 100-foot section of belt conveyor usually is composed of the following parts: (1) 205 feet of 4-ply rubber-impregnated canvas belting about 12 inches wide, (2) one gear head 2 horsepower electric motor, (3) one drive roller, (4) two idle end rollers,

(5) nine metal or wooden supports to hold the conveyor about 24 inches above floor level, and (6) 10-foot sections of metal or wooden rollers about 16 inches wide. To the standard belt conveyor can be added such attachments as "dip and load" sections, "curved end" sections, "power chain turns" and "dead roller" sections (fig. 4). Boxes may be moved from one conveyor to another either by gravity or power curves which carry boxes around corners, or by a section of curved dead rollers between the two conveyor units. Belt conveyors are used extensively to move the boxes of fruit between floors. In recent years a few firms have made use of sections of flexible dead roller conveyors for car loading.

Figure 4.--Roller conveyor extension to a belt conveyor used in unloading a truck.

Among the newer types of materials-handling equipment in use in Washington State apple houses are the industrial fork-lift truck, industrial clamp truck, and floor chain conveyor. These are now in commercial use in a few plants. In addition, other types of equipment, used experimentally during the course of this research project, are just being put into commercial use and will be discussed in the body of the report. Fork-lift trucks used in apple houses are of the same general design as fork-lift trucks used in other industries (fig. 5). They usually are

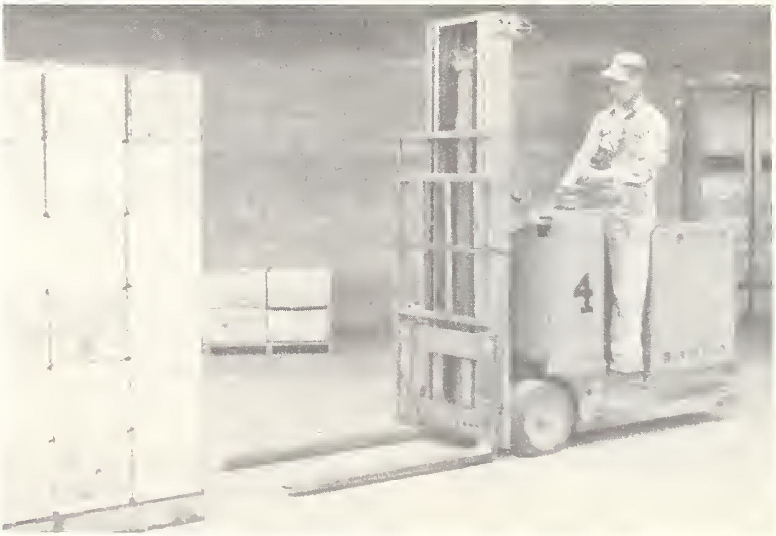

Figure 5.--Industrial fork-lift truck.

equipped with four-inch forks of sufficient length to lift and transport 40-by 48-inch or 36- by 40-inch pallets. The trucks handle pallet loads of unpacked apples stacked six boxes high, and packed fruit stacked five boxes high.

The industrial clamp truck has the same body and chassis as the fork-lift truck. The forks have been replaced by a set of arms that can be spread and narrowed hydraulically (fig. 6). When the lift truck is rolled forward, these clamps grasp a unit load of boxes with hydraulically regulated pressure. While the boxes are squeezed closely together the load is lifted and transported. Some industrial clamp trucks have broad clamps surfaced with rubber, to permit more secure handling of boxes and for handling cartons.

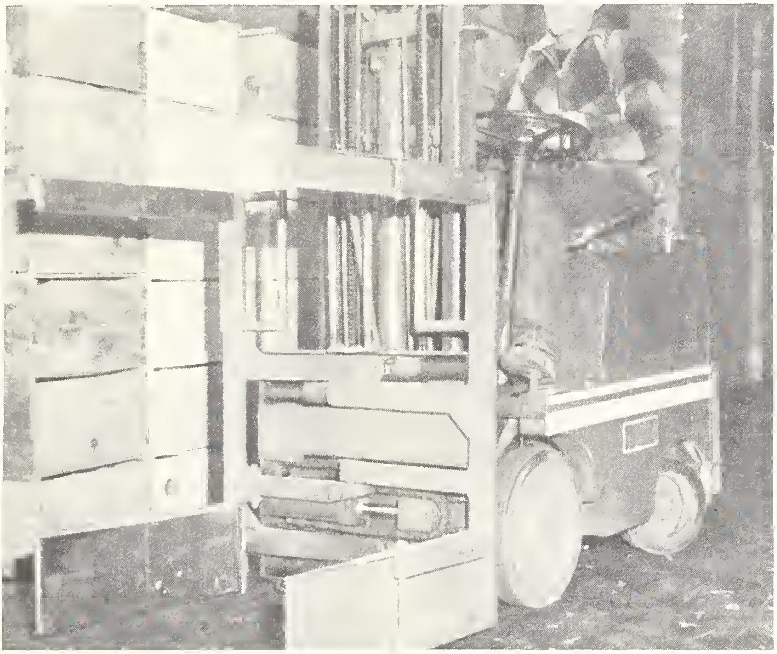

Figure 6.--Industrial clamp-lift truck.

Industrial clamp trucks are either of 36- or 24-box unit load capacity when handling loose fruit. When handling packed fruit, the load is limited to 20 or 30 boxes stacked 5 high.

The floor chain conveyor consists of a pair of link chains that run in parallel channels countersunk in the floor (fig. 7). The two chains travel at the same speed and are capable of moving a series of stacks of boxes along a floor between two fixed points. This is more or less auxiliary or supplementary equipment, and is usually, if not always, employed in combination with the clamp-type 2-wheel hand truck.

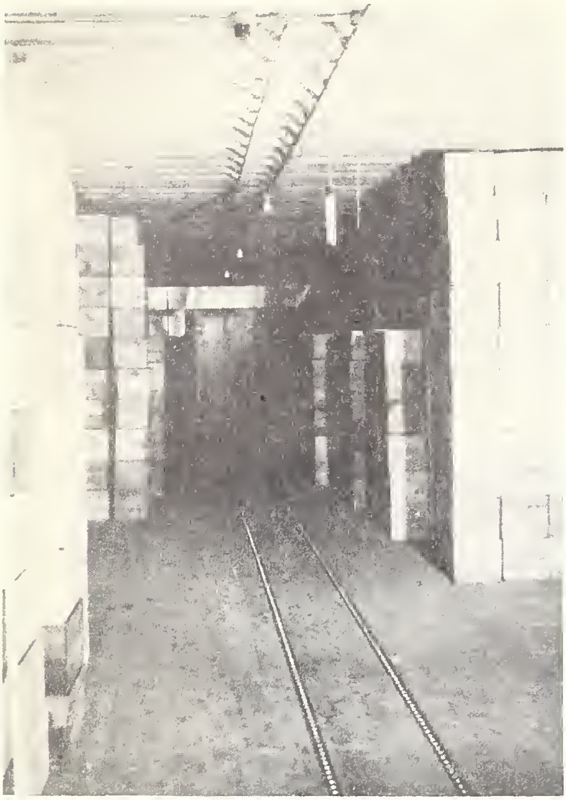

Figure 7.--Floor chain conveyor in a cold storage room.

Among the less important types of equipment used are the stackmaker, the stackbreaker, and the pallet transfer dolly. Stackmakers remove boxes, one at a time, from the end of the belt conveyors and build them into 6-high stacks. One plant uses the stackmaker to build unit loads going into a stackdumper. 3/ Another plant uses this equipment to build unit loads at the end of a belt conveyor on the third floor of the building, at which point the stacks move onto a floor chain conveyor.

The stackbreaker breaks down 6-high stacks of boxes so that they can be conveyed one box at a time. In some cases, stackbreakers are used to break stacks going into automatic dumpers.

Pallet transfer dollies consist of a set of rollers with a small frame on top. A pallet load placed on top of the frame can be moved inside refrigerator cars. It is used in only two or three plants to assist with car loading.

Types of Packages Handled

The standard Northwest apple box is the principal type of container used in Washington State for handling both packed and unpacked fruit. Its inside dimensions are 10-$\frac{1}{2}$ by 11-$\frac{1}{2}$ by 18 inches (fig. 8). This box is made of shook, usually 9/32 inches in thickness on the sides and 11/16 inches on the ends. Tops and bottoms are made of thinner shook so that the wood will spring over the bulge of the fruit as it is lidded.

The industry practice is to use the standard Northwest apple box both as a field box and as a shipping container. After boxes are made

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3/ A stackdumper is an automatic dumper used by a number of Washington State apple houses. Stacks of boxes are moved on a floor chain into the dumper mechanism. After a stack of boxes is in the dumping position, individual boxes are lifted mechanically off the stack and their contents dumped into the washer.

up they are taken to the orchard and distributed under the trees. The fruit is picked and placed in boxes with no fruit higher than the top level of the box. The boxes of apples are then moved to storage. Later, after the fruit has been dumped from the container at the packing line, the same box is sent forward on conveyors, and the packers wrap and pack fruit into them. Packed boxes are then lidded and either moved to storage or directly to a refrigerator car for shipment (fig. 9).

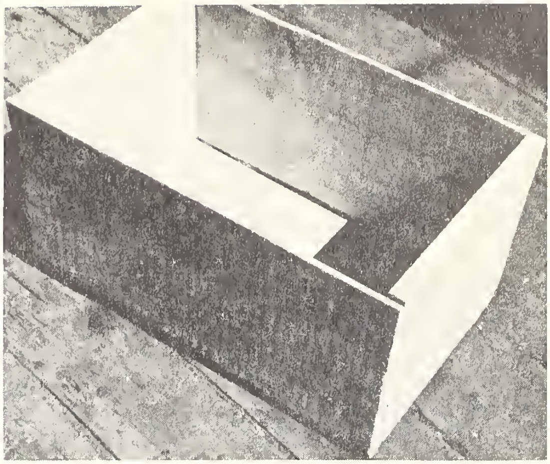

Figure 8.--Standard apple box.

Because of the increased use of cartons for packed fruit, a special field box is now being used more extensively. These boxes usually have the same inside dimensions as the standard apple box. The bottom and ends are of thicker material, and the inside corners usually are reinforced with corner posts (fig. 10). 4/

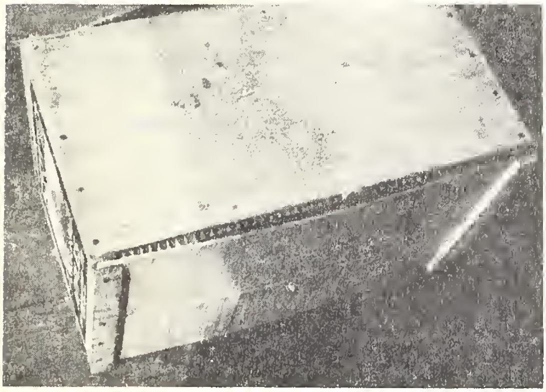

Figure 9.--Standard apple box (packed and lidded).

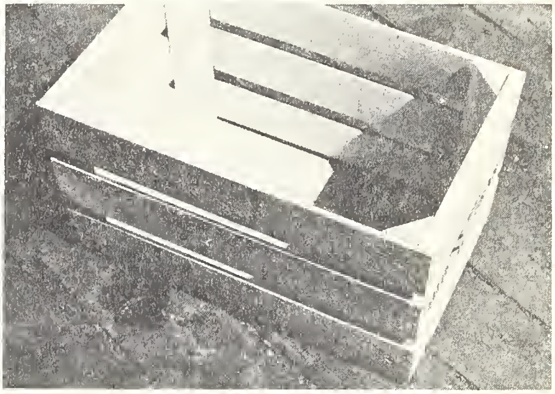

Figure 10.--Field apple box.

The weight of an unpacked standard box of apples is roughly 35 pounds. Boxes of unpacked fruit are not lidded and must be handled accordingly. The weight of a packed standard box is 50 pounds. Packed boxes are lidded before leaving the packing line and are handled and stacked on the side.

4/ A few firms in the Yakima area use a shallower and longer field container for their pear operations. These are mostly for cannery fruit. In some seasons, pear lugs may be available for handling apples.

Another type of container used for shipping apples is the cardboard carton. This carton is of regular slotted design (flap top) introduced by the Washington State Apple Commission Research Department, in 1949 (fig. 11). The greatest use of this carton is for tray-pack fruit (fig. 12). Molded pulpboard trays are used to hold apples in place during shipping. This carton usually has the following inside dimensions: 11-3/4 by 12-1/8 by 19-7/8 inches.

Figure 11.--Regular slotted carton.

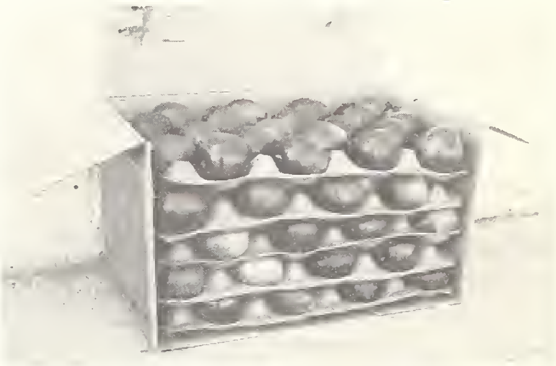

Figure 12.--Cross-section of a tray packed regular slotted carton.

Introduced recently as a master container for consumer-size packages is another carton having inside dimensions of 23-$\frac{1}{4}$ by 11 by 12-$\frac{1}{2}$ inches, which is referred to as a bonding carton. Its use has been limited. Most firms prepackaging apples use tray packed cartons as master containers. In addition to these, a few other package types are used in Washington State, but none of major importance in connection with materials-handling operations.

Description of Fruit-Handling Operations in Apple Packing and Storage Houses

In Washington State, apples are moved from the orchard to the packing plant either by orchard trailers or road trucks, and are unloaded there. When brought in by orchard trailers the usual load is 144 boxes, stacked in 3-high tiers on the trailer bed. When transported on road trucks, the usual load is 288 boxes stacked in 6-high tiers. After the fruit is unloaded, it usually is moved into cold storage rooms where it is stored for a time or "pre-cooled" before being moved to the packing line. In some houses, to avoid extra handling, fruit is moved directly to the packing line as it is being received. In either case, receiving consists of unloading the fruit from road trucks or orchard trailers as it arrives from the orchard and moving it into cold storage or to the packing line (fig. 13).

Many plants try to schedule their operations so that all fruit is received into designated cold storage rooms, later moved to the packing line, packed, and returned to different cold storage rooms. Thus in receiving to storage during the harvest season, one room, or part of a plant, may handle many more boxes of fruit than its absolute storage capacity.

Figure 13.--Unloading a road truck at a belt conveyor-hand truck plant.

In a relatively large number of plants, boxes of fruit must be high-piled in storage rooms as they are received. High-piling usually consists of manually lifting boxes of fruit and stacking them on top of rows of original 6-high stacks of boxes. Many plants store unpacked boxes of fruit 12 boxes high--a few as high as 14. Other plants high-pile 8 or 9 high, depending on storage room designs. The high-piling operation consists of elevating boxes to the top of the stacks, which is usually done by one worker handing boxes up to another, who in turn places them on top of the stacks to complete building the high pile (fig. 14). When the stack is not higher than 8 boxes, the operation usually is performed by one worker on the floor who lifts and positions the boxes on top of the stack. One operation was observed where a tall man was used to high-pile 9 boxes from the floor.

Figure 14.--High-piling unpacked boxes of fruit 12 high.

When the fruit is moved from storage to the packing line, the high-piled fruit usually is broken out by workers handing boxes down to other workers who build 6-high stacks on the floor. In a hand truck operation, these stacks are hand trucked to the washer, and in the belt-conveyor operation they are trucked to a belt conveyor where workers place the boxes one at a time on the belt carrying the fruit to the packing line. In fork-lift truck and industrial clamp truck operations, the trucks break out boxes of fruit from the stack and transport them to the packing line.

After they are packed, the boxes of apples are returned to storage or moved for loading out to refrigerator cars and motortrucks. In either case, the fruit usually must be segregated unless an unusual sale has been made of a natural run of sizes and grades. As they leave the packing line, packed boxes already are on a belt conveyor which can be connected with other conveyors, and the fruit usually is moved either to the railroad car or to the segregation area.

In plants where industrial trucks are used for handling apples, the segregation area is a special room or part of a room. In the conventional older-type plants, segregation is done in the cold storage room where the fruit is to be stored.

Segregation consists of removing packed boxes of fruit from the belt conveyor and placing each box, in accordance with grade and size, in separate stacks. Some plants segregate the fruit into individual sizes, other plants group two or three sizes. When the belt-conveyor-hand-truck methods are used, segregated fruit is stacked five or six boxes high (fig. 15). In industrial truck operations, the segregated stacks

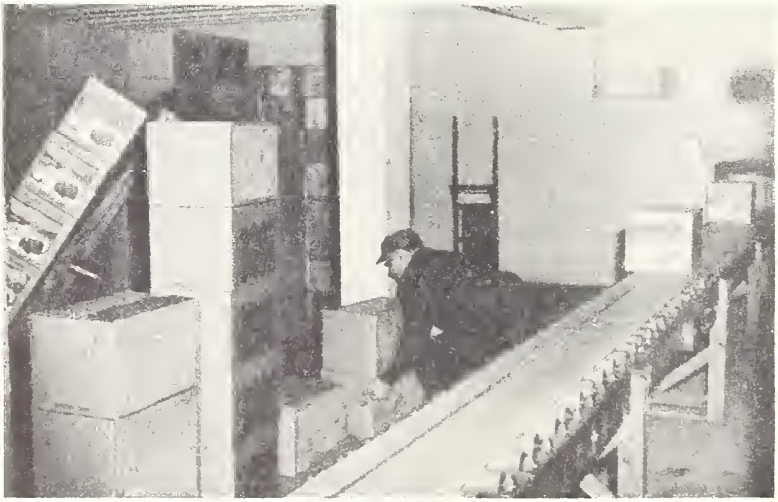

Figure 15.--Segregating packed cartons of apples in a belt conveyor-hand truck plant.

are blocked into unit loads of 20, 30, or 40 boxes, depending on the capacity of the industrial truck used.

When fruit is moved directly from the packing line to the refrigerator car or motortruck for loading, segregation consists of removing from the belt conveyor the grades and sizes that are not to be loaded. The conveyor is set so that fruit moves continuously into the car. The fruit removed from the conveyor is moved into storage.

Moving packed boxes of fruit from storage for loading out is similar to operations previously described. Boxes are broken out of high piles and transported with hand trucks or industrial trucks to the refrigerator car, or placed on belt conveyors leading to the car.

Fruit that is to be shipped is "blocked out" before the loading operation begins. Blocking out consists of setting aside in a separate area the proper number of boxes of each grade, size, and variety, as specified by the sales manifest. In some cases, this operation may entail moving considerable fruit in the cold storage room to obtain the specified grades and sizes. In other cases, it may involve nothing more than designating the rows and number of stacks of boxes that are to be moved from the storage position.

In addition to blocking out, carloading includes manifesting. Manifesting is the preparation of a tally sheet showing the number of boxes of each grade and size that go into the blocked-out load. It must check with the sales manifest. If it does not check, other boxes of certain sizes or grades from storage must be added to the block-out, and the unwanted boxes moved from the blocked-out unit back to storage. Manifesting may take place while the car is being loaded, and, depending on how the fruit has been segregated or sold, blocking out may be performed simultaneously with carloading operations, particularly when industrial trucks are used.

Classification of Plants by Types of Equipment Used

On the basis of the principal types or combinations of types of materials-handling equipment used, the 252 Washington State apple packing and storage houses, in operation during the 1950-51 season, can be classified as those using: (1) Clamp-type 2-wheel hand trucks, (2) clamp-type 2-wheel hand trucks and belt conveyors, (3) clamp-type 2-wheel hand trucks and floor chain conveyors, (4) clamp-type 2-wheel hand trucks and elevators, (5) industrial clamp trucks, and (6) industrial fork-lift trucks and pallets. Most of these plants use other less important types of equipment, such as sections of gravity-type roller conveyors or pallet dollies, in addition to the more basic types.

Hand Truck Plants

Most of the 90 plants that used hand trucks predominantly during the 1950-51 season are the smaller Washington State plants. As indicated, they handle fruit, in most operations, with 2-wheel hand clamp trucks. These plants usually are near the orchards and may have unrefrigerated storage area only. Multistoried hand truck plants use belt conveyors to move fruit between floors. Physical construction of the plants is usually frame or a combination of frame and concrete, depending on whether the storage area is refrigerated or unrefrigerated.

In hand truck plants, fruit usually can be received either directly to the dumper or into the storage area. When the packed boxes of fruit leave the packing line, conveyors move them into the storage area where the boxes are built into 6-high stacks and hand trucked to storage position. Such a plant usually operates only a single packing line. The typical plant uses only seven hand trucks and a belt conveyor footage varying up to 280 feet. The belt is used for moving fruit between floors or from the packing line.

Belt Conveyor and Hand Truck Plants

The older apple packing and storage plants are multistory buildings located in towns near rail facilities. These plants, which are among the largest in the State, use power-driven belt conveyors for moving boxes of fruit into storage and between floor levels. Clamp-type 2-wheel hand trucks are used to move the stacks of boxes on each floor to and from the belts. The 120 houses in this group in 1950-51 are sometimes referred to as "conventional" plants.

Plant construction is of frame, brick, reinforced concrete, or combinations of the three. Nearly all roofs and intermediate floors are supported on beams and columns. Some of the plants have no platforms for receiving fruit and use small openings in the sides of the building which permit the belt conveyors to be extended out so that trucks can be unloaded directly to the cold room. Two different belt conveyor arrangements are used in this type of plant--one with belts through the center of the room, the other with the belt conveyors placed along one of the walls. The first arrangement minimizes the distances boxes are moved to and from the conveyor, while the second requires less space and permits unrestricted travel across the cold room. These plants have from one to six packing lines.

Hand Truck and Floor Chain Conveyor Plants

During the 1950-51 season, four apple packing and storage plants used floor chain conveyors in combination with hand trucks for receiving fruit. Floor chain conveyors also are used in a few plants to feed the packing lines. Usually a short length of floor chain conveyor leads into a mechanical stackdumper.

The physical construction of floor-chain-conveyor plants is similar to that of belt conveyor plants, since all floor chain conveyor type plants are belt conveyor plants that have been converted.

Floor chain conveyors installed in these plants usually lead from the truck unloading area into cold rooms. In large rooms two floor chain conveyors leading in from two different entrances are sometimes used. Nearly all of these conveyors are on ground floors. One plant uses the chain for moving fruit from storage to the dumper, another for moving stacks of boxes the length of the cold room on the third floor of the plant. Two plants use floor chain conveyors for moving fruit within and between cold rooms.

Plants using floor chains had from one to three packing lines and great variations in the quantity of other handling equipment. All of these plants used belt conveyors to some extent, as well as hand clamp trucks, and all had at least 100 feet of floor chain conveyor.

Hand Truck and Elevator Plants

During the 1950-51 season, there were four plants that might be classified as hand-truck-elevator plants since the handling of fruit between floors was by use of elevators rather than belt conveyors. However, there were no plants in the State that used elevators exclusively for interfloor movement of fruit. Three of these four plants have only one elevator.

Industrial Clamp Truck Plants

The eight plants using industrial clamp trucks in 1950-51 varied widely with respect to types of layout and plant design. These plants were either former belt-conveyor and hand-truck plants or hand-truck plants. Since ceiling heights of storage rooms in these plants are relatively low, fruit is not tiered as high as it is in the newer fork-lift truck plants. Most of the industrial clamp-truck plants have obstructions that interfere with handling operations. Low-hanging air ducts or coils, beams, and columns are typical of the older plants.

In many of these older structures, the distance between the point where loose fruit is supplied to the dumper and the area where packed fruit is segregated for storage is so great that one machine cannot perform both phases of handling.

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In clamp-truck plants, fruit usually is segregated in the cold storage room off a belt conveyor, as in belt conveyor plants. Also, when the industrial clamp truck is used for moving packed fruit to storage, it must operate within cold rooms which frequently are on upper floors of the plants, which necessitates transferring the truck between floors. Such transfers are difficult without an elevator.

Pallet and Fork-Lift-Truck Plants

Most of the 26 fork-lift-truck and pallet plants in the State are one-story structures. A few of these plants are remodeled buildings and part of the plant also is served by belt conveyors. These plants are of concrete or concrete block construction with few beams or columns; the truss roof is universal except in plants that have been converted from a belt and hand-truck operation.

At present, many of the dumping and segregation areas in the palletized plants are separated by a considerable distance, making it difficult for one fork-lift truck to service both ends of the packing line.

CURRENT AND ASSUMED WAGE RATES USED IN COMPUTING LABOR COSTS

Except for workers used during the harvest and peak handling season, labor employed in the Washington State apple packing and storage plants is recruited largely from local sources. Although a relatively large number of itinerant workers formerly were employed, in recent years the industry has come to rely less on transient labor, mainly because of the decreased supply. Many local people employed in apple houses are kept on as year-round or "key" workers, and serve as foremen during the fruit-handling season. 5/ During the remainder of the year they are assigned miscellaneous repair and maintenance duties. In some instances "key" workers are shifted to orchard work during the summer, usually on the plant owner's ranch. In some of the plants, particularly in the northern part of the State, experienced itinerant workers hold "key" or supervisory positions. Most of these workers are professional fruit workers, who are employed part of the year in citrus or other fruit plants and part of the year in apple plants.

The degree of skill required of workers who handle apples is not very great. Only brief instructions on methods and duties are necessary for most recruits. However, less supervision is necessary for experienced workers. Plant managers usually are willing to pay experienced workers more than they pay recruits. "Key" workers receive from 6 cents to 12 cents per hour more than regular or unskilled workers.

In the Yakima area, most of the apple houses operated during the 1951-52 season under an agreement with the Fruit and Vegetable Packers and Warehousemen's Union. This agreement, which covered 30 plants, provided for wage rates of $1.12 per hour for regular workers and $1.18 per hour for "key" workers. In the Wenatchee-Okanogan area, apple houses were not operating under union agreements at the time this study was made. The Wenatchee Valley Traffic Association reported that prevailing wage rates, during the 1951-52 season, in the Wenatchee-Okanogan area were $1.08 for regular workers and $1.20 for "key" workers.

A wage rate of $1.15 per hour is, therefore, assumed to be the average rate for unskilled workers and this rate is used in the sections that follow for computing labor costs under "current" conditions.

Industrial-truck operators usually are "key" workers and can be classified as semiskilled employees, since a greater degree of skill is

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5/ A "key" worker is one who is familiar with the warehouse, can direct the storage of fruit in the various cold rooms, and oversee the segregation and storage of packed fruit.

required to operate a lift truck, without spilling apples, than is required to operate some other types of equipment. Lift-truck operation involves accurately judging distances either when driving the truck in the cold room or when maneuvering the truck in crowded areas. Packing plants pay industrial-truck operators from 10 to 20 cents per hour more than they pay regular workers. The highest rate paid lift-truck operators during the 1951-52 season was $1.32 to $1.42 per hour. Firms in the Yakima area paid $1.10 to $1.30 per hour. In the Wenatchee-Okanogan area, $1.25 per hour was more common.

A wage rate of $1.30 per hour is, therefore, assumed to be the average rate for semiskilled workers and this rate is used in the sections that follow for computing labor costs under "current" conditions.

Because of current trends in wage rates, cost comparisons made by use of current wage rates may not adequately reflect the comparative efficiency of various methods and types of equipment during some future period. Therefore, to show cost relationships if wages should increase further, an increase of 25 cents per hour has been made in "current" rates both for unskilled and semiskilled workers. Wage rates under these assumed conditions are $1.40 per hour for unskilled workers and $1.55 per hour for semiskilled workers. These rates are used in the sections that follow for computing labor costs under "assumed" conditions.

COSTS OF OWNERSHIP AND OPERATION OF MATERIALS-HANDLING EQUIPMENT

The costs incurred when materials-handling equipment is employed in fruit handling can be grouped into two major categories: (1) Ownership costs, which are considered to be fixed or relatively stable from year to year over a wide range of equipment use; and (2) operational costs, which are variable and fluctuate in direct relationship with the hours of use of the equipment.

Equipment ownership costs include depreciation, taxes, interest, and insurance. When equipment is purchased, the owners are entitled to recover, on an annual basis, the purchase price of the equipment and accessories by the time it reaches the end of its economic life. This useful life, in years, varies for different types of materials-handling equipment and the use to which it is put. For purposes of straight line depreciation, the method used in this research to obtain the annual rate of depreciation is to divide the total cost of equipment by the number of years of estimated life. State and municipal taxes, interest on the capital invested, and insurance premiums covering fire, disaster, and other forms of protection applicable to the materials-handling equipment, are the other items that round out the ownership costs, and are paid on an annual basis regardless of hours of use.

Costs of operation include fuel and oil in the case of equipment powered by internal combustion engines, and electricity for equipment powered by electric motors. These costs also include labor and parts for maintenance, repair, and overhaul of the equipment and inspection and servicing, such as lubrication. Theoretically, if equipment is not in use, and is kept protected from the weather, it does not accumulate operating costs. However, it should be recognized that if equipment is not used for an extended period some wasting of the equipment will be incurred due to the ravages of time in the form of deterioration of such parts as tires, hose connections, and batteries. This time element is recognized in the depreciation rate for the equipment.

Costs of Ownership

Interest

Most Washington apple plants use an interest rate of 5 percent to estimate their capital costs. This is the rate for money borrowed to make an investment, or the rate that should be returned on an investment. Although some packing houses pay more than 5 percent on borrowed funds, cooperatively owned packing houses and some others usually obtain funds at a lower interest rate. Therefore, an interest rate of 5 percent has been used as a basis of computations of interest costs.

Taxes and Insurance

The tax rates were computed by obtaining official rates of evaluation and assessment at the Yakima County Assessor's Office and applying the tax rates to the assessed valuation. Insurance rates were obtained from published rates of insurance companies. 6/

Insurance rates on apple packing and storage plants, including the equipment, vary relative to a number of factors, such as the location of the plant and its accessibility to fire protection equipment and its location relative to other plants and fire hazards. The construction of the plant also is a factor in determining the insurance rate. Construction features that are considered in determining rates include the plant layout, the number of floors and rooms, and the ways in which the rooms are connected to each other. In some plants and locations, a watchman service is available. Other plants have warning devices and automatic fire protection equipment. All of these factors affect rates. The principal differences in insurance rates appear to be associated with plant locations in municipal areas and locations in rural areas. Insurance rates are lower in municipal areas but taxes are higher than in rural areas. These two factors tend to offset each other, but as a whole, costs are slightly higher in rural areas. Average insurance and tax rates for plants located in rural and municipal areas are shown in table 1. A 2 percent allowance for taxes and insurance appears to be ample, since the combined rates in municipalities and rural areas were, respectively, 1.8 percent and 2.0 percent.

Table 1.--Annual cost per $1,000 of assessed value of materials-handling equipment for taxes and insurance in Washington State apple packing and storage plants in specified locations -- 1952

Location	Taxes	Insurance	Total	Allowance based on assessed valuation
	Dollars	Dollars	Dollars	Percent
Municipal	11.16	6.75	17.91	1.8
Rural	9.47	10.80	20.27	2.0

Depreciation Allowance

Depreciation allowances on equipment which are used in this report for computing costs of ownership are not necessarily the same as those used by plants. The periods used are in general longer, partly because

6/ Various suggested rates by Washington State Surveying and Rating Bureau.

of the relatively short time equipment is used each year. Depreciation allowances used herein are based on the useful life of the equipment. As an illustration, the life of a hand truck is almost perpetual, with only a minor amount of repair and upkeep being required. The practice in many plants is to depreciate equipment such as hand trucks over a very short period, sometimes even one year. However, to more closely represent the useful life of a hand truck, 20 years has been taken as the depreciation period.

Depreciation rates on industrial trucks, which have been used for only a few years in Washington State apple houses, cannot be determined from actual experience based on accounting records. Based on the experience of plant operators, a life of more than 10 years for industrial trucks may be expected.

Manufacturers of industrial trucks indicate that electric-powered equipment should have approximately twice the life of gasoline-powered equipment. Based on the length of operating season in the apple houses and the performance of the oldest trucks now in use, the estimate of depreciation life of gasoline-powered equipment is 10 years. Electric-powered equipment, assuming double the life of the gasoline engine-driven trucks, would be 20 years. 7/

Costs of Operation

Inspection and Servicing

Much of the equipment in conventional plants requires little inspection and servicing. Hand trucks and belt conveyors usually are checked once or twice a year. Such service usually is limited to greasing and oiling. Much of this work is done by regular workers during the off-season. Although full charges for this work have been estimated, plant managers generally feel that the labor charge is incidental since such jobs are a means of occupying year-round workers who might otherwise be idle.

Industrial trucks require considerably more servicing than other equipment. The amount of service work varies with the number of hours

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7/ The Electric Industrial Truck Association states: "Among users of electric trucks it is rare to find reserve accruals higher than 10% per year, and often a 16 year life is assumed for profit and loss cost accounting. This is two to three times the write-off period applied to engine-driven industrial trucks." "Handbook of Materials Handling with Industrial Trucks," 1950. Page 65.

the machines are used and with the individual plant. Equipment service includes lubrication, changing oil, supplying fuel, charging batteries, and inflating tires. Based on estimates of actual operations, weekly service work requires slightly less than one hour per machine.

Maintenance, Repairs, and Overhaul

Maintenance work on equipment in the Washington State apple houses usually is done during the off-season except in cases of emergency breakdowns. The maintenance crews frequently consist of year-round workers who, during the active fruit season, are assigned to supervisory or regular duties in the plants. Therefore, many plant managers do not consider maintenance labor costs to be a direct charge. Frequently, these workers do repair work that would be considered unnecessary or too costly if special workers were employed.

Common repairs to hand trucks include welding new tips on the clamping arms and replacing hard rubber tires. Common repairs to belt conveyors include splicing the belts, replacing pieces of worn belts, and replacing broken rollers. Repair and maintenance costs of floor chain conveyors were difficult to determine because most of these installations are not more than three years old. Some of them still are being serviced by the manufacturer's agent as part of the original guarantee and, to some extent, the installations were experimental with maintenance problems to be worked out as experience was gained. However, by drawing on the experience of plant operators, an estimate of maintenance cost has been made as a basis for computing repair and maintenance costs.

Costs of maintenance and repair of industrial lift trucks is relatively high. Maintenance work on industrial equipment consists of such work as replacing an engine, motor, or hydraulic parts; overhauling an engine; changing or repairing tires; "tuning up" an engine; and replacing electrical connections. Plant records show that, in general, electrically-powered trucks and equipment require relatively little repair or maintenance, but gasoline-powered equipment requires an engine overhaul about every four or five years. A number of plants send their industrial trucks to distributors or to the manufacturer's agent for complete overhaul jobs.

Energy Costs

Energy costs in plants using electric- or battery-powered industrial trucks are generally uniform with respect to the charges the plants pay per unit of power for electricity. Gasoline was 24.8 cents per gallon in the winter of 1951-52 in the main fruit areas. Outlying areas in the northern part of the State paid slightly more. A cost of 25 cents per gallon has therefore been assumed as a basis of computations in this report. The cost of motor oil was 40 cents a quart.

Studies revealed that a truck consumed from two to six gallons of gasoline a day, depending on the extent to which a machine was used, but consumption ranged from 1 to 1.25 gallons per actual operating hour. This consumption rate reflects the relatively short runs and the tiering of pallet loads. Energy costs for electric-lift trucks were relatively low. On the basis of scheduled charges in different brackets of power consumption and the indicated power consumption of packing and storage plants supplied by the Pacific Power and Light Company, most apple packing plants would be in a high-consumption bracket, paying 0.9 or 0.6 cents per kilowatt hour. The average packing plant paid about one cent per kilowatt hour, averaging in the lower rate brackets. 8/

Summary of Costs of Ownership and Operation

The costs of ownership and operation of various types of materials-handling equipment shown in table 2 reflect the manufacturer's quoted prices for the different capacities of equipment f.o.b. Yakima, Wash.

To estimate costs per hour, the annual hours of use for each type of equipment for the season were estimated. The assumed hours of use are based on observation in various plants on the quantity of fruit that can be handled and the length of the fruit-handling season. The assumed hours of use have been checked against the quantity of fruit that could be physically handled in a given period to judge whether the estimates were within reasonable limits. Any one plant actually might use its equipment more or less than the assumed hours and should adjust its own costs accordingly. In most plants, the annual hours of use probably would be slightly less than the estimate providing a basis for this assumption, since most plants have sufficient equipment to handle their peak work loads without delay.

8/ Net monthly electric rate of Pacific Power and Light Company, Yakima, Wash.:

75.0 cents for the first 16 kw.-hrs., or less
3.2 cents per kw.-hr. for the next 284 kw.-hrs.*
2.7 cents per kw.-hr. for the next 300 kw.-hrs.
1.3 cents per kw.-hr. for the next 1,400 kw.-hrs.
0.9 cents per kw.-hr. for the next 15,000 kw.-hrs.
.6 cents per kw.-hr. for the next 50,000 kw.-hrs.
.3 cents per kw.-hr. for all additional kw.-hrs.

*Where the demand exceeds 7 kw.-hrs., add 30 kw.-hrs. for each kilowatt over 7 kilowatts. Monthly rates for plants located in rural areas are slightly higher.

Table 2.--Estimated costs of ownership and operation of specified types of materials-handling equipment in Washington State apple packing and storage plants--1952. 1/

Type of equipment	Amount of equipment	Replacement cost 2/	Assumed annual use	Cost of ownership 3/ Per year	Cost of ownership 3/ Per hour	Cost of operation Per hour	Total cost per hour
	Unit	Dollars	Hours	Dollars	Dollars	Dollars	Dollars
Clamp-type two-wheel hand trucks	one	74.10	400	7.03	0.017	0.007	0.024
Belt conveyor	100 ft.	1,593.37	200	147.99	.74	.09	.83
Floor chain conveyor	100 ft.	2,918.00	300	325.84	1.09	.07	1.16
Roller conveyor	100 ft.	492.25	200	55.00	.275	.005	.28
Portable mechanical lift 4/	one	680.00	300	130.60	.43	.16	.59
Industrial clamp truck (800-pound capacity--gasoline - 12-box load)	one	1,152.00	250	167.04	.67	.25	.92
Stackmaker for building single boxes into six-high stacks	one	2,500.00	150	279.17	1.86	.15	2.01
Stackbreaker for breaking six-high stacks to single boxes	one	2,000.00	350	223.33	.64	.07	.71
Elevator for movement between floors 5/	one	13,375.00	400	1,270.62	3.17	.04	3.21
Booster to accelerate packed boxes going into refrigerated cars 6/	one	400.00	200	44.67	.22	.11	.33
Hydraulic device to stabilize road truck 7/	one	1,150.00	150	128.42	.86	.06	.92
Nonhydraulic device to stabilize road truck bed 8/	one	50.00	150	5.58	.04	-	.04
Industrial clamp-lift truck (1,000-pound capacity --gasoline-24-box load)	one	3,032.00	400	439.64	1.10	.53	1.63
Industrial clamp-lift truck (1,000-pound capacity--electric--24-box load) and battery charger	one each	4,493.00	400	490.33	1.23	9/ .19	1.42
Industrial clamp-lift truck (2,000-pound capacity--gasoline--36-box load)	one	3,560.00	400	516.20	1.29	.53	1.82
Industrial clamp-lift truck (2,000-pound capacity--electric--36-box load) and battery charger	one each	6,064.00	400	667.08	1.67	.19	1.86
Industrial fork-lift truck (2,000-pound capacity--gasoline--36-box load) 10/	one	3,033.00	400	439.78	1.10	.53	1.63
Industrial fork-lift truck (2,000-pound capacity--electric--36-box load) 10/ and battery charger	one each	5,537.00	400	617.01	1.54	.19	1.73
Industrial fork-lift truck (4,000-pound capacity--gasoline--48-box load)	one	4,042.00	400	586.09	1.46	.64	2.10
Industrial fork-lift truck (4,000-pound capacity--electric--48-box load) and battery charger	one each	7,271.00	400	807.16	2.02	.26	2.28
Industrial low-lift truck - walkie type (4,000-pound capacity--electric--48-box load) and battery charger	one each	2,097.00	200	223.29	1.12	9/ .38	1.50
Dunnage strips used between industrial clamp truck unit loads to stabilize stacks in storage. (24-box loads--2 loads high) 1 by 4 by 2-inch strips for 1,000 boxes at $50 per 1,000 board feet	41.6 bd. ft.	2.08	11/ 4.69	.51	.11	-	.11
Pallets--36-box--(36-inch by 40-inch)							
Pallets for 1,000 boxes at $2.80 per pallet	27.8	77.84	11/ 4.74	8.70	1.83	12/ .10	1.93
Pallets--48-box--(40-inch by 48-inch)							
Pallets for 1,000 boxes at $3.00 per pallet	20.8	62.70	11/ 3.64	7.02	1.92	12/ .10	2.02
Pallet dolly for loading out	one	42.85	200	10.50	.055	.005	.06

1/ See Appendix for data used in preparing cost summaries shown in table 16o.
2/ Total replacement cost f.o.b. Washington State points.
3/ Includes interest on investment at 5 percent, allowance for taxes and insurance at 2 percent, and depreciation.
4/ Used for high-piling and breaking out high-piled boxes of apples.
5/ Capacity 8,000 pounds, 40-foot lift, platform 8 by 10 feet.
6/ Electric device used to replace worker for pushing boxes on a roller conveyor from the doorway to the ends of a refrigerator car.
7/ Hydraulic device that holds truck bed against projection of platform, eliminates spring action of truck, and permits industrial equipment to operate on the truck bed.
8/ Device consists of metal frame wedge projecting from the loading dock. As truck is backed up, the metal frame prys the end of truck bed to an even height with dock platform which allows industrial truck to operate on bed of road truck. (Device usually operates properly only with the road trucks for which it is made.)
9/ Cost data not available; interpolations made from cost data on 2,000-pound capacity electric lift trucks.
10/ Recently there has been a trend toward the use of the 4,000-pound capacity fork-lift truck in 36-box pallet plants which tier 3 pallets high, because extra lift height is needed above that provided by standard 2,000-pound model. The additional cost of about $100 for the 4,000-pound as compared with the cost of the 3,000-pound model makes the shift to 4,000-pound trucks worthwhile to most operators.
11/ Estimated annual hours of use determined by computing the time pallets or dunnage strips are involved in handling operations, based on the man-hours of labor required per 1,000 boxes in all groups or cycles of handling operations. (Storage time not included.) Allocations to groups of operations follow.

	Receiving to storage	Storage to line	Line to storage	Storage to shipping out	Miscellaneous (culls, empty boxes, etc.)	Total per 1,000 boxes for all operations
	Man-hours	Man-hours	Man-hours	Man-hours	Man-hours	Man-hours
Dunnage strips	1.04	1.13	1.48	1.04	-	4.69
36-box pallet	.72	.78	.85	.81	1.58	4.74
48-box pallet	.55	.62	.63	.63	1.21	3.64

12/ Includes maintenance cost only at 25 cents per pallet over a life of 15 years.

HOW COSTS FOR PERFORMING FRUIT-HANDLING OPERATIONS CAN BE COMPARED

In the sections of the report that follow, total labor and equipment costs for performing various operations or groups of operations with different types or combinations of types of equipment have been computed. Obviously these costs do not reflect the value of the loss in quality that may result from rough and excessive handling, or the loss in storage life that may result from failure to move fruit into storage promptly. Retention of fruit quality in connection with the physical handling of apples usually is associated with prevention of bruises and damage to the apples and with attainment of prompt refrigeration. The first step in decay control is the prevention of bruising, since research results show that decay most frequently starts from a bruise and the larger the bruise the higher the incidence of decay. 9/ Studies also show that bruised apples tend to mature more rapidly.

Delays in moving apples into cold storage may be directly associated with the methods and equipment used. Delicious apples, the major variety in Washington State, lose approximately 10 days' storage life for each day they are left in the orchard after picking. 10/ Thus the cost of handling apples by a given method may be exceptionally high if the storage life of the fruit is shortened to the point where the market value of the fruit is impaired or the late-market price cannot be realized.

However, since materials-handling operations involve the handling of rigid containers of fruit, rather than the handling of the fruit itself (as is necessary in connection with packing-line operations), and since improved methods and equipment for performing physical-handling operations usually reduce the number of times packages are individually handled, studies were not made, in connection with this research, to evaluate bruises and other injuries occurring during handling operations by the various methods. Although comparisons of the amount and extent of bruises and other injuries caused by various methods and types of equipment are desirable, losses in quality would be difficult to evaluate in economic terms. Therefore, cost comparisons have been limited to the direct costs of labor and equipment.

9/ USDA, Bureau of Plant Industry study, "Blue Mold Decay of Delicious Apples in Relation to Handling Practices," December 1946, Circular No. 751.

10/ Reprint from the Washington State Horticultural Association proceedings, "Physiology and Dessert Quality of Delicious Apples as Influenced by the Handling, Storage, and Simulated Practices" by Fisk Gerhardt and Edwin Smith, USDA, Bureau of Plant Industry, Wenatchee, Wash.

Cycles of Fruit-Handling Operations

All fruit-handling operations in an apple packing and storage plant, except the operations in the packing line, may be grouped as follows:

1. Unloading and moving apples into storage.
2. Unloading and moving apples directly to the packing line.
3. Moving apples out of storage to the packing line.
4. Moving apples from the packing line back to storage.
5. Moving apples out of storage and loading out.
6. Moving apples from the packing line and loading out.

These six groups or cycles of fruit handling will be discussed in the sections that follow.

Time study data show that the elapsed time and the labor required to handle these standard boxes of unpacked fruit and specially constructed field boxes were identical. Therefore, discussions of methods and equipment for handling loose or unpacked fruit are applicable to either type of box.

Time study data also show that when packed boxes are handled individually or in unit loads, the elapsed time and the labor required per box or per load were the same as for unpacked boxes. However, when packed boxes are hand trucked, a unit load may consist of five boxes rather than six boxes as for loose fruit, and it is necessary to adjust the time and labor accordingly. These studies revealed the same relationships for larger unit loads handled by industrial equipment. Packed boxes and loose boxes were picked up and transported in the same time per unit load. Additional details are shown in the Appendix.

Definitions of Terms

The tables in the sections that follow show the amount of productive labor required by workers to perform a particular activity, operation, or group of operations. Productive labor is taken from the tables of comparative data shown in the Appendix. Productive labor is adjusted for differences in rate at which men work, and contains unavoidable delays--delays that are inherent in the method when using a certain type of equipment or crew size under variable conditions. Productive labor is the amount of work time necessary to complete an operation or cycle of operations.

In certain materials-handling operations, the capacity of the worker is affected by the strenuousness of the activity so that either the worker finds it necessary to pause to rest or his working pace slows down as the working day progresses. To adjust for this factor, an allowance has been made for fatigue. 11/ This allowance has been arrived at through experience and observations. Fatigue allowance is the estimated time allowed because of exertion required in doing a job.

Another allowance included in some of the tables is for crew interference, particularly in hand-trucking operations. 12/ Interference occurs when one member of a crew halts the work of or interferes with one or more of the other members. 13/ Crew interference is the time resulting from one member of a hand-trucking crew unavoidably delaying another worker.

One of the methods of analyzing the efficiency of an operation is to observe and record the wait time that results from a particular method or crew arrangement. By studying the wait time, it frequently is possible to determine ways in which the crew or method can be changed to increase efficiency. This loss in wait time is inherent in the crew size or method of doing the work. There are, of course, delays in an operation that are of a personal nature, such as when one worker stops to smoke. Wait time is the time one member or members of a crew spend in waiting on another member or members.

In many of the tables that follow, the total of productive labor, fatigue allowance, and wait time are added in a column called total labor. Total labor is the total labor inputs, expressed in man-hours or man-minutes, required for the performance of an operation or cycle of operations.

The time required to perform an operation also may be expressed as elapsed time. Elapsed time is especially important in the receiving cycle of operations because it determines the length of unloading time of a road truck or orchard trailer. Elapsed time is the length of time in minutes or hours from the beginning to the end of an operation or cycle of operations.

11/ See page 267 of the Appendix.
12/ See page 277 of the Appendix (fig. 133).
13/ Interference usually occurs in an area with narrow aisles, at a doorway, or at a bridgeplate.

METHODS AND EQUIPMENT FOR UNLOADING AND MOVING APPLES INTO STORAGE

The most important group or cycle of apple-handling operations in Washington State plants is unloading and moving the apples into storage. This cycle of operations is usually referred to as "receiving" and may include "receiving to storage" or "receiving to the packing line." Receiving is important because it requires the use of a great deal of labor and involves prompt storage which is highly essential in preserving the keeping quality of apples. During the receiving period there is a general scarcity of labor in apple packing plants, since harvest operations are carried on simultaneously with the warehouse work. Packing houses compete with the orchards for the labor.

In Washington State approximately 40 million boxes of unpacked apples are moved into storage or to the packing line each harvest season in a period of not more than eight weeks. In some areas the harvest season for apples may be even shorter. Warehouse operators usually are willing to sacrifice efficiency in handling to be able to receive fruit in a short period of time, for it is to the interest of both the grower and the warehouseman to preserve the storage life and quality of the fruit. Therefore, one of the interests of warehouse management in different types of handling equipment is to bring about more prompt and rapid receiving.

An important factor affecting the costs of unloading and moving apples into storage is the length of the receiving season, particularly with the newer types of equipment which involve relatively high capital investments. A short season does not permit ownership costs to be spread; consequently, capital cost per box may appear high to a number of those who consider new types of materials-handling equipment. Some of the receiving equipment in the industry has remained in good operating condition for more than twenty years, and is almost as valuable as new equipment, except for obsolescence. Until recent years fruit-handling equipment in the State has been rather standard, with few innovations being introduced, and it was not until the use of industrial equipment came into the picture that obsolescence was considered as a factor in determining costs.

In Washington State, as the harvest gets under way in the fall, the receiving season starts off slowly. Only a few of the earlier varieties, or the main varieties from early orchards, arrive at the warehouse. As the season progresses the number of road trucks arriving at the warehouses increases. At some plants with limited receiving capacity, loaded road trucks must wait in line for their turns to unload. This causes considerable loss of orchard labor. The harvest season usually is at its peak three to four weeks after the picking of the earlier varieties begins. Then, for two to three weeks, the number of boxes received daily at warehouses decreases rather gradually. In heavy crop years, this slow-down permits readjusting of some of the boxes in cold storage, so that space can be made for a few more boxes.

Considerable loss of time of receiving crews could be avoided if the arrival of fruit from the orchards could be scheduled. However, circumstances in the orchard in harvesting are so varied that a schedule cannot be followed. It is sometimes found that certain lots of fruit in the orchard develop a tendency to drop from the trees, and picking must be rescheduled. There may be a variation in the number of pickers in the crews from day to day, changes in weather that affect the volume of fruit ready to haul to the warehouse, and other factors. Inability to schedule the receiving of apples interferes with warehouse operations in another way. Good cold storage practice requires that lots of apples be segregated as they are received. Fruit that is to be sold on the early market must be treated differently than fruit that is to go to the late market. Certain parts of the cold storage rooms may be more accessible or have lower handling costs than others. Grower's lots of fruit must be moved to these storages as requirements indicate. A grower's lot of fruit may be all of the fruit from a small orchard, or from a large orchard; it may be all the fruit coming from one section of the orchard, or all of the fruit received on a certain day. The identity of each lot must be maintained unless it is pooled.

Usually fruit picked near the beginning of the season has better keeping qualities than fruit picked late in the season. The fruit picked late should be moved into the parts of storage facility where it is accessible for packing after the first few weeks of storage. In the first two weeks of the season, many houses ship a large part of their fruit directly to the terminal markets.

Field boxes of apples are transported from orchards to packing and storage houses by two types of equipment: Road trucks and orchard trailers, which usually are loaded with 288 field boxes and 144 field boxes, respectively. Unloading these trucks and trailers and moving the fruit to storage involves the following cycle of operations: (1) Picking up boxes, (2) transporting the boxes to the stacking or storage point, (3) stacking or placing in storage, and (4) returning with the materials-handling equipment empty to pick up the next load.

In performing this cycle of operations, a number of variations occur. For example, two types of equipment may be used in combination, such as a belt conveyor and 2-wheel hand trucks. With this equipment, boxes are unloaded and moved to a given point by belt conveyor, removed from the conveyor and stacked into 6-high stacks, and at that point picked up by a 2-wheel hand truck and moved to the warehousing point. Another example is a cycle in which pallet loads of apples are removed from the motor-truck and temporarily placed on an apron by a fork-lift truck and later picked up and transported to permanent storage. In these examples, certain operations are repeated to complete the cycle of unloading and moving to storage.

For the purposes of this report, the operation of picking up boxes consists of positioning the forks, clamps, or arms of the materials-handling equipment; setting the clamps; picking up, or, in the case of industrial trucks, lifting the load; and moving a short distance in the direction of travel. For the purpose of time study observations, pickup time started when the operator began positioning his equipment and ended when he was in position to begin the next operation in the cycle, transportation; or, in the case of industrial equipment, when the load cleared its original position.

Transporting boxes to the stacking point begins as soon as the worker with the hand truck is in position to move or the unit load cleared its original position, and ends when the worker with the hand truck or industrial truck reaches the storage point and starts to maneuver for the purpose of placing the stack or unit load in storage.

Stacking, or placing in storage, begins when the worker begins to maneuver the truck into position, and ends when the hand trucker begins to return empty or when the forks or clamps of the industrial trucks clear the load.

Returning empty with the transportation equipment begins when the hand trucker has completed his backing and turn and starts his return to pick up the next load or when the fork or clamps of the industrial truck clear the load, and ends when the trucker begins to position the forks or clamps for the purpose of picking up a load. Labor required in returning empty with transportation equipment is not shown separately in this report but is combined with transporting loaded and the combination is shown as transportation labor.

A special case exists when conveyors are used for performing certain handling operations. Actually, there are only two points at which labor is involved--at the loading and unloading ends of the conveyor. Picking up the boxes and placing them on the conveyor is the operation associated with the pick-up when other types of equipment are used. Removing boxes from the conveyor and placing them in 6-high stacks is the counterpart operation of placing boxes in storage with other types of equipment. For time study purposes, both of these operations begin when the worker starts to pick up the first box either on the truck or from the conveyor and ends when he sets the last box down either on the conveyor or into a 6-high stack. Transportation between loading and unloading points of the conveyor does not involve any labor, although equipment costs are incurred.

The cycle of operations involved in unloading and moving apples into storage, usually referred to as receiving of apples, includes the work that is performed in unloading boxes of loose apples from road trucks or orchard trailers and moving the boxes into the cold rooms with different types of equipment. This cycle of operations includes releasing the unit load on the floors of the storage room and tiering the boxes, either manually or mechanically, above the usual height of the stack brought in by the materials-handling equipment. In the manual receiving cycle, this operation is referred to as high-piling. Manual high-piling, and mechanical high-piling with a newly introduced mechanical lift, are performed when fruit is received with the older conventional equipment. High-piling is discussed as a separate cycle of operations.

The types of equipment used to unload and move apples into storage are: (1) Clamp-type 2-wheel hand truck, (2) clamp-type 2-wheel hand truck and belt conveyor, (3) clamp-type 2-wheel hand truck and floor chain conveyor, (4) belt conveyor, stackmaker, floor chain conveyor, and clamp-type 2-wheel hand truck, (5) clamp-type 2-wheel hand truck and elevator, (6) industrial fork-lift truck and pallets, and (7) industrial clamp-type lift truck. These equipment types and the methods involving their use are discussed in the sections that immediately follow.

Clamp-Type 2-Wheel Hand Trucks Alone

The clamp-type 2-wheel hand truck has been a standard type of handling equipment in the Washington State apple houses for a number of years (fig. 1). It is convenient for handling the Northwest standard apple box, and the capital investment required is relatively small. The hand truck probably is the most important single item of handling equipment used in apple houses. In plants where it is not used as the sole means of handling apples, it is used in conjunction with other equipment, such as belt conveyors, floor chain conveyors, and elevators. Only in a few of the newer plants that use industrial trucks has the importance of the 2-wheel hand clamp truck diminished, but even in these plants there usually are one or more hand trucks for standby use.

One of the features of the hand truck that makes it desirable for unloading operations is that it can be wheeled onto a highway truck or orchard trailer to pick up a load and transport it to the storage or stacking point. Unloading begins when a bridgeplate is put in place after the truck or trailer has backed up to the receiving dock. The bridgeplate is used as a floor from which to pick up the first stacks at the end of the road truck. After the first stacks have been removed, hand trucks can work directly from the bed of the vehicle. When unloading road trucks with clamp-type 2-wheel hand trucks, 6 boxes of unpacked apples always constitute a load and this load is handled as a unit. Since boxes are stacked 6 high on road trucks, no rebuilding of stacks is necessary. At the storage point, 6-high stacks are positioned and released as a unit (fig. 16). Boxes on orchard trailers usually are stacked 3 high and these stacks are built 6 high preparatory to unloading with hand trucks.

There are a number of circumstances that affect the efficiency with which the 2-wheel hand truck can be used for receiving fruit. Perhaps the most important of these is the number of workers assigned to hand-truck crews. If the transportation distance is short, and hand truckers tend to interfere with each other, delay time results. Delays occur where the hand truckers must traverse narrow aisles and cannot pass each other freely in going to and from picking up and releasing their loads. Similar delays occur when the bridgeplate is narrow and hand truckers either wait or pace themselves, so as to permit one worker at a time to cross the bridgeplate (fig. 17). In some plants posts interfere with the release of the load at the storage point, which affect the time and labor required to handle boxes of fruit.

Figure 16.--Releasing a 6-high stack of boxes from a hand truck in a storage room.

In a few plants differences in floor levels or elevations between one part of the plant and the other, or between the platform and storage rooms, may slow down operations, but where these differences are not too great they usually had little effect on transportation time. However they may require extra effort

Figure 17.--Waiting occurs when there are too many hand truckers.

on the part of hand truckers. In those places where the platform is higher than the bed of the truck, the worker usually pulls his load off of the truck backward rather than pushing it forward. Allowances have been made for these factors in the standard time values.

Transportation distances vary considerably during receiving operations in different plants. In a few cases, fruit was transported not more than 25 feet from the road truck or orchard trailer into storage. In other instances, fruit was transported as far as 200 feet with 2-wheel hand trucks. However, transportation distances usually were roughly 100 feet. For the purpose of this analysis, transportation distances have been standardized at 100 feet.

Unloading Boxes of Apples from Road Trucks and Moving to Storage

2-man crew.--A 2-man crew usually is employed for unloading road trucks by use of 2-wheel hand trucks (fig. 18). In plants where an effort is being made to reduce elapsed time for unloading, a 3-man crew or,

Figure 18.--Receiving to storage with a 2-man hand-trucking crew. Stacks of boxes are transported from road truck to the stacking point.

occasionally, a 4-man crew is used. When a 2-man crew is used, each crew member operates a hand truck and each performs comparable duties. Each hand trucker, in turn, wheels his empty hand truck onto the road truck bed, clamps and picks up a 6-high stack of boxes as a unit, turns, and wheels the stack to the storage point inside the plant. At the storage point he positions and releases the stack of boxes, again as a unit, and returns to the road truck to repeat the cycle.

As shown in table 3, the labor requirements for unloading from a road truck and moving into storage 1,000 boxes of unpacked apples by use of 2-wheel hand trucks, when a 2-man crew is used, are 2.94 man-hours. Of this total, 2 hours, or 68 percent, are spent in transporting fruit. Pickup requires slightly more time than releasing the fruit. Pickup and release account for 28 percent of the total labor.

Table 3.--Labor required for a 2-man crew to unload 1,000 unpacked boxes of apples from a road truck and move them into storage by use of clamp-type 2-wheel hand trucks 1/

Operation	Workers	Productive labor	Fatigue allowance	Wait time	Total labor
	Number	Man-hours	Man-hours	Man-hours	Man-hours
Set up and clean up	2	0.12	0.0	0	0.12
Pick up stack with 2-wheel hand truck	2	.39	.04	0	.43
Transport 100 feet with 2-wheel hand truck	2	1.82	.18	0	2.00
Release stacks with 2-wheel hand truck	2	.35	.04	0	.39
Total man-hours	-	2.68	.26	0	2.94
Elapsed time--hours					2/ 1.47

1/ Boxes of fruit are handled in unit loads consisting of 6-high stacks. Labor requirements shown do not include piling boxes above 6-high stack.
2/ A road truck load of 288 boxes can be unloaded in 25 minutes.

The elapsed time required to unload 1,000 boxes from road trucks and move into storage by this method is 1.47 hours, or 25 minutes per truck load of 288 boxes. At this rate, approximately 5,000 boxes or 17 truck-loads of apples could be received per crew per 8-hour day.

3-man crew.--The elapsed time to unload road trucks and move fruit into storage can be reduced by increasing the size of the crew. A 3-man crew reduces the elapsed time to 1.05 hours per 1,000 boxes. Thus, a road truck with a load of 288 boxes would be tied up at the receiving platform approximately 18 minutes.

However, at a standard transportation distance of 100 feet, the amount of delay time increased as the crew became larger. With a 2-man crew, no time was lost because of delays during the unloading of a truck. With a 3-man crew, more than 6 percent of the labor was accounted for by wait time (table 4).

Table 4.--Labor required for a 3-man crew to unload 1,000 unpacked boxes of apples from a road truck and move them into storage by use of clamp-type 2-wheel hand trucks 1/

Operation	Workers	Productive labor	Fatigue allowance	Wait time	Total labor
	Number	Man-hours	Man-hours	Man-hours	Man-hours
Set up and clean up	3	0.12	0.0	0.06	0.18
Pick up stack with 2-wheel hand truck	3	.39	.04	.0	.43
Transport 100 feet with a 2-wheel hand truck	3	1.82	.18	2/ .14	2.14
Release stacks with a 2-wheel hand truck	3	.35	.04	.0	.39
Total man-hours	-	2.68	.26	.20	3.14
Elapsed time--hours					3/ 1.05

1/ Boxes of fruit are handled in unit loads consisting of 6-high stacks. Labor requirements shown do not include piling boxes above 6-high stack.
2/ Waiting time caused by crew interference.
3/ A road truck load of 288 boxes can be unloaded in 18 minutes.

Comparison of 2-man crew and 3-man crew.--As shown in table 5, on the basis of "current" wage rates, the cost of unloading 1,000 boxes of apples from road trucks by use of a 2-man crew is 23 cents less than when a 3-man crew is used. However, because the elapsed time to unload is less, a number of plant operators find it advantageous to use a 3-man crew, at least during the peak periods of activity in the receiving cycle of operations.

Table 5.--Comparative labor and equipment costs for unloading from road trucks and moving into storage 1,000 unpacked boxes of apples by use of clamp-type 2-wheel hand trucks when crews of specified sizes are employed 1/

Method	Elapsed time	Labor and equipment required: Equipment time	Labor and equipment required: Wait time	Labor and equipment required: Total labor	Labor and equipment costs: Equipment	Labor and equipment costs: Labor 2/	Total cost: Current wages	Total cost: Assumed wages
	Hours	Machine-hours	Man-hours	Man-hours	Dollars	Dollars	Dollars	Dollars
2-man hand truck crew	1.47	2.94	0.0	2.94	0.07	3.38	3.45	4.19
3-man hand truck crew	1.05	3.14	.20	3.14	.07	3.61	3.68	4.47

1/ Boxes of fruit are handled in unit loads consisting of 6-high stacks. Costs shown do not include piling boxes above 6-high stacks. Transportation distance standardized at 100 feet.
2/ Computed from "current" wage rates.

Unloading Boxes of Apples from Orchard Trailers and Moving to Storage

3-man crew.--Two-wheel hand trucks also are used to unload orchard trailers at the plant. As shown in figure 19, boxes of apples are stacked 3 high on the trailer bed. After a trailer has been backed or pulled into place at the storage house, the tractor driver or a warehouse worker builds the 3-high stacks of boxes into 6-high stacks (fig. 20). As soon as the first stack has been completed, a 2-man crew

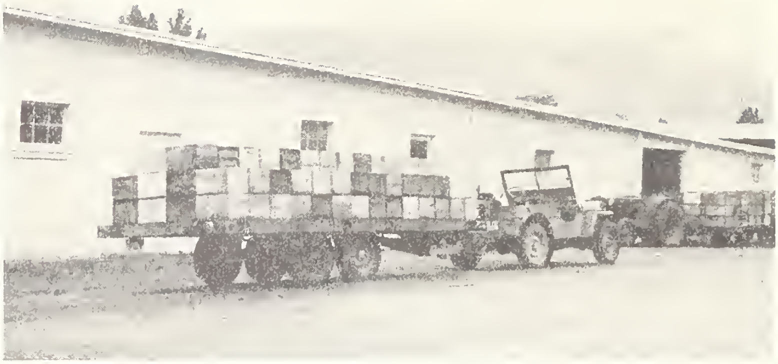

Figure 19.--Orchard trailers waiting at a storage plant to be unloaded, Note that boxes of apples are stacked three high.

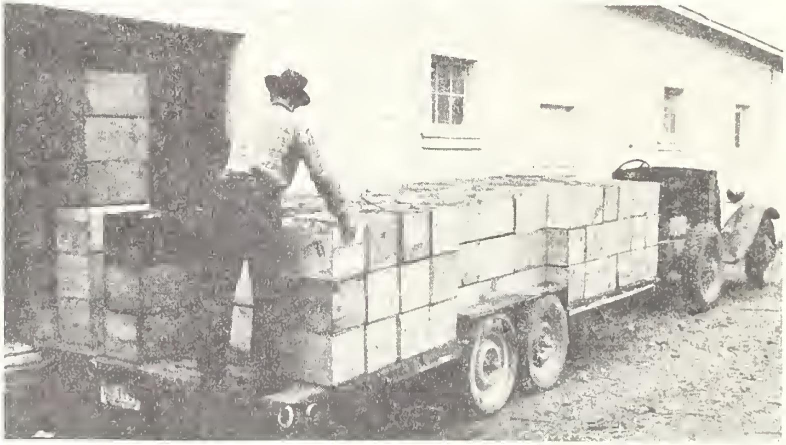

Figure 20.--Building stacks six boxes high on an orchard trailer. Hand trucks move the stacks to storage.

begins hand trucking the stacks from the trailer to the storage room. One worker continues to build 6-high stacks.

Of the total labor required when a crew of three men, two hand truckers and one worker building stacks, is used, 27 percent of the productive labor is required for building stacks. Transportation over a distance of 100 feet requires slightly more than twice as much labor as is required in picking up and releasing the stacks. As shown in table 6, a 3-man crew can unload and move 1,000 boxes into storage in 3.63 productive man-hours. Added to this labor should be an allowance for fatigue and delays due to waiting, which brings the total to more

Table 6.--Labor required for a 3-man crew to unload 1,000 unpacked boxes of apples from an orchard trailer and move them into storage by use of clamp-type 2-wheel hand trucks 1/

Operation	Workers	Productive labor	Fatigue allowance	Wait time	Total labor
	Number	Man-hours	Man-hours	Man-hours	Man-hours
Set up and clean up	3	0.10	0.0	0.05	0.15
Build 6-high stacks of boxes from 3-high stacks on orchard trailer	1	.97	.19	.25	1.41
Pick up 6-high stacks with a 2-wheel hand truck	2	.39	.04	.0	.43
Transport 6-high stacks 100 feet with a 2-wheel hand truck	2	1.82	.18	.0	2.00
Release 6-high stacks with a 2-wheel hand truck	2	.35	.04	.0	.39
Total man-hours	-	3.63	.45	.30	4.38
Elapsed time--hours					2/ 1.46

1/ Labor requirements shown do not include high-piling boxes above 6-high stacks in storage rooms.
2/ A trailer load of 144 boxes can be unloaded in 12-½ minutes.

than 4.00 man-hours per 1,000 boxes. Seven percent of the time is unproductive, but much of this idle time stems from the fact that the full time of the worker building stacks is not utilized. If the transportation distance is less than 100 feet, two hand truckers will keep the stackbuilder fully occupied. If the distance is great enough, the stackbuilder can keep three hand truckers occupied.

4-man crew.--When a 4-man crew is used to unload boxes of apples from an orchard trailer and move them into storage, one worker builds 6-high stacks and three workers unload and transport the fruit to storage. Delays occur when three workers unload and move fruit because their capacity to hand truck is greater than the capacity of one man to build stacks. In this method, 16 percent of the total man-hours required to handle 1,000 boxes is lost because of wait time.

A 2-man hand-truck crew can, under specified conditions, unload 1,000 boxes from trailers in 1.46 hours elapsed time, or approximately 13 minutes per trailer load. As shown in table 7, the 3-man hand-truck crew reduces this elapsed time by 15 minutes per 1,000 boxes, or about 2 minutes per trailer load of 144 boxes. At the peak of the receiving season, when there is pressure to move as much fruit as is possible, it may be desirable to use a 3-man hand-truck crew to unload trailers.

Comparison of 3-man crew and 4-man crew.--As shown in table 8, the costs of receiving apples from orchard trailers is approximately 50 cents per 1,000 boxes greater when a 4-man crew is used than when a 3-man crew is employed. Most of this increase is the result of increased labor costs.

Table 7.--Labor required for a 4-man crew to unload 1,000 unpacked boxes of apples from an orchard trailer and move into storage by clamp-type 2-wheel hand trucks 1/

Operation	Workers	Productive labor	Fatigue allowance	Wait time	Total labor
	Number	Man-hours	Man-hours	Man-hours	Man-hours
Set up and clean up	4	0.10	0.0	0.10	0.20
Build 6-high stacks of boxes from 3-high stacks on orchard trailer	1	.97	.19	.0	1.16
Pick up 6-high stacks with a 2-wheel hand truck	3	.39	.04	.51	.94
Transport 6-high stacks 100 feet with a 2-wheel hand truck	3	1.82	.18	2/ .14	2.14
Release 6-high stacks with a 2-wheel hand truck	3	.35	.04	.0	.39
Total man-hours	-	3.63	.45	.75	4.83
Elapsed time--hours					3/ 1.21

1/ Labor requirements do not include high-piling boxes above 6-high stacks in storage rooms.
2/ Waiting time caused by crew interference.
3/ A trailer load of 144 boxes can be unloaded in 10-½ minutes.

Table 8.--Comparative labor and equipment costs for unloading 1,000 unpacked boxes of apples from orchard trailers and moving into storage by use of clamp-type 2-wheel hand trucks when using crews of specified sizes 1/

Method	Elapsed time	Labor and equipment required: Equipment time	Labor and equipment required: Wait time	Labor and equipment required: Total labor	Labor and equipment costs: Equipment	Labor and equipment costs: Labor 2/	Total cost: Current wages	Total cost: Assumed wages
	Hours	Machine-hours	Man-hours	Man-hours	Dollars	Dollars	Dollars	Dollars
3-man crew (2 hand truckers--1 worker builds 6-high stacks)	1.46	2.92	0.30	4.38	0.07	5.04	5.11	6.20
4-man crew (3 hand truckers--1 worker builds 6-high stacks)	1.21	3.63	.75	4.83	.09	5.55	5.64	6.85

1/ Costs do not include high-piling boxes above 6-high stacks in storage rooms. Except for building 6-high stacks from 3-high stacks on trailer bed, all boxes are handled in unit loads consisting of 6 boxes.
2/ Computed from "current" wage rates.

Clamp-Type 2-Wheel Hand Trucks and Belt Conveyors

A larger volume of apples is received in Washington State plants by use of belt conveyors and 2-wheel hand trucks than by any other types of equipment. The belt conveyor equalizes transportation distances and is used extensively in multistoried buildings for moving fruit between floors. After boxes of fruit are placed on the belt, they can be transported various distances without adding to the labor required for handling the fruit. Figure 21 shows a belt conveyor plant in which the fruit is received through a portal into the storage room.

Figure 21.--Road truck waiting to be unloaded at a plant that uses belt conveyors and hand trucks for receiving apples. Note conveyor head in wall back of motortruck.

At storage houses using belt conveyors in combination with clamp-type 2-wheel hand trucks, field boxes of apples are transferred one box at a time from the road truck to a belt conveyor that moves the boxes into a cold storage room. As the working surface moves toward the front of the motortruck, sections of gravity roller-type or wheel-type conveyors are joined to the belt conveyor to eliminate the need for carrying each box to the belt (fig. 22). Inside the storage room, one or two workers, the number depending upon the speed of the belt and other factors, remove the boxes from the conveyor and build 6-high stacks (fig. 23). Other workers using clamp-type 2-wheel hand trucks pick up the stacks and transport them to the stacking point or final storage position (fig. 16).

Belt conveyors always are constructed to fit a particular job or layout. In plants where belt conveyors are used for moving boxes of fruit from one floor to another the framework is constructed so that the belt will move at an incline of not more than 35 percent. Obviously, this type of construction requires considerable space. Most installations are constructed so that the belts are reversible, the same belt being used to move fruit into or out of storage.

Figure 22.--A view of the motortruck end of a receiving operation using belt conveyors in combination with clamp-type 2-wheel hand trucks.

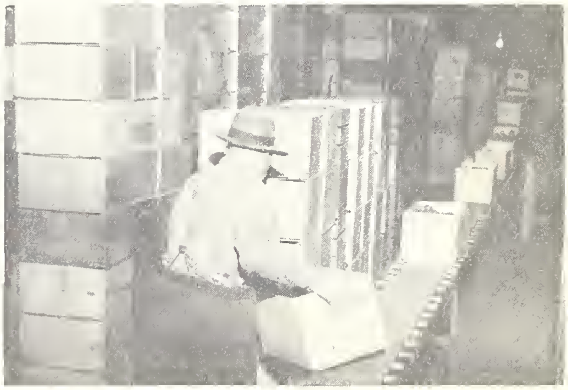

Figure 23.--Worker inside the storage room removing field boxes of fruit from the belt conveyor and placing them in 6-high stacks.

Belt conveyors usually operate at speeds of from 65 to 95 feet per minute. For most operations a speed of from 75 to 85 feet per minute is most desirable. The rate of operation of the belt conveyor tends to set the pace for other operations in the receiving cycle. However, there is a tendency to space boxes about the same distance apart on a conveyor regardless of its speed. At the faster speeds off-loading boxes from the conveyor is difficult. They are likely to move beyond the worker's reach before he is in a position to remove them.

When boxes of fruit are unloaded over the tailgate of the road truck, sections of gravity-type roller conveyors frequently are used to bridge the distance from the work face to the belt conveyor head. Two different lengths of extensions are used while unloading, to minimize the distance the workers must move the fruit. First a short roller conveyor section is used, then a longer section, and finally the short is added to the longer section. The roller conveyor sections are slightly elevated at the rear or truck end to help convey the boxes to the powered belt conveyor.

In some plants fruit occasionally is unloaded from the side of the road truck or trailer (fig. 24). The road truck and orchard trailer are not of sufficient width to necessitate the use of a roller conveyor. When unloading from the side of a truck or trailer the driver of the

Figure 24.--Unloading boxes to a belt conveyor from the side of a road truck.

truck or tractor pulls the vehicle forward after the first half of the boxes have been unloaded, so that the second half of the load can be removed without walking to place it on the roller conveyor. Trailers are more frequently unloaded from the side than are road trucks.

In most plants the unloading operation takes place over a receiving platform. However, some of the belt conveyor plants have portals cut into the side of the storage rooms for use in receiving fruit, rather than platforms. These portals are approximately two feet square, just sufficient for a belt or extension conveyor to carry a box through. Unloading at receiving portals usually is from the side of the truck.

While unloading, either one or two workers are stationed on the road truck or trailer to lift and place boxes of fruit on the conveyor (fig. 4). Inside the plant, one or two, or occasionally three, workers remove the fruit from the belt conveyor by grasping the boxes on the belt, swinging them to the side, and building 6-high stacks (fig. 25). Because the work of placing boxes on a conveyor in unloading and the work of off-loading the conveyor is nearly equal (under normal conditions), the same number of workers used to place boxes on a belt is employed for removing them. However, during peak receiving periods some plants use an additional worker for off-loading the conveyor because of the steady work involved and the pace that must be maintained. Part of the unloading usually is done by the driver of the road truck or trailer.

Figure 25.--Two workers building a double row of stacks with boxes from a belt conveyor.

In some plants where space for removing fruit from the belt and building stacks of boxes beside the belt conveyor is limited, stacks are built in double rows alongside the belt. However, in most cases only a single row is built. Hand truck operators remove these stacks as the unloading proceeds and transport them to the storage point where they are positioned and released as a unit. If there are not enough hand truckers, or if the distance from the belt conveyor to the storage point is fairly long in relation to the size of the hand-trucking crew, a double row of stacks alongside the belt is more likely to be used. The double row of stacks serves as a temporary storage supply for the hand truckers and may prevent delays while the next road truck or trailer is pulling into place for unloading.

Occasionally workers are unable to off-load fruit from the belt conveyor as rapidly as boxes are placed on the opposite end because of delay in hand-trucking operations, the use of a faster-than-normal belt speed, or the dropping of a box of fruit. The use of a section of gravity roller conveyor connecting with the belt conveyor near the off-loading position avoids these problems. By use of this arrangement, if a worker is unable to remove a box from the belt, it bypasses him and "accumulates" on the section of the roller conveyor.

Receiving fruit by use of 2-wheel hand trucks and belt conveyors requires close coordination or synchronization of three, and, in some cases, four different crews. These crews consist of the workers placing fruit on the belt, those removing fruit from the belt, the hand truckers, and, in some instances, the high pilers. Under some circumstances, one of these crews may be operating to capacity when the other crews are not. Unavoidable delays occur which add to the amount of time required to handle the boxes. Some plants avoid the necessity for balancing the work of receiving crews by moving fruit to be high-piled into a temporary storage bank. Later when the unloading of the road truck has been completed, a special crew high-piles boxes above the original 6-high stack.

Analyses of methods for receiving by use of belt conveyors and hand trucks are based on a standard transportation distance of 100 feet. This distance is made up of 50 feet of conveyor sections and 50 feet of transportation by hand trucks after the fruit is removed from the belt. Belt conveyors are assumed to move at 80 feet per minute. For the purposes of the analyses, no consideration has been given to the movement of fruit from one floor to another, because the labor and time required would be the same for the distance shown. (The summary of receiving to storage will present a comparison of receiving in single- and multi-floored plants.)

Unloading Boxes of Apples from Road Trucks and Moving to Storage

The principal variation in the use of belt conveyors and 2-wheel hand trucks for receiving unpacked boxes of apples is in the crew size. Four different crew sizes are used.

3-man crew.--When a 3-man crew is used, one worker on the road truck places boxes on the belt conveyor, one worker removes fruit from the conveyor inside the storage room, and the third worker hand trucks 6-high stacks, usually over about a 50-foot distance, from the conveyor belt to the storage point.

The workers placing fruit on and taking fruit off the belt wait 0.89 man-hours per 1,000 boxes received for the hand trucker to perform his duties. The 1.21 man-hours of nonproductive labor per 1,000 boxes involved in this method (table 9) accounts for 21 percent of the total labor required to receive 1,000 boxes.

In terms of total labor requirements, 30 percent is used for hand trucking and 61 percent is almost equally divided between placing fruit on the belt and removing it from the belt. As shown in table 9, a 3-man crew can unload 1,000 boxes in an elapsed time of 1.94 hours, or 34 minutes for a 288-box truckload. At this rate 13 or 14 road trucks can be unloaded at one receiving station per day.

Table 9.--Labor required for a 3-man crew to unload and move 1,000 unpacked boxes of apples into storage from a road truck by use of belt conveyors and clamp-type 2-wheel hand trucks 1/

Operation	Workers	Productive labor	Fatigue allowance	Wait time	Total labor
	Number	Man-hours	Man-hours	Man-hours	Man-hours
Set up and clean up	3	0.16	0.0	0.32	0.48
Place boxes on belt conveyor (conveyor moves boxes 50 feet)	1	1.09	.22	.47	1.78
Transfer boxes from belt conveyor to 6-high stacks	1	1.13	.23	.42	1.78
Pick up 6-high stacks by use of clamp-type 2-wheel hand trucks	1	.29	.03	.0	.32
Transport 6-high stacks 50 feet by use of 2-wheel hand trucks	1	.97	.10	.0	1.07
Release 6-high stacks from 2-wheel hand trucks	1	.35	.04	.0	.39
Total man-hours	-	3.99	.62	1.21	5.82
Elapsed time--hours					1.94

1/ Labor requirements shown do not include piling boxes above 6-high stacks. This size crew can receive 13 road truck loads of 288 boxes each per 8-hour day.

4-man crew.--Another method of unloading and moving fruit to storage with belt conveyors and hand trucks involves the use of a 4-man crew. One worker on the road truck places fruit on the belt conveyor, one worker inside the storage room removes boxes from the belt, and two workers hand truck 6-high stacks of boxes to the storage point.

Approximately the same amount of labor is required to receive 1,000 boxes of fruit with a 4-man crew as are required with the 3-man crew (table 10). However, the elapsed time is reduced to 1.52 hours per 1,000 boxes, or 26 minutes per highway truckload.

The use of a 4-man crew results in 1.47 hours wait time per 1,000 boxes. Most of this waiting occurs in the hand-trucking operation either during pickup or transport of boxes. Because the method is not properly balanced for a 50-foot transportation distance, hand truckers must wait for the stacks to be built from the belt conveyor. For greater distances the wait time of the hand truckers would be decreased.

Table 10.--Labor required for a 4-man crew to unload and move 1,000 unpacked boxes of apples into storage from a road truck by use of belt conveyors and clamp-type 2-wheel hand trucks 1/

Operation	Workers	Productive labor	Fatigue allowance	Wait time	Total labor
	Number	Man-hours	Man-hours	Man-hours	Man-hours
Set up and clean up	4	0.16	0.0	0.48	0.64
Place boxes on belt conveyor (conveyor moves boxes 50 feet)	1	1.09	.22	.05	1.36
Transfer boxes from belt conveyor to 6-high stacks	1	1.13	.23	.0	1.36
Pick up 6-high stacks by use of clamp-type 2-wheel hand trucks	2	.29	.03	.86	1.18
Transport 6-high stacks 50 feet by use of 2-wheel hand trucks	2	.97	.10	2/ .08	1.15
Release 6-high stacks from 2-wheel hand trucks	2	.35	.04	.0	.39
Total man-hours	-	3.99	.62	1.47	6.08
Elapsed time--hours					1.52

1/ Labor requirements shown do not include piling boxes above 6-high stacks. This size crew can receive 17 road truckloads of 288 boxes each per 8-hour day.
2/ Waiting caused by crew interference.

6-man crew.--When an effort is being made to receive fruit more rapidly than is possible with a 4-man crew, some plants use a 6-man crew. Two workers on the road truck place fruit on the belt conveyor, two workers inside the storage room remove boxes from the belt and build 6-high stacks, and two workers transport the stacks on hand trucks to storage.

As shown in table 11, the total labor required for a 6-man crew to receive 1,000 boxes of fruit is 6.06 man-hours, but the elapsed time by this method is 1.01 hours, or 18 minutes for a road truckload of 288 boxes.

At the standard transportation distance of 50 feet, 17 percent of the total labor is lost by waiting, which is rather equally divided between time lost by the men putting fruit on the belt and taking it off, because two hand truckers cannot transport stacks as rapidly as they can be built by two workers. Approximately 33 percent of the wait time is lost because four of the crew members are idle during setup.

For a transportation distance of less than 50 feet, the labor of the entire 6-man crew would be more productively utilized; for a transportation distance of 100 feet, it would be more efficient to add a third hand trucker.

Table 11.--Labor required for a 6-man crew to unload and move 1,000 unpacked boxes of apples into storage from a road truck by use of belt conveyors and clamp-type 2-wheel hand trucks 1/

Operation	Workers	Productive labor	Fatigue allowance	Wait time	Total labor
	Number	Man-hours	Man-hours	Man-hours	Man-hours
Set up and clean up	2/ 6	0.16	0.0	0.32	0.48
Place boxes on belt conveyor (conveyor moves boxes 50 feet)	2	1.28	.25	.33	1.86
Transfer boxes from belt conveyor to 6-high stacks	2	1.31	.26	.29	1.86
Pick up 6-high stacks by use of clamp-type 2-wheel hand trucks	2	.29	.03	.0	.32
Transport 6-high stacks 50 feet by use of 2-wheel hand trucks	2	.97	.10	3/ .08	1.15
Release 6-high stacks from 2-wheel hand trucks	2	.35	.04	.0	.39
Total man-hours	-	4.36	.68	1.02	6.06
Elapsed time--hours					1.01

1/ Labor requirements shown do not include piling boxes above 6-high stacks. This size crew can receive 25 road truckloads of 288 boxes each per 8-hour day.
2/ Two of these workers do the setup work at the road truck while 4 workers spend most of their time waiting.
3/ Waiting caused by crew interference.

5-man crew.--Some plants occasionally use a 5-man crew for receiving fruit with belt conveyors and hand trucks. When this size crew is used, one worker is assigned to place boxes of fruit on the belt conveyor, two workers to remove the fruit, and two workers to hand truck it to storage position. One reason for using this method is that the road truck driver is used to place fruit on the belt and it is assumed that he can maintain a faster pace than regular plant workers. The storage plant provides the four workers inside the plant. The total labor required to receive 1,000 boxes is 7.35 man-hours (table 12). Roughly 37 percent of the labor is lost in wait time. Most of the wait time is accounted for by the fact that the two workers who remove fruit from the belt are not supplied boxes at a rate that will keep them busy. They lose more time than is spent working. The two hand truckers also have considerable wait time. This method would be more efficient if either an additional man were added to help place fruit on the belt or two men were dropped, one from taking fruit off the belt and one from hand trucking.

Table 12.--Labor required for a 5-man crew to unload and move 1,000 unpacked boxes of apples into storage from a road truck by use of belt conveyors and clamp-type 2-wheel hand trucks 1/

Operation	Workers	Productive labor	Fatigue allowance	Wait time	Total labor
	Number	Man-hours	Man-hours	Man-hours	Man-hours
Set up and clean up	5	0.16	0.0	0.64	0.80
Place boxes on belt conveyor (conveyor moves boxes 50 feet)	1	1.09	.22	.0	1.31
Transfer boxes from belt conveyor to 6-high stacks	2	1.13	.23	1.26	2.62
Pick up 6-high stacks by use of clamp-type 2-wheel hand truck	2	.29	.03	.76	1.08
Transport 6-high stacks 50 feet with 2-wheel hand truck	2	.97	.10	2/ .08	1.15
Release 6-high stacks from 2-wheel hand truck	2	.35	.04	.0	.39
Total man-hours	-	3.99	.62	2.74	7.35
Elapsed time--hours					1.47

1/ Labor requirements shown do not include piling boxes above 6-high stacks. This size crew can receive 17 road truckloads of 288 boxes each per 8-hour day.
2/ Waiting caused by crew interference.

Comparison of four crew sizes.--As shown in table 13, total labor and equipment costs for receiving 1,000 unpacked boxes of fruit range from approximately \$7.89 with a 6-man crew to \$9.80 when a 5-man crew is

Table 13.--Comparative labor and equipment costs for unloading from road trucks and moving into storage 1,000 unpacked boxes of apples by use of belt conveyors and clamp-type 2-wheel hand trucks when crews of specified sizes are employed 1/

Method	Elapsed time	Labor and equipment required: Equipment time	Wait time	Total labor	Labor and equipment costs: Equipment	Labor 2/	Total cost: Current wages	Total cost: Assumed wages
	Hours	Machine-hours	Man-hours	Man-hours	Dollars	Dollars	Dollars	Dollars
One man places boxes on, 1 man stacks boxes off conveyor, and 1 man hand trucks	1.94	3/ 5.82	1.21	5.82	1.74	6.69	8.43	9.89
One man places boxes on, 1 man stacks boxes off conveyor, and 2 men hand truck	1.52	4/ 6.08	1.47	6.08	1.39	6.99	8.38	9.90
Two men place boxes on, 2 men stack boxes off conveyor, and 2 men hand truck	1.01	5/ 4.04	1.02	6.06	.92	6.97	7.89	9.41
One man places boxes on, 2 men stack boxes off conveyor, and 2 men hand truck	1.47	6/ 5.88	2.74	7.35	1.35	8.45	9.80	11.64

1/ In all hand-trucking operations, boxes of fruit are handled in unit loads consisting of 6-high stacks. Costs shown do not include piling boxes above 6-high stacks. Transportation distance standardized at 100 feet, 50 feet by use of belt conveyor and 50 feet by use of hand trucks.
2/ Computed from "current" wage rates.
3/ Clamp-type 2-wheel hand truck 1.94 machine-hours, 100-foot belt conveyor 1.94 machine-hours, 15-foot gravity roller conveyor 1.94 machine-hours, total 5.82 machine-hours.
4/ Clamp-type 2-wheel hand truck 3.04 machine-hours, 100-foot belt conveyor 1.52 machine-hours, 15-foot gravity roller conveyor 1.52 machine-hours, total 6.08 machine-hours.
5/ Clamp-type 2-wheel hand truck 2.02 machine-hours, 100-foot belt conveyor 1.01 machine-hours, 15-foot gravity roller conveyor 1.01 machine-hours, total 4.04 machine-hours.
6/ Clamp-type 2-wheel hand truck 2.94 machine-hours, 100-foot belt conveyor 1.47 machine-hours, 15-foot belt conveyor 1.47 machine-hours, total 5.88 machine-hours.

employed. The most costly method has an unbalanced arrangement of workers with only one worker placing fruit on the belt and two workers removing it. The least costly method uses the largest crew--six workers. This method has another advantage which may be more important than its cost; that is, its reduced elapsed time to unload. The elapsed time is 1.01 hours per 1,000 boxes, 69 percent of the next-best method. One reason a lower cost is obtained by use of the larger crew is that the method reduces machine time; to unload a truck the belt conveyor is employed for a shorter time. If a plant is equipped to receive on the basis of some other crew arrangement, this saving in capital cost could not be realized in actuality. A possible disadvantage of the 6-man crew is that during periods of critical labor supply there may be difficulty in obtaining the number of workers needed. Moreover, during slack work periods and between the arrival of truckloads, the plant operator either must find work for the crews or permit them to remain idle. When smaller crews are employed, fewer man-hours of labor are lost because of idle time between jobs.

Unloading Boxes of Apples from Orchard Trailers and Moving to Storage

The methods of receiving fruit from orchard trailers at the belt-conveyor and hand-truck plant are not greatly different from the methods of unloading from road trucks. The amount of setup and cleanup time is smaller when unloading from orchard trailers but the total amount of time in either case is not very great. Trailers usually are pulled up alongside the receiving portal or belt extension and are unloaded from the side (fig. 26). Thus, no labor is used in arranging extension conveyors.

Figure 26.--Unloading boxes of apples from an orchard trailer to a belt conveyor.

Another difference in receiving from road trucks and from trailers is that boxes on the trailers are stacked only two or three boxes high, which results in more lifting as the worker places the boxes on the belt. On road trucks when boxes are stacked 6-high, the upper boxes are lifted and swung down to the belt. Consequently, 29 percent of the productive labor required for unloading a trailer is used in placing fruit on the belt as compared with 27 percent when unloading boxes from 6-high stacks on road trucks.

3-man crew.--The labor requirements per 1,000 unpacked boxes of apples for unloading from an orchard trailer and moving into storage by use of a 3-man crew are shown in table 14.

Table 14.--Labor required for a 3-man crew to unload and move 1,000 unpacked boxes of apples into storage from an orchard trailer by use of belt conveyors and clamp-type 2-wheel hand trucks 1/

Operation	Workers	Productive labor	Fatigue allowance	Wait time	Total labor
	Number	Man-hours	Man-hours	Man-hours	Man-hours
Set up and clean up	3	0.10	0.0	0.32	0.42
Placing boxes on a belt conveyor (conveyor moves boxes 50 feet)	1	1.18	.24	.36	1.78
Transfer boxes from belt conveyor to 6-high stacks	1	1.13	.23	.42	1.78
Pick up 6-high stacks by use of 2-wheel hand truck	1	.29	.03	.0	.32
Transport 6-high stacks 50 feet by use of 2-wheel hand truck	1	.97	.10	.0	1.07
Release 6-high stacks from 2-wheel hand truck	1	.35	.04	.0	.39
Total man-hours	-	4.02	.64	1.10	5.76
Elapsed time--hours					1.92

1/ Labor requirements shown do not include piling boxes above 6-high stacks. This size crew can receive 27 orchard trailer loads of 144 boxes each per 8-hour day.

Comparative Labor Requirements for Unloading from Road Trucks and Orchard Trailers

Crew sizes and arrangements for unloading at the belt conveyor plant usually are the same when unloading from trailers as when unloading from road trucks. Labor requirements per 1,000 boxes to transfer the fruit from the belt to stacks and to wheel it to storage position are identical. The principal differences in labor requirements for other parts of the operation are shown in table 15. When unloading from road trucks, 0.09 of a man-hour less labor is required to place boxes on the belts. However, the setup and cleanup labor is reduced 0.06 man-hours, which makes a very small net difference of 0.03 man-hours per 1,000 boxes.

Table 15.—Comparative labor requirements for specified operations performed in unloading 1,000 unpacked boxes of apples from road trucks and orchard trailers by use of belt conveyors and a 3-man crew 1/

Transportation equipment	Operation: Placing boxes on belt conveyor	Operation: Stacking boxes off belt conveyor	Operation: Set up	Operation: Clean up	Total labor
	Man-hours	Man-hours	Man-hours	Man-hours	Man-hours
Unloading a road truck at the warehouse	1.09	1.13	0.09	0.07	2.38
Unloading an orchard trailer at the warehouse	1.18	1.13	.05	.05	2.41
Increased labor for unloading from orchard trailer	.09	.0	- .04	- .02	.03

1/ Although only 1 worker of 3-man crew unloads truck or trailer, all 3 help in set up and clean up.

Comparative Costs of Receiving from Road Trucks and Orchard Trailers

Table 16 shows the estimated labor and equipment costs of receiving from orchard trailers as slightly less than the costs of receiving from highway trucks. Differences in labor required are accounted for in the operations involved in placing fruit on the belt, and in setup and cleanup. With a 3-man crew, the cost per 1,000 boxes when unloading from trailers is $8.34, which roughly is 1 percent less than when unloading from road trucks. The principal consideration in the use of road trucks or trailers should be the possible economy in the hauling to the warehouse.

Table 16.—Comparative labor and equipment costs of unloading and moving 1,000 unpacked boxes of apples into storage by use of clamp-type 2-wheel hand trucks and belt conveyors with a 3-man crew receiving from orchard trailers and from road trucks 1/

Transportation equipment and method	Elapsed time	Labor and equipment required: Equipment time	Labor and equipment required: Wait time	Labor and equipment required: Total labor	Labor and equipment costs: Equipment	Labor and equipment costs: Labor 2/	Total cost: Current wages	Total cost: Assumed wages
	Hours	Machine-hours	Man-hours	Man-hours	Dollars	Dollars	Dollars	Dollars
Road truck One man places boxes on, 1 man stacks boxes off conveyor, 1 man hand trucks	1.94	3/ 5.82	1.21	5.82	1.74	6.69	8.43	9.89
Orchard trailer One man places boxes on, 1 man stacks boxes off conveyor, 1 man hand trucks	1.92	4/ 5.76	1.10	5.76	1.72	6.62	8.34	9.78

1/ In all hand-trucking operations boxes of fruit are handled in unit loads consisting of 6-high stacks. Costs shown do not include piling boxes above 6-high stacks. Transportation distance standardized at 100 feet, 50 feet by use of belt conveyors, and 50 feet by use of hand trucks.

2/ Computed from "current" wage rates.

3/ Clamp-type 2-wheel hand truck, 100-foot belt conveyor, and 15-foot gravity roller conveyor 1.94 machine-hours each, total 5.82 machine-hours.

4/ Clamp-type 2-wheel hand truck, 100-foot belt conveyor, and 15-foot gravity roller conveyor 1.92 machine-hours each, total 5.76 machine-hours.

Clamp-Type 2-Wheel Hand Trucks and Floor Chain Conveyors

The floor chain conveyor is a relatively new type of equipment in Washington State apple houses. Only four plants in the State were using this equipment during the 1950-51 season. Floor chain conveyors are used for receiving fruit at the warehouse; moving fruit from the cold storage rooms to the washing and packing line; and feeding boxes into stack-breakers, stackmakers, or mechanical dumpers.

As shown in figure 27, the floor chain conveyor consists of two separate endless chains resting in channel irons imbedded in the floor. The conveyor is powered by an electric drive unit also installed in the floor, which is operated by an automatic cut-off switch. Six-high stacks of boxes are released and picked up from the chain with clamp-type 2-wheel hand trucks. Chain speeds vary from 10 to 30 feet per minute.

Figure 27.--A floor chain conveyor in a storage room.

For receiving boxes of unpacked fruit at the storage plant, the floor chain conveyor frequently is used to accumulate a supply of stacks which it moves into a stackdumper.14/ Placing stacks on a floor chain tends to even out the work load in supplying the dumper and avoids the extra handling of boxes that occurs when the boxes are fed to the dumper one at a time.

For use in receiving, floor chain conveyors usually range from 50 to 125 feet in length. These conveyors operate in only one direction, and chains for receiving cannot be used for other operations.

When floor chain conveyors are used for receiving fruit, 6-high stacks of boxes are hand trucked off the road truck or trailer a distance ranging from 20 to 35 feet from the road truck to floor chains which extend from the receiving platform to some point inside the cold storage

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14/ See footnote 3, page 10.

room and are released on the conveyor (fig. 28). The stacks, resting on the conveyor, are moved through swinging doors into the cold storage room (fig. 29). Adjacent to the point where the fruit is to be stored,

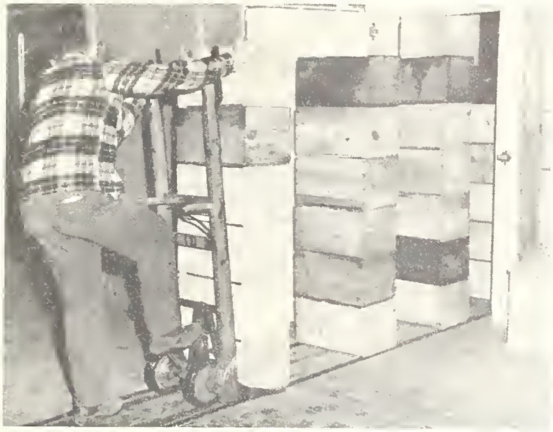

Figure 28.--Hand truck being used to deposit a stack on a floor chain conveyor.

Figure 29.--Stacks being conveyed into cold storage.

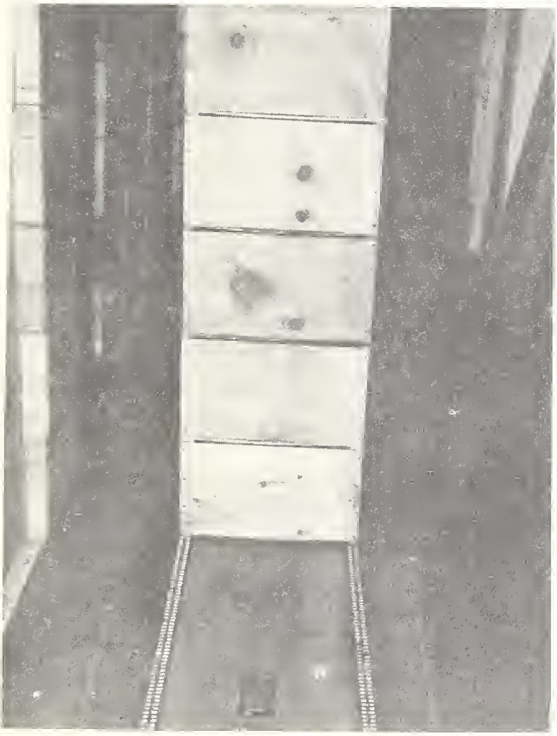

Figure 30.--A stack approaching the unloading end of a chain conveyor. When the stack reaches the switch the conveyor stops.

hand truckers pick up the slowly moving stacks from the chain and wheel them to the storage point where they are positioned and released. The automatic cut-off switch near the end of the chain is provided in the event workers inside the plant are unable to keep abreast of the moving stacks and the stacks bypass them. The switch, shown between the chains in figure 30, is activated by a stack of boxes passing over it, thereby stopping the conveyor. When the stack resting on the switch is removed, the conveyor starts again. When the floor chain is temporarily stopped because of an oversupply of stacks available to the inside crew, several feet of floor chain on the receiving platform usually are unoccupied and this space serves as accumulation space which avoids the necessity for stopping the crew. This makes possible a flexible system of continuous work.

The layouts of plants using floor chain conveyors for receiving are rather varied. However, the cold storage rooms served by these conveyors usually are similar. Usually the areas served by floor chain conveyors are relatively long and narrow. The width of the cold storage room usually determines the number of conveyors installed since it is desirable to keep to a minimum the distance fruit is hand trucked from the side or the end of the chain to the storage point.

To obtain maximum utilization of floor chain conveyors for receiving fruit, most plants that do not have installations in all their cold storage rooms attempt to move unpacked fruit out of the rooms having conveyor installations as promptly as possible. This fruit is moved to the packing line during the receiving season. Because of this practice, floor chain conveyors may handle more fruit during a season than the capacity of the cold rooms they serve.

When unloading a road truck or trailer to floor chain conveyors, workers first place bridgeplates from the receiving platform to the bed of the vehicle and begin unloading 6-high stacks with hand trucks. The method used is identical to that of unloading fruit in a clamp-type hand-truck plant. However, stacks are not hand trucked to storage position but are moved to and released on the floor chain conveyor. Since these conveyors can accommodate the equivalent of two or more truckloads in 6-high stacks, there seldom are stacks of boxes or other factors that interfere with this release. It is necessary for the workers to release the stack of boxes so that the outer edges or cleats on the box ride on the chains. This factor requires no extra time in making the release.

The floor chain conveyor breaks the sequence of operations of the crew unloading fruit from the vehicle and the workers inside the plant. The men unloading the highway truck use hand trucks to move stacks a distance of 10 to 30 feet, which permits rapid unloading of the truck. As pointed out, the chains usually are of sufficient length to hold one or two truckloads of boxes. Thus, the workers outside the plant can begin work on a second load before the inside crew has completely removed the first load of boxes from the floor chain to a final storage position.

The part of the crew inside the plant consists of hand truckers who move fruit from the conveyor to storage position. The hand-trucking operation in the storage room is the same as in the belt conveyor plant except that when unit loads are picked up from the floor chain conveyor, the pickup occurs under relatively "free" conditions, permitting a slight reduction in labor as compared to that required for belt-conveyor hand trucking.

Unloading Boxes of Apples from Road Trucks and Moving to Storage

When unpacked boxes of apples are received from highway trucks, at a floor chain conveyor plant, three different methods, based on differences in crew sizes, are used. The efficiency of a large crew depends in part on the distance fruit is moved from the floor chain conveyor to its storage point. At the standardized transportation distance of 100 feet used for comparative analysis, it is assumed that hand trucking fruit from the road truck to the floor chain conveyor accounts for 20 feet, the floor chain conveyor 50 feet, and hand trucking from the conveyor to the storage point 30 feet.

One worker.--In a floor chain conveyor plant, fruit can be unloaded and moved into storage by one worker. This worker trucks fruit to the floor chain conveyor until the road truck is unloaded. The truckload accumulates on the chains (fig. 31). After the truck leaves, the same worker hand trucks the fruit to storage.

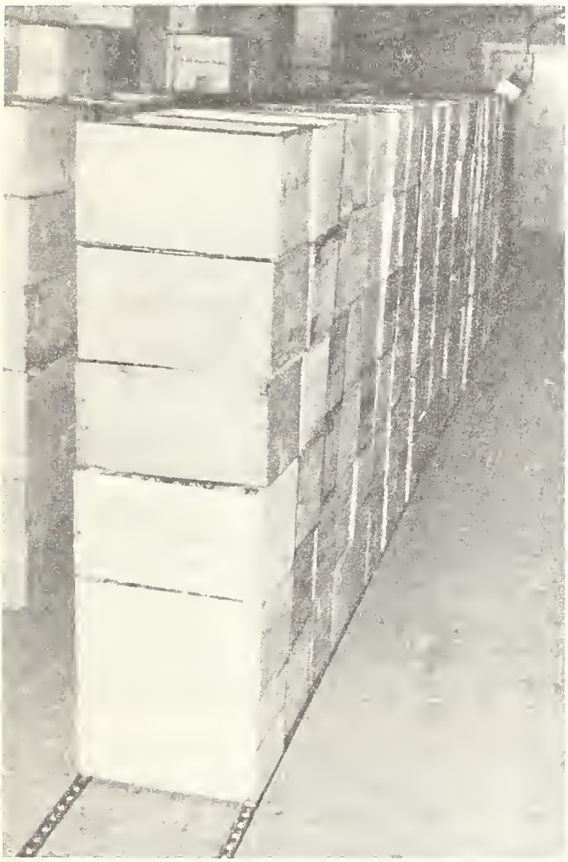

Figure 31.--A truckload of boxes accumulated on a floor chain conveyor.

About 5 percent of the productive labor of one worker is spent in setup and cleanup. No time is lost in delays or waiting. More productive labor is required to transport the fruit away from the floor chain conveyor where the transportation distance is greater than for moving the fruit onto the conveyor. As shown in table 17, the elapsed time required for one worker to handle 1,000 boxes is 2.63 hours. However, the road truck is not tied up for this length of time. It is held only for the unloading time. The actual elapsed time for unloading a truck is approximately 1.31 hours per 1,000 boxes or 23 minutes for a 288-box truckload. Plants do not use one worker alone during the peak receiving season for unloading since a road truck would be delayed while the worker emptied the floor chain conveyor.

2-man crew.--A 2-man receiving crew is used more frequently at a floor chain conveyor plant. One worker unloads the truck and releases the fruit to the conveyor,

Table 17.--Labor required for 1 worker to unload and move 1,000 unpacked boxes of apples into storage from a road truck by use of clamp-type 2-wheel hand trucks and floor chain conveyors 1/

Operation	Workers	Productive labor	Fatigue allowance	Wait time	Total labor
	Number	Man-hours	Man-hours	Man-hours	Man-hours
Set up and clean up	1	0.12	0.0	0.0	0.12
Pick up 6-high stacks on road truck bed by use of 2-wheel hand truck	1	.39	.04	.0	.43
Transport 6-high stacks 20 feet by use of 2-wheel hand truck	1	.45	.05	.0	.50
Release 6-high stacks on floor chain conveyor by use of 2-wheel hand truck (conveyor moves stack 50 feet)	1	.24	.02	.0	.26
Pick up 6-high stacks off floor chain conveyor by use of 2-wheel hand truck	1	.23	.02	.0	.25
Transport 6-high stacks 30 feet by use of 2-wheel hand truck	1	.62	.06	.0	.68
Release 6-high stacks in storage by use of 2-wheel hand truck	1	.35	.04	.0	.39
Total man-hours	-	2.40	.23	.0	2.63
Elapsed time--hours					2.63

1/ Labor requirements shown do not include piling boxes above 6-high stacks. One worker can receive 10 road truckloads of 288 boxes each per 8-hour day.

and another inside the plant removes stacks from the conveyor and hand trucks them to storage position or to a high-piling crew.

The distribution of the work done by a 2-man crew is almost identical with that of one worker, except that a small amount of wait time develops. The wait time in hand trucking is a result of the greater hand-truck distance inside the storage room, and the labor required to unload the truck is increased. The wait time in the setup operation is the time required for the first stack to reach the inside worker after unloading starts.

As shown in table 18, 1,000 unpacked boxes can be unloaded and moved to storage with 3.04 man-hours of labor. The elapsed time required is roughly 1.52 hours per 1,000 boxes or 26 minutes per truckload.

4-man crew.--When a 4-man crew is used, two workers place fruit on the floor chain conveyor from the road truck and two workers hand truck stacks from the conveyor to the storage point inside the storage room.

Table 19 shows that 0.87 man-hour of labor per 1,000 boxes was lost in wait time, or slightly less than 25 percent of the total labor required. The majority of this wait time is in the setup and cleanup operations. The total labor to receive 1,000 boxes was 3.50 man-hours. The elapsed time to unload a highway truck is 16 minutes per highway truckload of 288 boxes or 0.88 man-hour per 1,000 boxes.

Table 18.--Labor required for a 2-man crew to unload and move 1,000 unpacked boxes of apples into storage from a road truck by use of clamp-type 2-wheel hand trucks and floor chain conveyors 1/

Operation	Workers	Productive labor	Fatigue allowance	Wait time	Total labor
	Number	Man-hours	Man-hours	Man-hours	Man-hours
Set up and clean up	2	0.12	0.0	0.28	0.40
Pick up 6-high stacks on road truck bed by use of 2-wheel hand truck	1	.39	.04	.0	.43
Transport 6-high stacks 20 feet by use of 2-wheel hand truck	1	.45	.05	.0	.50
Release 6-high stacks on floor chain conveyor by use of 2-wheel hand truck (conveyor moves stacks 50 feet)	1	.24	.02	.13	.39
Pick up 6-high stacks off floor chain conveyor by use of 2-wheel hand truck	1	.23	.02	.0	.25
Transport 6-high stacks 30 feet by use of 2-wheel hand truck	1	.62	.06	.0	.68
Release 6-high stacks in storage by use of 2-wheel hand truck	1	.35	.04	.0	.39
Total man-hours	-	2.40	.23	.41	3.04
Elapsed time--hours					1.52

1/ Labor requirements shown do not include piling boxes above 6-high stacks. This size crew can receive 17 road truckloads of 288 boxes each per 8-hour day.

Table 19.--Labor required for a 4-man crew to unload and move 1,000 unpacked boxes of apples into storage from a road truck by use of clamp-type 2-wheel hand trucks and floor chain conveyors 1/

Operation	Workers	Productive labor	Fatigue allowance	Wait time	Total labor
	Number	Man-hours	Man-hours	Man-hours	Man-hours
Set up and clean up	4	0.12	0.0	0.52	0.64
Pick up 6-high stacks off the road truck bed by use of 2-wheel hand truck	2	.39	.04	.0	.43
Transport 6-high stacks 20 feet by use of 2-wheel hand truck	2	.45	.05	2/ .12	.62
Release stacks on floor chain conveyor by use of 2-wheel hand truck (conveyor moves stacks 50 feet)	2	.24	.02	.12	.38
Pick up 6-high stacks off floor chain conveyor by use of 2-wheel hand truck	2	.23	.02	.0	.25
Transport stacks 30 feet by use of 2-wheel hand truck	2	.62	.06	2/ .11	.79
Release stacks in storage by use of 2-wheel hand truck	2	.35	.04	.0	.39
Total man-hours	-	2.40	.23	.87	3.50
Elapsed time--hours					.88

1/ Labor requirements shown do not include piling boxes above 6-high stacks. This size crew can receive 29 road truckloads of 288 boxes each per 8-hour day.
2/ Waiting caused by crew interference.

Comparison of different size crews.--Equipment costs incurred in receiving fruit by use of floor chain conveyors are relatively high. When only one worker is employed for receiving, equipment costs are almost as great as labor costs. When labor costs are computed on the basis of "current" wage rates, the total cost for receiving 1,000 boxes of apples is lowest for a 4-man crew. During slack receiving periods, the use of only one worker for receiving probably would be most efficient. However, there is always the possibility of three or four trucks arriving about the same time and use of only one worker would mean considerable wait for the trucks. Therefore, considering all factors involved, most plants probably will find that a 2-man crew is most desirable because of the elapsed time factor.

During the peak of the receiving season when the reduction of elapsed time for unloading road trucks is important, the 4-man crew probably would be most desirable. It is possible that when high-piling operations are performed, coordination of receiving and high-piling operations might alter other considerations involved in these crew sizes. Table 20 presents a comparison of labor and equipment costs for three sizes of crews.

Table 20.--Comparative labor and equipment costs for unloading from road trucks and moving into storage 1,000 unpacked boxes of apples by use of clamp-type 2-wheel hand trucks and floor chain conveyors when crews of specified sizes are employed 1/

Crew size and method	Elapsed time	Labor and equipment required: Equipment time	Labor and equipment required: Wait time	Labor and equipment required: Total labor	Labor and equipment costs: Equipment	Labor and equipment costs: Labor 2/	Total cost: Current wages	Total cost: Assumed wages
	Hours	Machine-hours	Man-hours	Man-hours	Dollars	Dollars	Dollars	Dollars
1 worker								
1 worker transports 20 feet to chain and 30 feet from chain to storage	2.63	3/ 5.26	0.0	2.63	3.11	3.02	6.13	6.79
2-man crew								
1 worker transports 20 feet to chain, 1 worker transports 30 feet from chain to storage	1.52	4/ 4.56	.41	3.04	1.84	3.50	5.34	6.10
4-man crew								
2 workers transport 20 feet to chain, 2 workers transport 30 feet from chain to storage	.88	5/ 4.40	.87	3.50	1.10	4.02	5.12	6.00

1/ In all hand-trucking operations, boxes of fruit are handled in unit loads consisting of 6-high stacks. Costs shown do not include piling boxes above 6-high stacks. Transportation distance standardized at 100 feet, 50 feet by use of hand trucks and 50 feet by use of floor chain conveyor.

2/ Computed from "current" wage rates.

3/ Clamp-type 2-wheel hand truck 2.63 machine-hours, 100-foot floor chain conveyor 2.63 machine-hours, total 5.26 machine-hours.

4/ Clamp-type 2-wheel hand truck 3.04 machine-hours, 100-foot floor chain conveyor 1.52 machine-hours, total 4.56 machine-hours.

5/ Clamp-type 2-wheel hand truck 3.52 machine-hours, 100-foot floor chain conveyor 0.88 machine-hours, total 4.40 machine-hours.

Unloading Boxes of Apples from Orchard Trailers and Moving to Storage

When apples are received from orchard trailers at floor chain conveyor plants an additional operation is involved, since boxes of apples on the trailer are in stacks two or three boxes high. (This analysis is based on 3-high stacks.) These stacks must be built to 6-high stacks before they are hand trucked to the floor chain. The cost of this additional operation must be added to the costs of the road truck unloading operation. Delay time also is greater than in road truck unloading, because of extra work involved in unloading trailers.

2-man crew.--When a 2-man receiving crew is used to unload trailers at a floor chain conveyor plant, one worker (usually the tractor driver) on the trailer stacks the boxes 6 high. The other worker hand trucks stacks from the trailer onto the floor chain conveyor at the trailer end and hand trucks them off in the storage room. This size crew for unloading trailers is equivalent to one worker for unloading road trucks.

As shown in table 21, the total labor required for the two-man crew is approximately the same as the labor required for one worker to unload road trucks, but the elapsed time is slightly less. The time the trailer is tied up at the plant for unloading is 11 minutes per 144 boxes. It should be pointed out that with a 1-man crew, if several trailers arrive at the warehouse simultaneously there will be considerable waiting to unload while the stacks of boxes are being removed from the floor chain conveyor.

Table 21.--Labor required for a 2-man crew to unload and move 1,000 unpacked boxes of apples into storage from an orchard trailer by use of clamp-type 2-wheel hand trucks and floor chain conveyors 1/

Operation	Workers	Productive labor	Fatigue allowance	Wait time	Total labor
	Number	Man-hours	Man-hours	Man-hours	Man-hours
Set up and clean up	2	0.10	0.0	0.10	0.20
Build 3-high stacks of boxes into 6-high stacks	1	.97	.19	.03	1.19
Pick up 6-high stacks off orchard trailer by use of 2-wheel hand truck	1	.39	.04	.0	.43
Transport 6-high stacks 20 feet by use of 2-wheel hand truck	1	.45	.05	.0	.50
Release 6-high stacks on floor chain conveyor by use of 2-wheel hand truck (conveyor moves stacks 50 feet)	1	.24	.02	.0	.26
Pick up 6-high stacks off floor chain conveyor by use of 2-wheel hand truck	1	.23	.02	.0	.25
Transport 6-high stacks 30 feet by use of 2-wheel hand truck	1	.62	.06	.0	.68
Release 6-high stacks in storage by use of 2-wheel hand truck	1	.35	.04	.0	.39
Total man-hours	-	3.35	.42	.13	3.90
Elapsed time--hours					2.61

1/ Labor requirements shown do not include piling boxes above 6-high stacks.

3-man crew.--When the 3-man crew is used to receive apples from orchard trailers at a floor chain conveyor plant, one worker, usually the tractor driver, builds 6-high stacks of boxes from 3-high stacks. One worker hand trucks stacks of boxes from the trailer bed and releases them on the floor chain conveyor. The third worker, inside, removes stacks from the floor chain conveyor and transports them to cold storage position.

This crew size and arrangement provides a fairly well balanced operation. However, there are delays, the majority of which occur in setup and cleanup. The amount of wait is large on a 1,000-box basis because the average trailer hauls about 144 boxes. There also is some delay on the part of the worker hand trucking from trailer to conveyor, because one worker inside the storage room cannot remove stacks from the conveyor as rapidly as they arrive, since he transports 30 feet compared with 20 feet for the worker loading onto the conveyor. Of the total labor 24 percent is unproductive because of delays. The elapsed time to unload a trailer with this size crew is 1.66 hours per 1,000 boxes or approximately 14 minutes per 144-box trailer load (table 22).

Table 22.--Labor required for a 3-man crew to unload and move 1,000 unpacked boxes of apples into storage from an orchard trailer by use of clamp-type 2-wheel hand trucks and floor chain conveyors 1/

Operation	Workers	Productive labor	Fatigue allowance	Wait time	Total labor
	Number	Man-hours	Man-hours	Man-hours	Man-hours
Set up and clean up	3	0.10	0.0	0.92	1.02
Build 3-high stacks of boxes into 6-high stacks	1	.97	.19	.16	1.32
Pick up 6-high stacks off orchard trailer by use of 2-wheel hand truck	1	.39	.04	.0	.43
Transport 6-high stacks 20 feet by use of 2-wheel hand truck	1	.45	.05	.0	.50
Release 6-high stacks on floor chain conveyor by use of 2-wheel hand truck (conveyor moves stacks 50 feet)	1	.24	.02	.13	.39
Pick up 6-high stacks off floor chain conveyor by use of 2-wheel hand truck	1	.23	.02	.0	.25
Transport 6-high stacks 30 feet by use of 2-wheel hand truck	1	.62	.06	.0	.68
Release 6-high stacks 30 feet by use of 2-wheel hand truck	1	.35	.04	.0	.39
Total man-hours	-	3.35	.42	1.21	4.98
Elapsed time--hours					1.66

1/ Labor requirements shown do not include piling boxes above 6-high stacks.

Comparison of 2-man crew and 3-man crew.--As shown in table 23, labor and equipment costs of receiving from orchard trailers are lower with a 3-man crew than a 2-man crew. During the peak receiving period when the rate of unloading is important, a 3-man crew would be the best arrangement. During the slack receiving period the smaller crew would be more efficient.

Comparative Labor Requirements for Unloading and Moving Boxes of Apples into Storage from Road Trucks and Orchard Trailers

The crew sizes and their arrangement employed for unloading orchard trailers conform closely to those employed for unloading highway trucks

Table 23.--Comparative labor and equipment costs for unloading from orchard trailers and moving into storage 1,000 unpacked boxes of apples by use of clamp-type 2-wheel hand trucks and floor chain conveyors when crews of specified sizes are employed 1/

Crew size and method	Elapsed time	Labor and equipment required: Equipment time	Labor and equipment required: Wait time	Labor and equipment required: Total labor	Labor and equipment costs: Equipment	Labor and equipment costs: Labor 2/	Total cost: Current wages	Total cost: Assumed wages
	Hours	Machine-hours	Man-hours	Man-hours	Dollars	Dollars	Dollars	Dollars
2-man crew								
1 worker hand stacks boxes from 3 to 6 high on the trailer bed. Another worker hand trucks stacks onto the floor chain and later the same worker trucks the stacks from the chain to storage position	2.61	3/ 5.22	0.13	3.90	3.09	4.49	7.58	8.55
3-man crew								
1 worker hand stacks boxes from 3 to 6 high on the trailer bed. Another worker hand trucks stacks to the floor chain conveyor. At the same time, the third worker trucks the stacks from the chain to storage position	1.66	4/ 4.98	1.21	4.98	2.01	5.73	7.74	8.98

1/ In all hand-truck operations, boxes of fruit are handled in unit loads consisting of 6-high stacks. Costs shown do not include piling boxes above 6-high stacks. Transportation distance standardized at 100 feet, 50 feet by use of hand trucks and 50 feet by use of floor chain conveyor.

2/ Computed from "current" wage rates.

3/ Clamp-type 2-wheel hand truck 2.61 machine-hours, 100-foot floor chain conveyor 2.61 machine-hours, total 5.22 machine-hours.

4/ Clamp-type 2-wheel hand truck 3.32 machine-hours, 100-foot floor chain conveyor 1.66 machine-hours, total 4.98 machine-hours.

Table 24.--Comparative labor requirements under specified conditions for unloading 1,000 boxes of apples from road trucks and from orchard trailers by use of clamp-type 2-wheel hand trucks and floor chain conveyors 1/

Method and equipment	Workers	Productive time	Fatigue allowance	Wait time	Total labor
	Number	Man-hours	Man-hours	Man-hours	Man-hours
Total labor required to unload 1,000 boxes from orchard trailers and move to storage--2-man crew	2	3.35	0.42	0.13	3.90
Total labor required for building 3-high stacks to 6-high stacks on the trailer bed--including the allowance and wait time for this operation (1,000 boxes)	1	.97	.19	.03	1.19
Total labor required to unload 1,000 boxes from orchard trailers and move to storage by use of 2-man crew minus labor required for building 3-high stacks to 6-high	1	2.38	.23	.10	2.71
Total labor required to unload 1,000 boxes from road trucks and move into storage-- 1 worker	1	2.40	.23	.0	2.63

1/ In all hand-trucking operations, boxes of fruit are handled in unit loads consisting of 6-high stacks. Labor requirements shown do not include piling boxes above 6-high stacks. Transportation distance standardized at 100 feet, 50 feet by use of hand trucks and 50 feet by use of floor chain conveyor.

except for the additional worker required on trailers for stacking boxes 6 high. Thus, a 2-man crew unloading boxes from trailers requires about the same man-hours of labor as one worker unloading for road trucks, after the labor of the stackmaker is subtracted (table 24). The difference in productive labor required for unloading the two types of vehicles, after this adjustment is made, is only 0.02 man-hour per 1,000 boxes. When wait time is included, the difference in total labor amounts to 0.08 man-hour per 1,000 boxes.

Belt Conveyor, Stackmaker, Floor Chain Conveyor and Clamp-Type 2-Wheel Hand Truck

In seeking to reduce labor requirements during harvest, the manager of one belt-conveyor and hand-truck plant has installed a stackmaker and floor chain conveyor. This equipment was used experimentally during 1950-51 and 1951-52 seasons. This stackmaker operates on the third floor of the plant. Single boxes of apples are moved from the receiving platform to this floor on a belt conveyor by the method described for this type of equipment. As the boxes reach the third floor they are fed by the belt conveyor into the stackmaker, which builds them into stacks 6 boxes high (fig. 32).

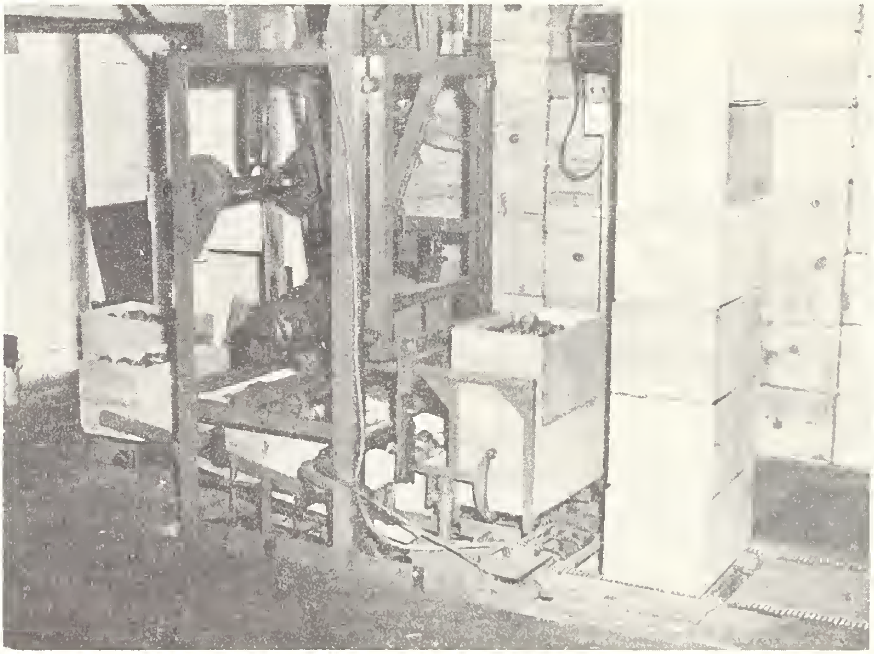

Figure 32.--Boxes from a belt conveyor going into stackmaker. Stacks automatically move out onto the floor chain conveyor after they are built 6 boxes high.

When a stack contains six boxes, the stack automatically moves to a floor chain conveyor. The conveyor moves the stack toward the storage position (fig. 33), where it is picked up by clamp-type 2-wheel hand trucks and trucked to storage position or the high-piling crew. The stackmaker eliminates the workers who ordinarily would be used to off-load the belt conveyor and manually build the boxes into 6-high stacks. The floor chain conveyor transports the stacks toward the desired storage point, thereby reducing the distance the clamp-type hand truck operators move the fruit to storage.

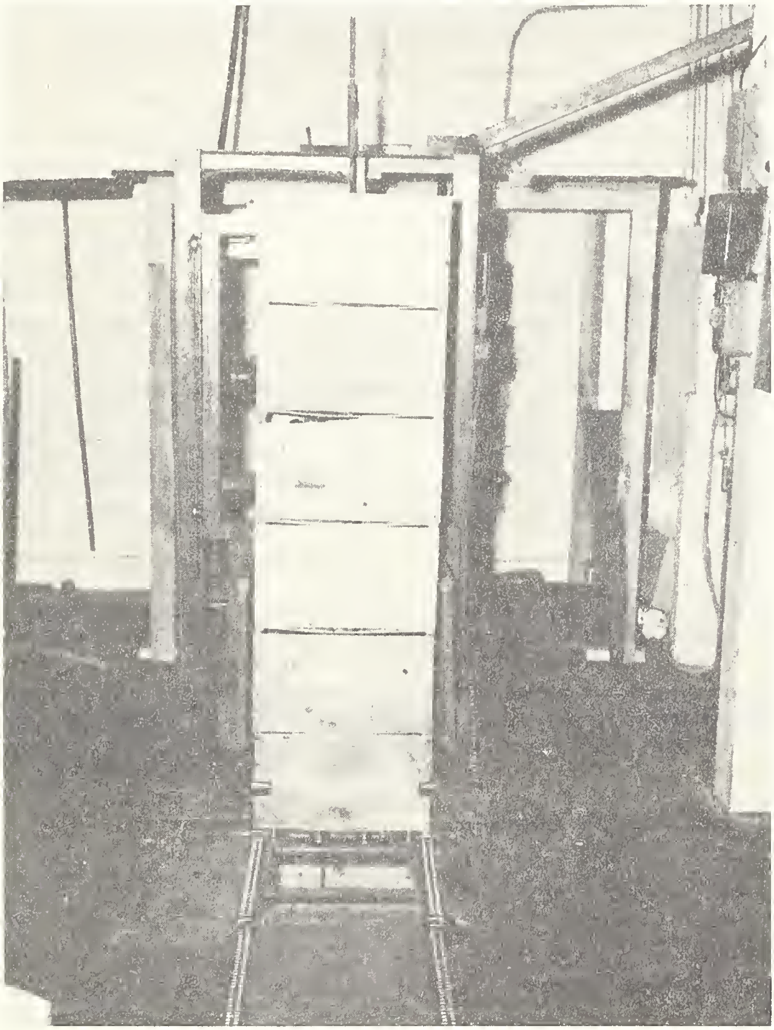

Figure 33.--A stack moves on the floor chain conveyor where it will be picked up by a hand truck and moved to storage position.

Unloading Boxes of Apples from Road Trucks and Moving to Storage

2-man crew.--Two different crew sizes and arrangements have been tried with this combination of types of equipment--belt conveyor, stackmaker, floor chain conveyor, and clamp-type 2-wheel hand truck. When a 2-man crew is used, one worker places boxes on the belt conveyor at the receiving platform and one worker picks up stacks from the floor chain conveyor and transports them to storage position. Nineteen percent of the total labor is lost by delays (table 25). Most of this delay occurs when the worker placing fruit on the belt cannot proceed because the belt is shut down by the worker picking up stacks from the floor chain conveyor. This temporary work stoppage is necessary because stacks of boxes move onto the floor chain conveyor too fast for one worker to remove them and are transported beyond his pickup station. That is, if the worker hand trucking stacks away from the floor chain conveyor does not remove a stack of boxes at the proper time, the stack rolls to the end of the floor chain conveyor where it touches the limit switch stopping the conveyor. Rather than permit the boxes to roll past, the hand truck operator removing fruit from the conveyor intermittently stops the chain, which automatically stops the belt conveyor. One of the ways of reducing this delay would be the use of a portable limit switch so constructed that the hand truck operator could place it at various points along the floor chain conveyor. When such a switch is used, the stacks of boxes will not proceed beyond his pickup point. However, with such an arrangement there is a possibility that a hand truck operator would tend to reduce his rate of trucking. Labor requirements for a 2-man crew are shown in table 25.

Table 25.--Labor required for a 2-man crew to unload and move 1,000 unpacked boxes of apples into storage from a road truck by use of belt conveyor, stackmaker, floor chain conveyor, and clamp-type two-wheel hand truck 1/

Operations	Workers	Productive labor	Fatigue allowance	Wait time	Total labor
	Number	Man-hours	Man-hours	Man-hours	Man-hours
Set up and clean up	2	0.16	0.0	0.34	0.50
Place single boxes on belt conveyor (conveyor moves boxes 25 feet)	1	1.09	.22	.40	1.71
Machine stackmaker builds stacks 6 high and feeds onto floor chain conveyor (conveyor moves stacks 25 feet) 2/	0	.0	-	-	-
Pick up 6-high stacks by use of 2-wheel hand truck	1	.23	.02	.0	.25
Transport 6-high stacks 50 feet by use of 2-wheel hand truck	1	.97	.10	.0	1.07
Release 6-high stacks by use of 2-wheel hand truck	1	.35	.04	.0	.39
Total man-hours	-	2.80	.38	.74	3.92
Elapsed time--hours					1.96

1/ Labor requirements shown do not include piling boxes above 6-high stacks. This size crew can receive 13 road truckloads of 288 boxes each per 8-hour day.

2/ The stackmaker is an automatic machine that requires 0.92 of a machine-hour to build 1,000 boxes of apples into 6-high stacks.

4-man crew.--Two workers on the road truck place fruit on the belt and two workers hand truck the stacks from the floor chain conveyor to storage. As shown by comparing tables 25 and 26 the total man-hours of labor were increased approximately one-half of a man-hour per 1,000 boxes by use of a 4-man crew. Part of this increase was delay or wait time which occurred because the additional crew members stood by during setup and cleanup and while the first boxes were traveling on the belt and being built into stacks.

Use of a 4-man crew, when compared with a 2-man crew, reduces the elapsed time required to unload 1,000 boxes of apples from 1.96 to 1.12 hours. The larger crew unloaded and moved a road truckload of 288 boxes into storage in a little over 19 minutes.

Table 26.--Labor required for a 4-man crew to unload and move 1,000 unpacked boxes of apples into storage from a road truck by use of belt conveyor, stackmaker, floor chain conveyor, and clamp-type 2-wheel hand trucks 1/

Operation	Workers	Productive labor	Fatigue allowance	Wait time	Total labor
	Number	Man-hours	Man-hours	Man-hours	Man-hours
Set up and clean up	4	0.16	0.0	0.64	0.80
Place single boxes on belt conveyor (conveyor moves boxes 25 feet)	2	1.28	.26	.30	1.84
Machine stackmaker builds stacks 6 high and feeds onto floor chain conveyor (conveyor moves stacks 25 feet)	0	.0	-	-	-
Pick up 6-high stacks by use of 2-wheel hand truck	2	.23	.02	.05	.30
Transport 6-high stacks 50 feet by use of 2-wheel hand truck	2	.97	.10	2/ .08	1.15
Release 6-high stacks by use of 2-wheel hand truck	2	.35	.04	.0	.39
Total man-hours	-	2.99	.42	1.07	4.48
Elapsed time--hours					1.12

1/ Labor requirements shown do not include piling boxes above 6-high stacks. This size crew can receive 24 road truckloads of 288 boxes each per 8-hour day.
2/ Wait time caused by crew interference.

Comparison of 2-man crew and 4-man crew.--On the basis of labor and equipment costs a 4-man crew can receive 1,000 boxes of apples at $1.92 less than a 2-man crew (table 27). The savings are a result of decreased equipment costs. The larger crew receives more boxes in a given length of time than the smaller crew and equipment costs are distributed over a larger number of boxes. However, if a plant has a certain number of boxes to receive by use of this equipment 15/, fixed costs (which account for the majority of the total costs) will remain the same. In other

15/ The boxes being stored in one cold storage room or on one floor level.

words, the hourly cost rate used is based on a certain number of hours of annual use. Therefore, the savings attributed to the larger crew are based on the assumption the equipment would be used to receive a greater total number of boxes than the smaller crew.

Table 27.--Comparative labor and equipment costs for unloading from road trucks and moving into storage 1,000 unpacked boxes of apples by use of belt conveyor, stackmaker, floor chain conveyor, and clamp-type 2-wheel hand trucks when crews of specified sizes are employed 1/

Crew size and method	Elapsed time	Labor and equipment required			Labor and equipment costs			
		Equipment time	Wait time	Total labor	Equipment	Labor 2/	Total cost	
							Current wages	Assumed wages
	Hours	Machine-hours	Man-hours	Man-hours	Dollars	Dollars	Dollars	Dollars
Two-man crew								
One worker places boxes on the belt conveyor leading into the stackmaker. After stacks are made, they are wheeled to storage from the floor chain conveyor by 1 hand trucker	1.96	3/ 9.80	0.74	3.92	6.02	4.51	10.53	11.51
Four-man crew								
Two workers place boxes on the belt conveyor leading into the stackmaker. After stacks are made, they are wheeled to storage from the floor chain conveyor by 2 hand trucks	1.12	4/ 6.72	1.07	4.48	3.46	5.15	8.61	9.73

1/ In all hand-truck operations boxes of fruit are handled in unit loads consisting of 6-high stacks. Costs shown do not include piling boxes above 6-high stacks. Transportation distance standardized at 100 feet, 25 feet by use of belt conveyor, 25 feet by use of floor chain conveyor, and 50 feet by use of clamp-type 2-wheel hand trucks.

2/ Computed from "current" wage rates.

3/ Clamp-type 2-wheel hand trucks, 50-foot belt conveyor, 50-foot floor chain conveyor, stackmaker, and 15-foot gravity roller conveyor 1.96 machine-hours each, total 9.80 machine-hours.

4/ Clamp-type 2-wheel hand trucks 2.24 machine-hours, and 50-foot belt conveyor, 50-foot floor chain conveyor, stackmaker, and 15-foot gravity roller conveyor 1.12 machine-hours each, total 6.72 machine-hours.

Unloading Boxes of Apples from Orchard Trailers and Moving to Storage

Although apples could be received from orchard trailers by use of stackmakers in combination with belt conveyor, floor chain conveyor, and clamp-type 2-wheel hand trucks, the one plant using the stackmaker did not receive fruit on trailers. The required labor could easily be ascertained by combining data on the use of the stackmaker when unloading road trucks, previously discussed, with data on unloading orchard trailers at a belt conveyor plant. The labor required to receive apples with a stackmaker in combination with other equipment may be calculated in a similar way when the fruit is unloaded from road trucks.

Clamp-Type 2-Wheel Hand Trucks and Elevators

None of the four Washington State apple packing and storage plants that use elevators for moving fruit between floors depend entirely on this type of equipment for interfloor transporation. That is, elevators are installed to serve only parts of these plants. None of the elevators in use are of the automatic type. Therefore, an operator is required to ride with the load. The speed of the elevators ranges from 27 to 59 feet per minute. The number of boxes carried by elevators, in the plants studied, ranges from 72 to 162 boxes. Other Washington State plants have elevators that carry loads of from 12 to 180 boxes.

In elevator plants, fruit is unloaded by use of clamp-type 2-wheel hand trucks either from orchard trailers or from road trucks. Therefore, the method of unloading is the same as that previously described for clamp-type 2-wheel hand truck operations either alone or in combination with floor chain conveyors.

When only one elevator is available, fruit may be handled on the elevator by either of two methods. By the first method, the fruit is (1) hand trucked to a temporary bank or block on the first floor near the elevator shaft, (2) then moved onto the elevator in stacks of boxes, (3) lifted to the floor on which they are to be stored, (4) trucked again to a temporary bank on the storage floor, and (5) hand trucked in stacks to "permanent" storage. The work of the crews in moving the fruit to and from the elevator is coordinated with the cycles of the elevator. By the other method, fruit is unloaded directly onto the elevator, lifted to the storage floor, and moved from the elevator directly to storage. Either of these methods, with modifications, is applicable in a plant using two elevators.

Unloading and Moving Boxes of Apples into Storage from a Road Truck by Use of a Single Elevator

Freight elevator installations are relatively expensive. Their costs vary greatly but the assumed cost of a single elevator installation for the purpose of this analysis is $13,375. Because of the investment, only one Washington State plant has more than one elevator. The use of a single elevator is more difficult to coordinate than the use of two elevators.

Fruit moved directly to elevator to storage.--The simplest method of using a single elevator in combination with hand trucks is to move 6-high stacks of boxes directly from the road truck and release the stacks onto the elevator. For purposes of analysis this distance is assumed to be 30 feet. When the elevator is loaded, the three hand truckers, with their equipment, ride the elevator to the upper floor where they hand truck the fruit 70 feet to storage (the distance remaining from the 100 feet assumed as standard for the purpose of the analysis). 16/ After the elevator has been unloaded and the fruit moved to storage position, the three workers ride down to pick up the next load and repeat the cycle.

By use of this method, a 3-man crew works 4.70 man-hours to receive 1,000 boxes (table 28). Most of this labor was spent in productive effort. Wait time and fatigue accounted for 24 percent of the total labor. Of the productive labor required to do the work, 36 percent was used to move the fruit to the elevator from the road truck and 55 percent to move it from the elevator to storage.

Table 28.--Labor required for a 3-man crew to unload and move 1,000 unpacked boxes of apples into storage from a road truck by use of a single elevator and clamp-type 2-wheel hand trucks when fruit is moved directly to elevator to storage 1/

Operation	Workers	Productive labor	Fatigue allowance	Wait time	Total labor
	Number	Man-hours	Man-hours	Man-hours	Man-hours
Set up and clean up	3	0.12	0.0	0.06	0.18
Pick up 6-high stacks off the road truck bed by use of a 2-wheel hand truck	3	.39	.04	.0	.43
Transport 6-high stacks 30 feet to elevator by use of a 2-wheel hand truck	3	.62	.06	2/ .27	.95
Release 6-high stacks on elevator by use of a 2-wheel hand truck	3	.29	.03	.0	.32
Elevator cycle 3/	3	.20	.0	.40	.60
Pick up 6-high stacks off the elevator by use of a 2-wheel hand truck	3	.29	.03	.0	.32
Transport 6-high stacks 70 feet from elevator to storage point by use of 2-wheel hand trucks	3	1.31	.13	2/ .07	1.51
Release 6-high stacks at storage point by use of a 2-wheel hand truck	3	.35	.04	.0	.39
Total man-hours	-	3.57	.33	.80	4.70
Elapsed time--hours					4/ 1.57

1/ Elevator load is 168 boxes. Labor requirements shown do not include piling boxes above 6-high stacks.
2/ Wait time caused by crew interference.
3/ Vertical transportation distance is not included in 100-foot standardized distance.
4/ This size crew can receive 16 road truckloads of 288 boxes each per 8-hour day if arrivals are closely coordinated.

The elapsed time required to unload 1,000 boxes is 1.57 hours or 27 minutes per 288-box truckload. Thus, only about 16 road trucks can

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16/ Vertical distance, or distance traveled by elevator, is not included. This distance might be included and the total horizontal distance adjusted accordingly to retain the standardized transportation distance of 100 feet.

be unloaded per day provided there is close coordination of the arrivals at the warehouse.

Fruit moved to temporary bank, to elevator, to a temporary bank, and to storage.--To minimize the delays inherent in single elevator operations, some plants use temporary banks of supply near the elevator to break the sequence of operations and the interdependence of various operations in the cycle. The first of these temporary banks or blocks is set up near the elevator shaft on the main floor. Stacks of boxes 6 high are first moved from the road truck and placed in this bank. These stacks later are moved a short distance onto the elevator. When the elevator is unloaded the stacks are again placed in a temporary bank as near the elevator head as possible. While the elevator is returning for another load, hand truckers move the stacks from the second temporary bank to storage. While the elevator is being unloaded, hand truckers continue to move stacks from the road truck to the temporary bank on the main floor.

Because of the two temporary banks 50 feet additional transportation distance is required to move the stacks 100 feet horizontally from the road truck to the storage point, or a total of 150 feet. Of the 150 feet, 30 feet is for moving stacks out of the first temporary bank onto the elevator and 30 feet is for moving stacks off the elevator to the second temporary bank. This method involves the use of a 7-man crew. Two workers move fruit from the road truck to the first temporary bank and three men move it onto the elevator. The three workers who move the boxes onto the elevator ride the elevator to the storage floor. At this point they move the fruit 30 feet to a temporary bank and return on the elevator to repeat the cycle. Two workers stationed on the storage floor move the fruit the remaining 60 feet to storage.

A total of 8.68 man-hours is required to receive 1,000 boxes using the banks of supply, 3.98 man-hours more than by the "direct" method (table 29). There are two added pickups and releases in moving the fruit to and from the temporary banks of supply, plus the additional transportation distance.

The elapsed time required to unload and store the fruit amounts to 22 minutes per truckload of 288 boxes compared with 27 minutes for the method previously described. The reduction in total elapsed time has been accomplished by a larger crew, seven men in place of three. The most important advantage, however, is the reduced time that the truck must remain at the plant.

Table 29.--Labor required for a 7-man crew to unload and move 1,000 unpacked boxes of apples into storage from a road truck by use of a single elevator and clamp-type 2-wheel hand trucks when fruit is moved into and out of 2 temporary banks 1/

Operation	Workers	Productive labor	Fatigue allowance	Wait time	Total labor
	Number	Man-hours	Man-hours	Man-hours	Man-hours
Set up and clean up	2	0.12	0.0	0.0	0.12
Pick up 6-high stacks off the road truck bed by use of 2-wheel hand trucks	2	.39	.04	.0	.43
Transport 6-high stacks 30 feet to a temporary bank near the elevator by use of 2-wheel hand trucks	2	.62	.06	2/ .11	.79
Release 6-high stacks in bank by use of 2-wheel hand trucks	2	.24	.02	.88	1.14
Pick up 6-high stacks in bank by use of 2-wheel hand trucks	3	.29	.03	.0	.32
Transport 6-high stacks 30 feet to elevator by use of 2-wheel hand trucks	3	.62	.06	2/ .27	.95
Release 6-high stacks in elevator by use of 2-wheel hand trucks	3	.29	.03	.0	.32
Elevator cycle 3/	3	.20	.0	.40	.60
Pick up 6-high stacks off elevator by use of 2-wheel hand trucks	3	.29	.03	.0	.32
Transport 6-high stacks 30 feet to a temporary bank by use of 2-wheel hand trucks	3	.62	.06	2/ .27	.95
Release 6-high stacks in bank by use of 2-wheel hand trucks	3	.24	.02	.0	.26
Pick up 6-high stacks in bank by use of 2-wheel hand trucks	2	.29	.03	.44	.76
Transport 6-high stacks 60 feet to the storage point by use of 2-wheel hand trucks	2	1.14	.11	2/ .08	1.33
Release 6-high stacks at the storage point by use of 2-wheel hand trucks	2	.35	.04	.0	1.39
Total man-hours	-	5.70	.53	2.45	8.68
Elapsed time--hours					4/ 1.24

1/ Elevator load is 168 boxes. Labor requirements shown do not include piling boxes above 6-high stacks. Because of handling in and out of 2 temporary banks or blocks, the 100-foot standardized transportation distance from road truck to storage point is increased to 150 feet.
2/ Wait time caused by crew interference.
3/ Vertical transportation distance is not included in total in-plant transportation distance.
4/ This size crew can receive 20 road truckloads of 288 boxes each per 8-hour day.

Unloading and Moving Boxes of Apples to Storage from a Road Truck by Use of Two Elevators

Work flows smoother when two elevators are available. Two elevators permit on- and off-loading to be alternated so that one elevator is in loading or unloading position most of the time.

Fruit moved directly to elevators to storage.--One of the methods of receiving apples when two elevators are available is to unload stacks of boxes from the road truck and move them directly to the elevators. On the floor where they are to be stored, the stacks are moved from the elevators directly to storage. This method involves the use of a 5-man crew. Two workers transport the fruit 30 feet from the road truck and release it onto the elevator. When the elevator is loaded, a third worker takes the elevator to the off-loading floor. On this floor the elevator operator assists two workers stationed on the storage floor in unloading the elevator and moving the fruit the remaining 70 feet into storage. Thus, three workers hand truck fruit from the elevator. When the elevator has been unloaded the elevator operator takes it down and leaves it at the main floor. The elevator operator then takes the second elevator, which has been loaded while the first was being unloaded, to the storage floor to repeat the cycle.

Table 30 shows that a 5-man crew, using two elevators, works 5.25 man-hours to unload and move 1,000 boxes into storage. Of this time 25 percent is lost in wait time. A little more than one-third of the productive time is spent in loading the elevators. The elapsed time required to unload a road truckload of 288 boxes and move the fruit to storage is 18 minutes.

Table 30.--Labor required for a 5-man crew to unload and move 1,000 unpacked boxes of apples into storage from a road truck by use of 2 elevators and clamp-type 2-wheel hand trucks when fruit is moved directly to elevator to storage 1/

Operation	Workers	Productive labor	Fatigue allowance	Wait time	Total labor
	Number	Man-hours	Man-hours	Man-hours	Man-hours
Set up and clean up	5	0.12	0.0	0.18	0.30
Pick up 6-high stacks off the road truck bed by use of 2-wheel hand trucks	2	.39	.04	.0	.43
Transport 6-high stacks 30 feet to the elevator by use of 2-wheel hand trucks	2	.62	.06	2/ .11	.79
Release 6-high stacks in the elevator by use of 2-wheel hand trucks	2	.29	.03	.44	.76
Elevator cycle 3/	3	.25	.0	.50	.75
Pick up 6-high stacks off the elevator by use of 2-wheel hand trucks	3	.29	.03	.0	.32
Transport 6-high stacks 70 feet from the elevator to the storage point by use of 2-wheel hand trucks	3	1.31	.13	2/ .07	1.51
Release 6-high stacks at the storage point by use of 2-wheel hand trucks	3	.35	.04	.0	.39
Total man-hours	-	3.62	.33	1.30	5.25
Elapsed time--hours					4/ 1.05

1/ Elevator load is 168 boxes. Labor requirements shown do not include piling boxes above 6-high stacks.
2/ Wait time caused by crew interference.
3/ Vertical transportation distance is not included in 100-foot standardized distance.
4/ This size crew can receive 24 road truckloads of 288 boxes each per 8-hour day.

Fruit moved to temporary banks, to elevators, to temporary banks, and to storage.--Another method when two elevators are available involves the use of temporary banks of supply. A 9-man crew is employed. Two workers hand truck fruit off the road truck to a temporary bank of supply near the elevators. Two workers move the stacks from the temporary bank of supply onto the elevators. At the off-loading floor two workers hand truck the stacks to a temporary bank. After one elevator is unloaded one of these hand truckers takes the elevator to the on-loading floor and brings a loaded elevator to the off-loading floor. Three workers stationed on the storage floor transport the stacks of boxes 60 feet to permanent storage.

By use of this method 8.45 man-hours of labor are required to receive 1,000 boxes to storage, which is 3.20 man-hours greater than when the fruit was loaded directly to two elevators (table 31). The additional productive labor is required because of two extra pickups and releases, and transporting 50 feet added distance.

The elapsed time required to unload a truckload of 288 boxes was reduced to about 16 minutes, compared with 18 minutes when the two elevators were used without the temporary bank of supply.

Table 31.--Labor required for a 9-man crew to unload and move 1,000 unpacked boxes of apples into storage from a road truck by use of 2 elevators and clamp-type 2-wheel hand trucks when fruit is moved into and out of temporary banks 1/

Operation	Workers	Productive labor	Fatigue allowance	Wait time	Total labor
	Number	Man-hours	Man-hours	Man-hours	Man-hours
Set up and clean up	2	0.12	0.0	0.0	0.12
Pick up 6-high stacks off the road truck bed by use of 2-wheel hand trucks	2	.39	.04	.0	.43
Transport 6-high stacks 30 feet to a bank near the elevator by use of 2-wheel hand trucks	2	.62	.06	2/ .11	.79
Release 6-high stacks in bank by use of 2-wheel hand trucks	2	.24	.02	.28	.54
Pick up 6-high stacks in bank by use of 2-wheel hand trucks	2	.29	.03	.0	.32
Transport 6-high stacks 30 feet to the elevator by use of 2-wheel hand trucks	2	.62	.06	2/ .11	.79
Release 6-high stacks in the elevator by use of 2-wheel hand trucks	2	.29	.03	.44	.76
Elevator cycle 3/	2	.25	.0	.25	.50
Pick up 6-high stacks off the elevator by use of 2-wheel hand trucks	2	.29	.03	.0	.32
Transport 6-high stacks 30 feet to a bank by use of 2-wheel hand trucks	2	.62	.06	2/ .11	.79
Release 6-high stacks in the bank by use of 2-wheel hand trucks	2	.24	.02	.0	.26
Pick up 6-high stacks in the bank by use of 2-wheel hand trucks	3	.29	.03	.66	.98
Transport 6-high stacks 60 feet to the storage point by use of 2-wheel hand truck	3	1.14	.11	2/ .21	1.46
Release 6-high stacks at the storage point by use of 2-wheel hand trucks	3	.35	.04	.0	.39
Total man-hours	-	5.75	.53	2.17	8.45
Elapsed time--hours					.94

1/ Elevator load is 168 boxes. Labor requirements shown do not include piling boxes above 6-high stacks. Because of handling in and out of 2 temporary blocks or banks, the 100-foot standardized transportation distance from road truck to storage point is increased to 150 feet.
2/ Wait time caused by crew interference.
3/ Vertical transportation distance is not included in total in-plant transportation distance.

Comparison of Single-Elevator and Two-Elevator Methods

The costs of using elevators to receive fruit to storage are comparatively large, especially because of the high capital cost of the equipment. When a single elevator is used, the more economical method is to move the fruit directly to the elevator and off to storage. Table 32 shows that the cost per 1,000 boxes by use of the direct method is $10.56 compared with $14.18 when temporary banks of supply are used. Under some conditions the use of temporary banks of supply might prove superior. The temporary bank of supply method reduces the time of the road truck at the plant because of the relatively short distance from the receiving platform to the first temporary bank.

When two elevators are used, the most economical method of receiving also is to move the fruit directly to the elevators and from the elevators to storage. Receiving costs are increased $3.05 per 1,000 boxes

Table 32.--Comparative labor and equipment costs for unloading from road trucks and moving into storage 1,000 unpacked boxes of apples by use of specified numbers of elevators and clamp-type 2-wheel hand trucks into storage from road trucks when four specified methods are used 1/

Method	Crew size	Elapsed time	Labor and equipment required: Equipment time	Labor and equipment required: Wait time	Labor and equipment required: Total Labor	Labor and equipment costs: Equipment	Labor and equipment costs: Labor 2/	Total cost: Current wages	Total cost: Assumed wages
	No.	Hours	Machine-hrs.	Man-hrs.	Man-hrs.	Dollars	Dollars	Dollars	Dollars
One elevator									
Three men hand truck stacks from road truck onto elevator. Elevator taken to off-loading floor where the 3 men hand truck stacks to storage position. 3/	3	1.57	4/ 6.28	0.80	4.70	5.15	5.41	10.56	11.73
Two men unload road truck to temporary bank near storage. Three men hand truck stacks from bank to elevator and from elevator to bank on the off-loading floor, 2 men hand truck stacks from temporary bank to storage position. 5/	7	1.24	6/ 9.92	2.45	8.68	4.20	9.98	14.18	16.35
Two elevators									
Two men hand truck stacks from road truck onto elevators. Elevator moved to upper floor by 1 operator who then helps 2 other hand truckers in wheeling the stacks to storage. After unloading, the elevator is taken to the on-loading floor and loaded elevator is again moved to storage floor. 3/	5	1.05	7/ 7.35	1.30	5.25	6.87	6.04	12.91	14.22
Two hand truckers move stacks from road truck to temporary bank of supply where 2 other workers hand truck stacks onto elevator. At off-loading floor, 2 workers hand truck stacks to temporary bank. After elevator is unloaded, 1 of these workers takes empty elevator to on-loading floor and brings a loaded elevator to off-loading floor. Three men hand truck stacks from temporary bank to permanent storage. 5/	9	.94	8/ 10.34	2.17	8.45	6.24	9.72	15.96	18.07

1/ Boxes of fruit are handled in unit loads consisting of 6-high stacks. Costs shown do not include piling boxes above 6-high stacks.
2/ Computed from "current" wage rates.
3/ Horizontal transportation distance standardized at 100 feet. Vertical distance is not included.
4/ Clamp-type 2-wheel hand truck 4.71 machine-hours, 8,000 pound capacity elevator 1.57 machine-hours, total 6.28 machine-hours.
5/ A horizontal transportation distance of 150 feet is necessary to accomplish 100 feet of net distance because of additional hand trucking required by temporary banks. Vertical distance is not included.
6/ Clamp-type 2-wheel hand truck 8.68 machine-hours, 8,000 pound capacity elevator 1.24 machine-hours, total 9.92 machine-hours.
7/ Clamp-type 2-wheel hand truck 5.25 machine-hours, 8,000 pound capacity elevator 2.10 machine-hours, total 7.35 machine-hours.
8/ Clamp-type 2-wheel hand truck 8.46 machine-hours, 8,000 pound capacity elevator 1.88 machine-hours, total 10.34 machine-hours.

when the fruit is moved through temporary banks of supply. This cost, however, could be affected by shorter transportation distances to the temporary storage points. The use of temporary banks reduces elapsed time for receiving 0.11 hour per 1,000 boxes.

The decision to use one elevator or two would rest quite largely on the length of the receiving season and the total volume of fruit that would be handled by use of elevators. The cost data shown in table 32 are based on assumptions of 400 hours of annual use for the elevators. If these hours are not realized, the costs would be higher per box. Another cost item that should be taken into account when two elevators are used is the additional space required which otherwise would be used for cold storage.

High-Piling Unpacked Boxes of Apples

In plants that use the types and combinations of types of materials-handling equipment discussed in previous sections of this chapter for receiving apples, 6-high stacks of boxes are positioned and released, as unit loads, at the storage position. However, much of the fruit that goes into storage is stacked or high-piled on these original 6-high stacks. High-piling is therefore the piling or stacking of boxes on top of the 6-high stacks brought to storage position by hand truckers. High-piling is done by several different methods and under various conditions. In the conventional type, multistory plants, boxes usually are stacked 9, 10, or 12 high. A few plants have ceiling heights which either limit or permit stacks 8, 11, 13, and even as high as 15 boxes.

High-piling operations may be performed concurrently with or following the completion of the receiving cycle of operations. At what time the operation is performed depends on plant practices, available labor, harvest period, and other factors. Usually, high-piling is done during the unloading of each truck, immediately following the unloading of each truck, or during the late evening when no more fruit is being received.

High-piling operations begin after the 6-high stacks are in place in a specified floor area. Boxes are high-piled manually by different methods and crew arrangements, but usually two workers perform the operation. In some plants, four men are employed to work in a single high-piling crew of two teams. In each 2-man crew the worker on the floor lifts or hands the boxes to a worker on top of the stacks who places them in position, completing the high-pile.

When fruit is not stacked higher than 10 boxes, some high-piling methods make use of a bench. One worker standing on the bench stacks boxes handed up to him by the worker on the floor. When high-piles are not more than 9 boxes high, one tall man working alone may be used to lift and stack the boxes from the floor. In all manual methods, each box of fruit is handled individually.

During the course of the research, the research workers developed a mechanical high-piler and tested it under actual operating conditions. Although several types of equipment for high-piling have been tested previously under operating conditions, they either failed to achieve the desired production or required too much valuable cold storage space to make their use economical. The new mechanical lift will be described in connection with mechanical high-piling.

Manual high-piling is burdensome work. Boxes are lifted one at a time, frequently above the worker's head and shoulders, which makes it difficult for workers to handle the fruit gently, especially after they have tired. Moreover, the workers on top of the stacks must balance themselves on the edges of the boxes which requires additional effort and makes occasional slips unavoidable. As a consequence, workers are reluctant to accept high-piling work if other jobs are available.

Not only is high-piling heavy work, but percentagewise it accounts for a relatively large part of plant handling costs. When field boxes of apples are received at storage houses by use of belt conveyors and hand trucks and are stacked 12 high, 38.5 percent of the total labor required for receiving is used for manually high-piling the upper 6 boxes in the stack (table 33). When stacked 10 boxes high, 31 percent of the total labor required for receiving is used for stacking the upper 4 boxes.

Several factors affect the amount of labor required to high-pile boxes. Among these factors are the height of the ceilings in the cold storage room and the amount of space taken in some storage rooms for refrigerator coils or air ducts. In some storage plants, high-piling

Table 33.--Comparative labor requirements for receiving and stacking to 2 specified heights 288 field boxes of apples (1 road truckload) at storage houses by use of powered belt conveyor and clamp-type 2-wheel hand trucks 1/

Operation	Workers	Labor required for receiving when boxes are stacked in storage			
		10 boxes high		12 boxes high	
	Number	Man-hours 2/	Percent of total	Man-hours 2/	Percent of total
Placing boxes on belt conveyor (unloading)	1	0.41	21.5	0.41	19.2
Removing boxes from belt and building 6-high stacks	1	.39	20.5	.39	18.3
Transporting from belt to storage position and positioning 6-high stacks 3/	1	.51	27.0	.51	24.0
High-piling 4/	2	.59	31.0	.82	38.5
Total	5	1.90	100.0	2.13	100.0

1/ Receiving is the following cycle of operations: (1) Unloading field boxes of apples from the road truck, (2) transporting the boxes from the road truck to the storage point, and (3) stacking the boxes at the storage point.

2/ The man-hours of labor shown are the productive time required in performing the operation plus allowances for fatigue and crew interference. Idle and nonproductive time between truckloads received, changing job assignments, and other delays are not included. Therefore, costs computed on the basis of the man-hours of labor shown should be used for comparative purposes only since they may be somewhat lower than costs computed by usual methods in the warehouse.

3/ Boxes are transported in 6-high stacks from the end of the belt conveyor inside the plant to the storage point with clamp-type 2-wheel hand trucks, where they are released and positioned as a unit. Transportation distance standardized at 50 feet.

4/ Boxes are manually lifted and stacked above the original 6-high stack. Of the 288-box load, 115 boxes are high-piled when boxes are stacked 10 high. In 12-high stacks 144 boxes are high-piled.

conditions are affected by the decision of management to high-pile during the receiving operations, or after hours using overtime crews. High-piling after hours is possible by placing the boxes to be high-piled in temporary storage until the end of the day.

Because of the many variable conditions under which high-piling operations are performed, a number of factors affecting efficiency will be eliminated or held constant. High-piles of 9, 10, and 12 boxes high are used for comparative purposes. Variables and circumstances affecting these heights will be noted.

Manual High-Piling

2-man crew.--Manual high-piling is performed by one worker on the floor who lifts and hands boxes of fruit to another worker on top of the stack who places them on the high-piled stacks. When the stack is not more than 9 or 10 boxes high, the worker who completes the stacks may stand on a bench. When the stacks are higher than 10 boxes, a high-piler stands on top of the boxes, usually on pieces of plywood to give firmer footing. At other times, he balances himself on the edge of the boxes (fig. 34).

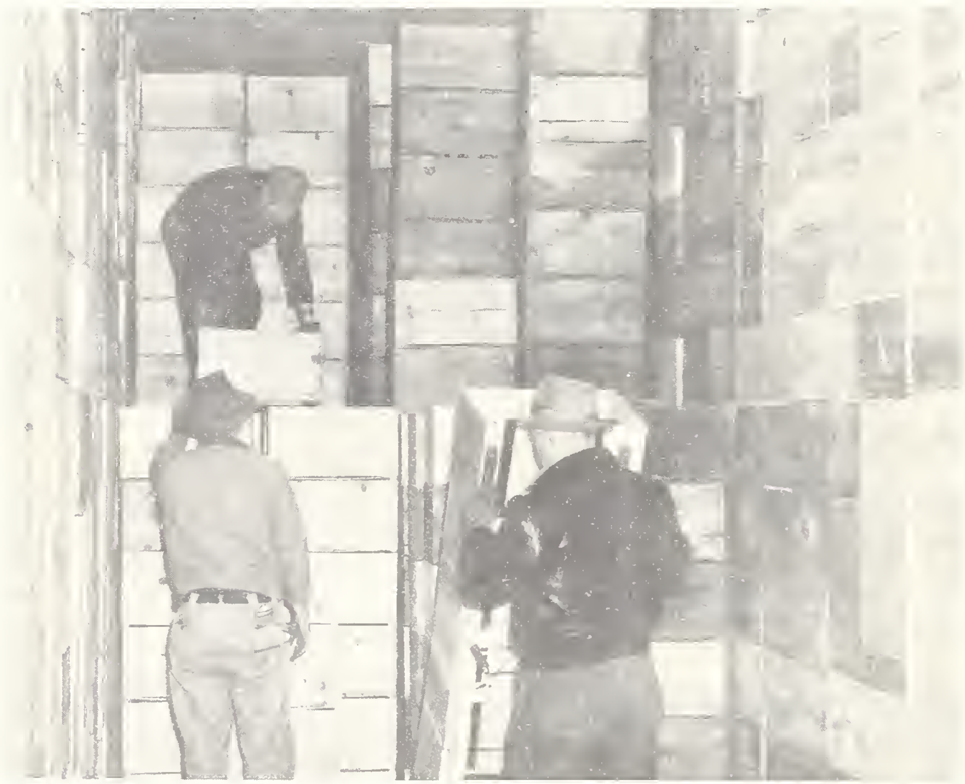

Figure 34.--The hand trucker wheels stacks to the 2-man crew who high-pile the boxes.

Total labor required to high-pile 9 boxes high is 4.92 man-hours per 1,000 boxes stacked above the original 6-high stack (table 34). Nearly 17 percent of the labor required for high-piling 9 high was an allowance for fatigue. This fatigue is less than when high-piling to 10, 11, or 12 boxes high.

High-piling in 10-high stacks required an additional 0.20 of a man-hour of labor per 1,000 boxes all of which is accounted for by a larger fatigue allowance. Twelve-high stacks required 0.74 of a man-hour of labor more than 9 high. Thus, it is relatively less efficient to high-pile to the higher heights.

Table 34.--Comparative labor requirements for a 2-man crew to manually high-pile 1,000 unpacked boxes of apples to specified heights 1/

Height of stack	Productive labor	Fatigue allowance	Total labor
	Man-hours	Man-hours	Man-hours
9 boxes high 2/	4.10	0.82	4.92
10 boxes high 3/	4.10	1.02	5.12
12 boxes high 4/	4.54	1.12	5.66

1/ Labor requirements shown do not include unloading, transporting, and releasing the boxes of fruit high-piled nor the 6-high stacks on which they are high-piled.
2/ Three boxes in each 9-high stack are high-piled.
3/ Four boxes in each 10-high stack are high-piled.
4/ Six boxes in each 12-high stack are high-piled.

The labor required for high-piling boxes of apples may be stated in two different ways: (1) In terms of the number of boxes high-piled, or (2) in terms of the total boxes received. When boxes are high-piled 9 high, only 33.3 percent of the total fruit received is high-piled. Similarly, when boxes are high-piled 10 high, 40 percent of the total boxes received are high-piled. Plant operators usually are more interested in knowing how much labor will be needed to high-pile the number of boxes that must be high-piled as the fruit is received. The total labor required to high-pile 1,000 boxes adjusted in proportion to the percentages of the boxes high-piled is shown in table 35.

Table 35.--Comparative labor and elapsed time required for a 2-man crew to manually high-pile a total of 1,000 unpacked boxes of apples to specified heights and to high-pile the required proportion of each 1,000 boxes received to these heights

Height of stack	Labor required per 1,000 boxes high-piled	Labor required per 1,000 boxes received	Elapsed time per 1,000 boxes received
	Man-hours	Man-hours	Hours
9 boxes high	4.92	1/ 1.64	0.82
10 boxes high	5.12	2/ 2.05	1.02
12 boxes high	5.66	3/ 2.83	1.41

1/ Labor required for high-piling 333 boxes.
2/ Labor required for high-piling 400 boxes.
3/ Labor required for high-piling 500 boxes.

Another important factor in high-piling is the elapsed time. This rate is necessary in scheduling work loads and in arriving at decisions as to whether the high-piling should be performed during receiving operations or whether to move the fruit to be high-piled into temporary storage for high-piling after hours.

The determination by plant operators of the height to which boxes are to be stacked is not based exclusively on the labor or the elapsed time required by each of the various heights. Rather, the ceiling height of the storage rooms is likely to be the determinant of how high the boxes are to be stacked. Usually, fruit is stacked as high as the ceiling height permits. However, during years when total production is relatively small, fruit may be high-piled to less than ceiling heights.

4-man crew.--The time studies show that a 4-man crew is as efficient as a 2-man crew. In practice a 4-man high-piling crew works as two teams of two workers each (fig. 35). Use of the 4-man crew cuts in half the elapsed time to high-pile 1,000 boxes but does not increase labor requirements. The larger crew has a definite advantage in warehousing operations when receiving must be carried on with dispatch.

Figure 35.--Manual high-piling with a 4-man crew.

Comparative labor costs for various stacking heights.--The labor cost per 1,000 boxes of fruit received for manual high-piling ranged from $1.88 when stacked 9 boxes high to $3.25 when stacked to 12 high. Table 36 shows the costs for three specified stacking heights computed on the basis of both current and assumed wage rates.

Table 36.--Comparative elapsed times and labor costs for manually high-piling, by use of a 2-man crew, the volumes high-piled from each 1,000 boxes of apples received when stacked to specified heights

Height of stack	Elapsed time	Total labor	Total cost: Current wages	Total cost: Assumed wages
	Hours	Man-hours	Dollars	Dollars
9 boxes high (333 boxes high-piled)	0.82	1.64	1.88	2.30
10 boxes high (400 boxes high-piled)	1.02	2.05	2.36	2.87
12 boxes high (500 boxes high-piled)	1.41	2.83	3.25	3.96

Mechanical High-Piling

Mechanical high-piling is done with a portable lift. The lift consists of a simple, light-weight superstructure mounted on casters to provide mobility. Its width is such that the lift operates within the space occupied by one row of boxes. The lifting mechanism consists in part of clamps, one on either side of the machine, which grip or squeeze the ends of the boxes to be lifted in a manner comparable to the clamp-type industrial truck. The thickness of the clamps and the outrigger is no greater than the amount of space normally left between rows of boxes for air circulation. The lift mechanism operates hydraulically from a small electric motor which in turn operates from a storage battery. (Although an automobile storage battery operated the lift during test runs, a larger capacity, industrial-size battery may be preferable.)

The prototype of this machine, used in earlier tests, is capable of lifting two 6-high stacks of boxes simultaneously, or a total of 12 boxes of fruit. Following the earlier tests, a single-stack lift was placed on the market. A later model was tested. It is powered by an electric motor connected to the house line.

2-stack lift.--In using the mechanical lift, four 6-high stacks of boxes are first placed side by side in the same row by use of 2-wheel hand trucks. These stacks are handled as units as in the methods previously described. The lift is then pushed into position, straddling two of the stacks, the operator motivates the clamping arms, and lifts the load (fig. 36). The stacks to be high-piled either can be pushed forward on the lift while they are being elevated or after they have been lifted enough to clear the top of the two base stacks (fig. 37). After moving the lift

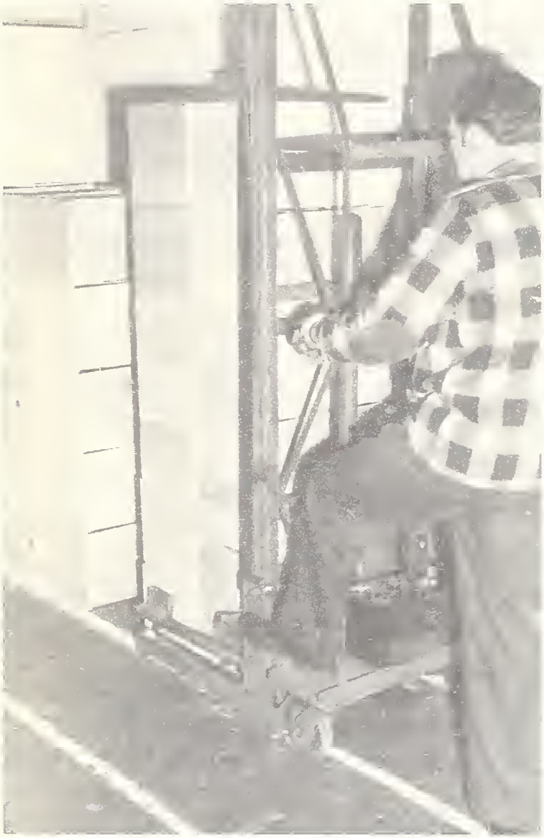

Figure 36.--Operator activating clamping arms to grasp the load. After clamping the stacks, the boxes are lifted to stacking height.

Figure 37.--With the stacks elevated, the operator pushes the loaded lift forward to move the load over the lower stacks.

forward, with its load over the stacks on which they are to be released, the operator motivates a valve releasing the load (figs. 38 and 39). One worker operates the lift. While the mechanical lift is high-piling boxes in one row, hand truckers place four 6-high stacks of boxes in an adjacent row to which the lift is moved to repeat the cycle. This is a balanced operation and crew interference is minimized.

When boxes are stacked 9 high, the original 6-high stacks must be broken into 3-high stacks for high-piling. When stacked 10 high the original stacks are built 5 high rather than 6 high.

The elapsed times and labor requirements for high-piling 1,000 boxes of fruit to various heights are shown in table 37.

Figure 38.--A worker pushes the load forward until the top stacks are over the lower stacks. The worker then operates the hydraulic lever which lowers the top stacks into position.

Figure 39.--After the top stacks are lowered the worker withdraws the machine from the stacks and the clamping arms are lowered for another pick up.

Table 37.--Comparative labor and elapsed time required to high-pile 1,000 unpacked boxes of apples to specified heights and to high-pile the required proportion of each 1,000 boxes received to these heights by use of a 2-stack portable mechanical lift 1/

Height of stack	Labor required per 1,000 boxes high-piled	Labor required per 1,000 boxes received	Elapsed time per 1,000 boxes received
	Man-hours	Man-hours	Hours
9 boxes high	3.21	2/ 1.07	1.07
10 boxes high	2.44	3/ .98	.98
12 boxes high	1.78	4/ .89	.89

1/ A fatigue allowance of 10 percent is included.
2/ Labor required for high-piling 333 boxes.
3/ Labor required for high-piling 400 boxes.
4/ Labor required for high-piling 500 boxes.

Single-stack lift.--Two views of a single-stack lift, which is now manufactured commercially, are shown in figures 40 and 41.

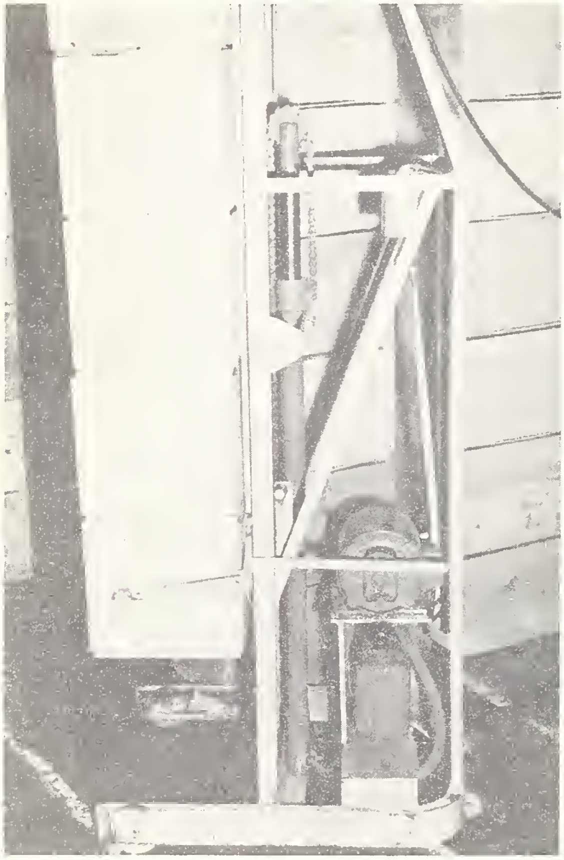

Figure 40.--A single-stack high-piler lifting a stack of 6 boxes.

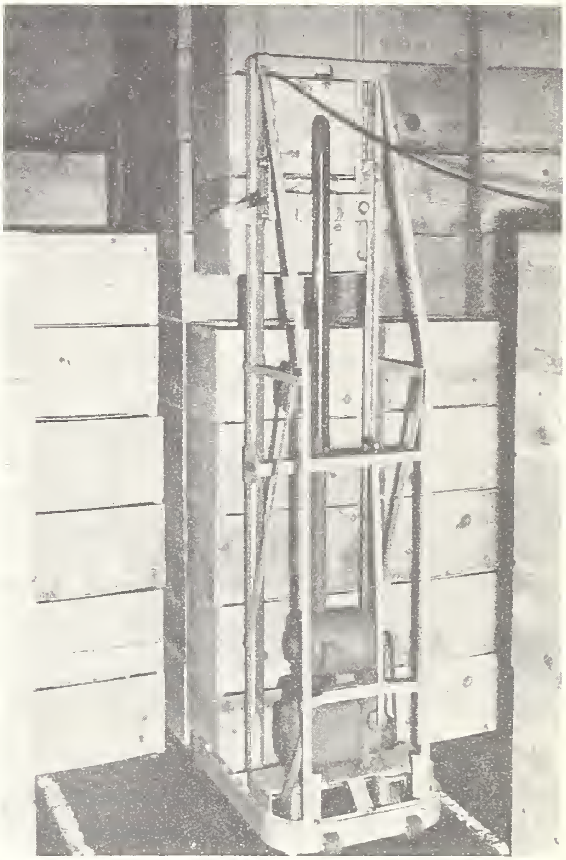

Figure 41.--A stack being released in storage position.

Table 38.--Comparative labor and elapsed time required to high-pile 1,000 unpacked boxes of apples to specified heights and to high-pile the required proportion of each 1,000 boxes received to these heights by use of a single-stack portable mechanical lift 1/

Height of stack	Labor required per 1,000 boxes high-piled	Labor required per 1,000 boxes received	Elapsed time per 1,000 boxes received
	Man-hours	Man-hours	Hours
9 boxes high	3.72	2/ 1.24	1.24
10 boxes high	2.57	3/ 1.03	1.03
12 boxes high	1.89	4/ .94	.94

1/ A fatigue allowance of 10 percent is included.
2/ Labor required for high-piling 333 boxes.
3/ Labor required for high-piling 400 boxes.
4/ Labor required for high-piling 500 boxes.

Labor requirements for high-piling 1,000 boxes of fruit by use of a single-stack lift are greater than with a 2-stack lift, or 3.72 man-hours per 1,000 boxes when stacked 9 high compared with 3.21 using a 2-stack machine. The elapsed time also was slightly greater than with the 2-stack lift. The performance of a single-stack lift is shown in table 38.

Comparison of 2-stack and single-stack lifts.--The comparative efficiency, based on labor and equipment costs, of the 2-stack and single-stack lifts is shown in table 39.

Table 39.--Comparative labor and equipment costs for high-piling by use of specified types of mechanical lifts, the volumes high-piled from each 1,000 boxes of apples received when stacked to specified heights

Height of stack and type of equipment	Elapsed time	Labor and equipment required: Equipment time	Labor and equipment required: Total labor	Labor and equipment costs: Equipment	Labor and equipment costs: Labor 1/	Total cost: Current wages	Total cost: Assumed wages
	Hours	Machine-hours	Man-hours	Dollars	Dollars	Dollars	Dollars
9 boxes high (333 boxes high-piled):							
2-stack lift	1.07	1.07	1.07	0.63	1.23	1.86	2.13
Single-stack lift	1.24	1.24	1.24	.73	1.43	2.16	2.47
10 boxes high (400 boxes high-piled):							
2-stack lift	.98	.98	.98	.58	1.13	1.71	1.95
Single-stack lift	1.03	1.03	1.03	.61	1.18	1.79	2.05
12 boxes high (500 boxes high-piled):							
2-stack lift	.89	.89	.89	.53	1.02	1.55	1.78
Single-stack lift	.94	.94	.94	.55	1.08	1.63	1.87

1/ Computed from "current" wage rates.

Comparison of Manual and Mechanical High-Piling

As shown in table 40, manual high-piling to a height of 9 boxes is just as efficient as mechanically high-piling by use of the 2-stack lift and is more efficient than the single-stack lift. However, mechanical high-piling can be accomplished by use of a smaller crew, one worker, and the fruit is handled more gently. It would therefore appear to be advantageous to a firm to use the machine when going to this height.

When stacking 10 or 12 boxes high, the 2-stack mechanical high-piler shows a definite saving over the manual method, amounting to $0.65 per 1,000 boxes received when stacking boxes to 10 high, and $1.70 per 1,000 boxes when stacking 12 high. Even though this saving is obvious, the decision as to whether high-piling should be done manually or mechanically may depend upon other factors such as the layout of the plant, the interference of ducts and posts and other factors which may prohibit the mechanical high-piler from being used to full capacity. Moreover, the mechanical high-piler would have to be used enough each season to defray its ownership and operating costs. 17/

17/ Operating 300 hours a year these costs are estimated to be $177.45.

Table 40.--Comparative costs for high-piling, by use of specified methods, the volumes high-piled from each 1,000 boxes of apples received when stacked to specified heights 1/

Methods	Total labor and equipment costs based on current wage rates when stacked: 9 boxes high	10 boxes high	12 boxes high
	Dollars	Dollars	Dollars
High-piling boxes manually by use of 2-man crew	1.88	2.36	3.25
High-piling boxes mechanically by use of 2-stack lift and 1 operator	1.86	1.71	1.55
High-piling boxes mechanically by use of single-stack lift and 1 operator	2.16	1.79	1.63

1/ Costs shown include labor costs, and for mechanical high-piling equipment costs.

Effect of Manual High-Piling on Wait Time in Other Operations in Receiving Cycle

One of the crew arrangements used for unloading and moving apples to storage by use of belt conveyors and 2-wheel hand trucks is to station two workers on the road truck to place fruit on the belt conveyor, two workers to off-load the conveyor, two hand truckers to transport stacks to storage position, and two men to high-pile (fig. 42). High-piling is done simultaneously with unloading and storage operations. Thus a delay in one operation in the cycle may be transmitted to and cause a corresponding delay in each of the other operations.

By use of this method the 2-man high-piling crew could not manually stack boxes of fruit at the rate they were brought to the storage position. Therefore, the hand truckers found it necessary to delay their operations occasionally to wait for the high-pilers to catch up. This wait in turn delayed the workers removing boxes from and placing boxes on the belt conveyor. These delays totaled 4.10 man-hours per 1,000 boxes received or 34 percent of the total labor required (table 41).

To minimize wait time and obtain a better balanced operation the question arises as to whether or not adding high-pilers would permit a better balanced operation. However, high-pilers work in teams of two, so an increase would require the addition of two workers, making a total of 10 in the crew. With this larger receiving crew, the amount of wait time by the hand truckers is reduced to a nominal amount and the

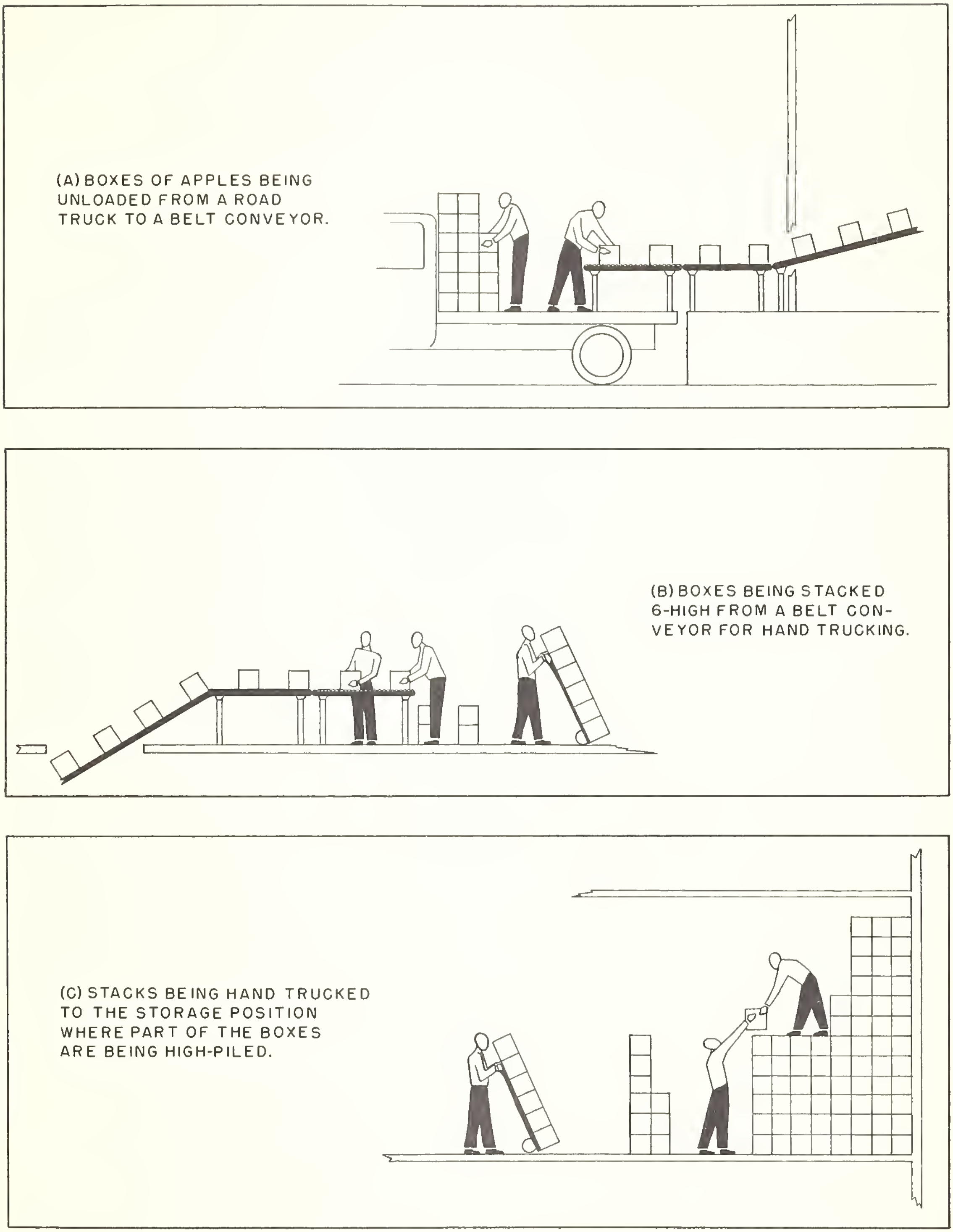

Figure 42.--8-man crew receiving boxes of apples from road truck by use of belt conveyors and 2-wheel hand trucks. High-piling is a manual operation.

Table 41.--Labor required for an 8-man crew to unload and move 1,000 unpacked boxes of apples into storage from a road truck by use of a belt conveyor and clamp-type 2-wheel hand trucks and manually high-pile boxes 12 high as fruit is being received

Operation	Workers	Productive labor	Fatigue allowance	Wait time	Total labor
	Number	Man-hours	Man-hours	Man-hours	Man-hours
Set up and clean up	1/ 8	0.16	0.0	0.52	0.68
Place boxes on belt conveyor (conveyor moves boxes 50 feet)	2	1.28	.25	1.29	2.82
Transfer boxes from belt conveyor to 6-high stacks	2	1.31	.26	1.25	2.82
Pick up 6-high stacks by use of 2-wheel hand trucks	2	.29	.03	.0	.32
Transport 6-high stacks 50 feet by use of 2-wheel hand trucks	2	.97	.10	2/ .08	1.15
Release 6-high stacks from 2-wheel hand trucks	2	.35	.04	.96	1.35
High-piling boxes 12 high (500 boxes)	2	2.27	.56	.0	2.83
Total man-hours	-	6.63	1.24	4.10	11.97
Elapsed time--hours					3/ 1.50

1/ Two of these workers do the setup work at the road truck while 6 workers spend most of their time waiting.
2/ Waiting caused by crew interference.
3/ This size crew can receive 17 road truckloads of 288 boxes each per 8-hour day.

Table 42.--Labor required for a 10-man crew to unload and move 1,000 unpacked boxes of apples into storage by use of a belt conveyor and clamp-type 2-wheel hand truck and manually high-pile boxes 12-high as fruit is being received

Operation	Workers	Productive labor	Fatigue allowance	Wait time	Total labor
	Number	Man-hours	Man-hours	Man-hours	Man-hours
Set up and clean up	1/ 10	0.16	0.0	0.69	0.85
Place boxes on belt conveyor (conveyor moves boxes 50 feet)	2	1.28	.25	.33	1.86
Transfer boxes from belt conveyor to 6-high stacks	2	1.31	.26	.29	1.86
Pick up 6-high stacks by use of 2-wheel hand trucks	2	.29	.03	.0	.32
Transport 6-high stacks 50 feet by use of 2-wheel hand trucks	2	.97	.10	2/ .08	1.15
Release 6-high stacks from 2-wheel hand trucks	2	.35	.04	.0	.39
High-piling boxes 12 high (500 boxes)	4	2.27	.56	.89	3.72
Total man-hours	-	6.63	1.24	2.28	10.15
Elapsed time--hours					3/ 1.01

1/ Two of the workers do the setup work at the road truck while 8 workers spend most of their time waiting.
2/ Waiting caused by crew interference.
3/ This size crew can receive 25 road truckloads of 288 boxes each per 8-hour day.

delay time of high-pilers is increased to about 1 man-hour per 1,000 boxes received. Delay time also is reduced for workers placing fruit on the belt and removing it from the belt by nearly 2 man-hours. This reduction is partly off-set by delays of the high-pilers so that the total labor required to move 1,000 boxes into storage is 10.15 man-hours, a reduction of 15 percent from the labor used by an 8-man crew (table 42). This saving results entirely from the elimination of nearly 2 man-hours of wait time. The elapsed time required to unload also has been reduced to 1.01 hours per 1,000 boxes.

Comparative Labor Requirements, and Labor and Equipment Costs, of Various Methods of Unloading and Moving to Storage When Boxes Are High-Piled as Received by Use of Manual and Mechanical Methods

In previous discussions of various types and combinations of types of materials-handling equipment for receiving apples, the labor requirements and cost data have not included stacking boxes above the 6-high stacks released as unit loads in storage position. Table 43 shows, for selected methods that previously have been discussed, labor and elapsed time required for receiving unpacked boxes of fruit when manual high-piling is included. High-piling operations shown are for 12-high stacks. Transportation distances are standardized at 100 feet except for two elevator methods.

When the fruit is not being high-piled, the least labor, 2.63 man-hours per 1,000 boxes, is required with the floor chain conveyor and 2-wheel hand truck operated by 1 worker. This still requires the least labor for receiving, or 5.55 man-hours per 1,000 boxes, when a 2-man crew is added for manual high-piling. Without high-piling the combination of a single elevator and 2-wheel hand trucks, operated by a 7-man crew, moving boxes through temporary banks of supply requires the largest labor inputs, or 8.68 man-hours per 1,000 boxes. In high-piling, the labor requirement is greatest, 12.20 man-hours per 1,000 boxes, when using two elevators and temporary banks.

The elapsed time required to receive 1,000 boxes for each of these methods with and without the high-piling, is the same in nearly all cases. This is because the rate of receiving tends to be set by the pace at which the fruit is placed on the conveyors or is hand trucked, so that the capacity to handle the boxes by other parts of the receiving crew does not regulate the number of boxes moved into storage. In all cases, the wait time by various crew members increases when high-piling is added to the receiving operation. In some cases, the increases are rather large.

The addition of manual high-piling to receiving operations usually increases the amount of wait time and alters the relative efficiency of different methods and types of equipment. Mechanical high-piling, by use of the portable mechanical lift, can be used as a substitute for manual high-piling in nearly all methods. Because the mechanical high-piling is performed by one worker using one machine and proceeds at a different

Table 43.--Elapsed time and labor required, by various specified methods, for unloading 1,000 unpacked boxes of apples as received from road trucks, moving them to storage, and manually high-piling them in 12-box-high stacks

Type of equipment and method	Elapsed time required: When not high-piled	Elapsed time required: Additional for high-piling	Elapsed time required: Total	Labor required: When not high-piled 1/	Labor required: For manually high-piling 2/	Labor required: Additional wait time when manually high-piled	Labor required: Total	Increased labor requirements for manually high-piling
	Hours	Hours	Hours	Man-hours	Man-hours	Man-hours	Man-hours	Percent
Clamp-type 2-wheel hand truck								
Two workers hand truck 100 feet, 2 workers high-pile (table 3)	1.47	-	1.47	2.94	2.83	0.12	5.89	100.3
Three workers hand truck 100 feet, 4 workers high-pile (table 4)	1.05	-	1.05	3.14	2.83	1.36	7.33	133.4
Belt conveyor and clamp-type 2-wheel hand truck								
One worker places boxes on conveyor, 1 worker transfers boxes from conveyor, 1 worker hand trucks 50 feet, 2 workers high-pile (table 9)	1.94	-	1.94	5.82	2.83	1.05	9.70	66.7
One worker places boxes on conveyor, 1 worker transfers boxes from conveyor, 2 workers hand truck 50 feet, 2 workers high-pile (table 10)	1.52	0.05	1.57	6.08	2.83	.53	9.44	55.3
Two workers place boxes on conveyor, 2 workers transfer boxes from conveyor, 2 workers hand truck 50 feet, 4 workers high-pile (table 11)	1.01	-	1.01	6.06	2.83	1.21	10.10	66.7
Floor chain conveyor and clamp-type 2-wheel hand truck								
One worker hand trucks 20 feet to chain and 30 feet from chain, 2 workers high-pile (table 17)	2.63	.09	2.72	2.63	2.83	.09	5.55	111.0
Two workers hand truck 20 feet to chain, 2 workers hand truck 30 feet from chain, 4 workers high-pile (table 19)	.88	-	.88	3.50	2.83	.67	7.00	100.0
Belt conveyor, stackmaker, floor chain conveyor and 2-wheel hand truck								
One worker places boxes on conveyor, 1 worker hand trucks 50 feet from floor chain conveyor, 2 workers high-pile (table 25)	1.96	-	1.96	3.92	2.83	1.09	7.84	100.0
Two workers place boxes on conveyor, 2 workers hand truck 50 feet from floor chain conveyor, 4 workers high-pile (table 26)	1.12	-	1.12	4.48	2.83	1.65	8.96	100.0
Elevators and clamp-type 2-wheel hand trucks								
Three workers hand truck 30 feet to an elevator, ride the elevator, and hand truck 70 feet to storage, 2 workers high-pile (table 28)	1.57	-	1.57	4.70	2.83	.31	7.84	66.8
Two workers hand truck 30 feet to bank, 3 workers hand truck 30 feet from bank to elevator, ride the elevator, and hand truck 30 feet to bank, 2 workers hand truck 60 feet to storage, 2 workers high-pile (table 29) 3/	1.24	.25	1.49	8.68	2.83	.41	11.92	37.3
Two workers hand truck 30 feet to 2 elevators, 1 worker operates elevators, 3 workers hand truck 70 feet from 2 elevators, 4 workers high-pile (table 30)	1.05	-	1.05	5.25	2.83	1.37	9.45	80.0
Two workers hand truck 30 feet to bank, 2 workers hand truck 30 feet to 2 elevators, 1 worker operates elevators, 2 workers hand truck 30 feet from elevators to bank, 3 workers hand truck 60 feet from elevator to storage, 4 workers high-pile (table 31) 3/	.94	-	.94	8.45	2.83	.92	12.20	44.4

1/ Labor required for unloading from road trucks, transporting to storage point, and releasing 6-high stacks of boxes as unit loads. Includes wait time involved in performing these operations.
2/ Labor required to high-pile 500 boxes of apples.
3/ Standardized transportation distance of 100 feet increased to 150 feet because of method.

rate from the manual high-piling operation, the desirability of different crew sizes and arrangements for receiving is altered.

For most of the methods shown in table 43, the additional wait time, when high-piling is performed concurrently with other receiving operations, is reduced by use of the mechanical high-piling method. Table 44 shows elapsed times and labor requirements for these methods when fruit is mechanically high-piled in 12-box-high stacks. The total labor required to receive 1,000 boxes of apples when mechanically high-piled is in every case less than with the manual methods of high-piling. These savings range from 1.48 to 3.36 man-hours per 1,000 boxes.

As shown in table 45, the use of the mechanical high-piler in receiving reduces costs in all cases below costs for manual high-piling in 12-box-high stacks. This savings in cost, however, does not represent the full saving that should be realized by use of mechanical stacking. A larger saving should be possible through eliminating the idle and unproductive time of three workers in a 4-man high-piling crew. This fact again calls attention to the mechanical high-piler's ability to reduce the labor force required during the critical harvest period.

Obviously, equipment costs are increased when a mechanical high-piler is used rather than manual high-piling. When fruit is received by hand trucks, equipment costs account for only a fraction of total costs. The addition of the mechanical high-piler greatly increases machine costs on a percentage basis.

High-Piling Methods Used When Boxes Are Not Stacked as Received

The necessity for balancing high-piling operations with other operations in the receiving cycle, when fruit is high-piled as it is received, previously has been discussed. However, when operations are balanced, frequent delays occur because of the interdependence of these operations which makes it possible for one operation to set the pace for all others. One way of avoiding these delays is to high-pile separately from other receiving operations, by placing one-half of the boxes received (in a 12-high stacking operation) into temporary storage. After regular receiving hours, a special crew removes the fruit placed in temporary storage and high-piles it.

However, additional work is involved in high-piling after the regular receiving operation. This work is caused by the necessity of moving the boxes by hand truck to the high-piling point. For the purpose of this analysis, the added transportation distance is assumed to be 30 feet.

High-piling after receiving is frequently done by use of sections of gravity-type roller conveyors. These extensions are placed on top of the 6-high stacks. The worker stationed on the floor places each box on one

Table 44.--Elapsed time, and labor and equipment requirements required for unloading from road trucks and moving to storage 1,000 unpecked boxes of apples, by use of specified methods, and mechanically high-piling the required volume in 12-box high stacks as fruit is received

Type of equipment and method	Elapsed time required: When not high-piled	Elapsed time required: Additional for high piling	Elapsed time required: Total	Equipment time required: When not high-piled	Equipment time required: Productive time mechanical high-piler	Equipment time required: Wait time mechanical high-piler	Equipment time required: Total mechanical high-piler	Equipment time required: Total all equipment	Labor required: When not high-piled 1/	Labor required: For mechanically high-piling 2/	Labor required: Additional wait time when mechanically high-piled	Labor required: Total	Increased labor requirements for mechanically high-piling
	Hours	Hours	Hours	Machine-hrs.	Machine-hrs.	Machine-hrs.	Machine-hrs.	Machine-hrs.	Man-hrs.	Man-hrs.	Man-hrs.	Man-hrs.	Percent
Clamp-type 2-wheel hand truck and mechanical high-piler													
Two workers hand truck 100 feet, 1 worker high-piles	1.47	-	1.47	2.94	0.89	0.58	1.47	4.41	2.94	0.89	0.58	4.41	50.0
Three workers hand truck 100 feet, 1 worker high-piles	1.05	-	1.05	3.14	.89	.16	1.05	4.19	3.14	.89	.16	4.19	33.4
Belt conveyor, clamp-type 2-wheel hand truck, and mechanical high-piler													
One worker places boxes on, 1 worker transfers boxes from conveyor, 1 worker hand trucks 50 feet, 1 worker high-piles	1.94	-	1.94	5.82	.89	1.05	1.94	7.76	5.82	.89	1.05	7.76	33.3
One worker places boxes on, 1 worker transfers from conveyor, 2 workers hand truck 50 feet, 1 worker high-piles	1.52	-	1.52	6.08	.89	.63	1.52	7.60	6.08	.89	.63	7.60	25.0
Two workers place boxes on, 2 workers transfer from conveyor, 2 workers hand truck 50 feet, 1 worker high-piles	1.01	-	1.01	4.04	.89	.12	1.01	5.05	6.06	.89	.12	7.07	16.7
Floor chain conveyor, clamp-type 2-wheel hand truck, and mechanical high-piler													
One worker hand trucks 20 feet to chain and hand trucks 30 feet from chain, 1 worker high-piles	2.63	-	2.63	5.26	.89	.43	1.32	6.58	2.63	.89	.43	3.95	50.2
Two workers hand truck 20 feet to chain, 2 workers hand truck 30 feet from chain, 1 worker high-piles	.88	0.17	1.05	4/ 5.25	.89	.16	1.05	6.30	3.50	.89	.86	5.25	50.0
Belt conveyor, stackmaker, floor chain conveyor, clamp-type 2-wheel hand truck and mechanical high-piler													
One worker places boxes on conveyor, 1 worker hand trucks 50 feet, 1 worker high-piles	1.96	-	1.96	9.80	.89	1.07	1.96	11.76	3.92	.89	1.07	5.88	50.0
Two workers place boxes on conveyor, 2 workers hand truck 50 feet, 1 worker high-piles	1.12	-	1.12	6.72	.89	.23	1.12	7.84	4.48	.89	.23	5.60	25.0
Elevators, clamp-type 2-wheel hand trucks, and mechanical high-piler													
Three workers hand truck 30 feet to elevator, ride the elevator, hand truck 70 feet to storage, 1 worker high-piles	1.57	-	1.57	6.28	.89	.68	1.57	7.85	4.70	.89	.68	6.27	33.4
Two workers hand truck 30 feet to bank, 3 workers hand truck 30 feet from bank to elevator, ride the elevator, hand truck 30 feet to bank, 2 workers hand truck 60 feet to storage, 1 worker high-piles 3/	1.24	-	1.24	9.92	.89	.35	1.24	11.16	8.68	.89	.35	9.92	14.3
Two workers hand truck 30 feet to 2 elevators, 1 worker operates elevators, 3 workers hand truck 70 feet from 2 elevators to storage, 1 worker high-piles	1.05	-	1.05	7.35	.89	.16	1.05	8.40	5.25	.89	.16	6.30	20.0
Two workers hand truck 30 feet to bank, 2 workers hand truck 30 feet to 2 elevators, 1 worker operates elevators, 2 workers hand truck 30 feet from elevators to bank, 3 workers transport 60 feet from elevator to storage, 1 worker high-piles 3/	.94	-	.94	10.34	.89	.05	.94	11.28	8.45	.89	.05	9.39	11.1

1/ Labor required for unloading road trucks, transporting to storage point, and releasing 6-high stacks of boxes as unit loads. Includes wait time involved in performing these operations.
2/ Labor required to high-pile 500 boxes of apples.
3/ Standardized transportation distance of 100 feet increased to 150 feet because of method.
4/ Includes 0.85 machine-hours (clamp-type 2-wheel hand truck 0.68 machine-hours and 100 foot floor chain conveyor 0.17 machine-hours) of equipment time caused by increased elapsed time of 0.17 hours when high-piling is performed.

Table 45.--Comparative labor and equipment costs for unloading from road trucks and moving to storage 1,000 unpacked boxes of apples, by use of specified methods and types of equipment, when fruit is not high-piled, and when required volume is high-piled by use of manual and mechancial methods in 12-box high stacks as fruit is received 1/

Type of equipment and method	Equipment cost	Labor cost current wage rates	Total cost current wage rates	Total cost assumed wage rates
	Dollars	Dollars	Dollars	Dollars
Clamp-type 2-wheel hand trucks:				
Two workers hand-truck 100 feet, and				
No high-piling (table 5)	0.07	3.38	3.45	4.19
2 workers manually high-pile	.07	6.77	6.84	8.32
1 worker and mechanical lift high-pile	.94	5.07	6.01	7.11
Three workers hand-truck 100 feet, and				
No high-piling (table 5)	.07	3.61	3.68	4.47
4 workers manually high-pile	.07	8.43	8.50	10.33
1 worker and mechanical lift high-pile	.70	4.82	5.52	6.57
Belt conveyors and clamp-type 2-wheel hand trucks:				
One worker places boxes on conveyor, 1 worker transfers boxes from conveyor, 1 worker hand-trucks 50 feet, and				
No high-piling (table 13)	1.74	6.69	8.43	9.89
2 workers manually high-pile	1.74	11.16	12.90	15.32
1 worker and mechanical lift high-pile	2.88	8.92	11.80	13.74
One worker places boxes on conveyor, 1 worker transfers boxes from conveyor, 2 workers hand-truck 50 feet, and				
No high-piling (table 13)	1.39	6.99	8.38	9.90
2 workers manually high-pile	4/ 1.45	10.86	12.31	14.67
1 worker and mechanical lift high-pile	2.29	8.74	11.03	12.93
Two workers place boxes on conveyor, 2 workers transfer boxes from conveyor, 2 workers hand-truck 50 feet, and				
No high-piling (table 13)	.92	6.97	7.89	9.41
4 workers manually high-pile	.92	11.62	12.54	15.06
1 worker and mechanical lift high-pile	1.53	8.13	9.66	11.43
Floor chain conveyors and clamp-type 2-wheel hand trucks:				
One worker hand-trucks 20 feet to conveyor and 30 feet from conveyor to storage, and				
No high-piling (table 20)	3.11	3.02	6.13	6.79
2 workers manually high-pile	4/ 3.23	6.38	9.61	11.00
1 worker and mechanical lift high-pile	3.89	4.54	8.43	9.42
Two workers hand-truck 20 feet to conveyor and 2 workers hand-truck 30 feet from conveyor to storage, and				
No high-piling (table 20)	1.10	4.02	5.12	6.00
4 workers manually high-pile	1.10	8.05	9.15	10.90
1 worker and mechanical lift high-pile	1.94	6.04	7.98	9.29
Belt conveyor, stackmaker, floor chain conveyor, and clamp-type 2-wheel hand trucks:				
One worker places boxes on belt conveyor, 1 worker hand-trucks 50 feet from floor chain conveyor to storage, and				
No high-piling (table 27)	6.02	4.51	10.53	11.51
2 workers manually high-pile	6.02	9.02	15.04	17.00
1 worker and mechanical lift high-pile	7.18	6.76	13.94	15.41
Two workers place boxes on belt conveyor, 2 workers hand-truck 50 feet from floor chain conveyor to storage, and				
No high-piling (table 27)	3.46	5.15	8.61	9.73
4 workers manually high-pile	3.46	10.30	13.76	16.00
1 worker and mechanical lift high-pile	4.12	6.44	10.56	11.96
Elevators and clamp-type 2-wheel hand trucks: 2/				
Three workers hand-truck 30 feet into single elevator, ride elevator, and hand-truck 70 feet to storage, and				
No high-piling (table 32)	5.15	5.41	10.56	11.73
2 workers manually high-pile	5.15	9.02	14.17	16.13
1 worker and mechanical lift high-pile	6.08	7.21	13.29	14.86
Two workers hand-truck 30 feet to bank, 3 workers hand-truck 30 feet from bank into single elevator and ride elevator then hand-truck 30 feet to bank, 2 workers hand-truck 60 feet to storage, and 3/				
No high-piling (table 32)	4.20	9.98	14.18	16.35
2 workers manually high-pile	4/ 5.00	13.71	18.71	21.69
1 worker and mechanical lift high-pile	4.92	11.41	16.33	18.81
Two workers hand-truck 30 feet into one of two elevators, 1 worker operates elevators, 3 workers hand-truck 70 feet from two elevators to storage, and				
No high-piling (table 32)	6.87	6.04	12.91	14.22
4 workers manually high-pile	6.87	10.87	17.74	20.10
1 worker and mechanical lift high-pile	7.49	7.25	14.74	16.31
Two workers hand-truck 30 feet to bank, 2 workers hand-truck 30 feet from bank into one of two elevators, 1 worker operates elevator, 2 workers hand-truck 30 feet from elevators to bank, 3 workers hand-truck 60 feet from bank to storage, and 3/				
No high-piling (table 32)	6.24	9.72	15.96	18.07
4 workers manually high-pile	6.24	14.03	20.27	23.32
1 worker and mechanical lift high-pile	6.79	10.80	17.59	19.94

1/ Cost data for mechanical high-piling covers use of one 2-stack portable lift. Cost data for both manual and mechanical high-piling cover costs of unloading, transporting, and releasing 6-high stacks at storage position plus costs of high-piling 500 boxes. Except as otherwise noted, all transportation distances standardized at 100 feet.

2/ Vertical transportation distances are not included in elevator methods.

3/ Standardized transportation distance of 100 feet increased to 150 feet because of method.

4/ Equipment costs were increased because of additional elapsed time required when high-piling was performed as fruit was received.

end of the roller conveyor and gives it a push. The high-piler, who stands at the end of the row or at the point where the high-piling is being done, picks each box up from the roller conveyor and places it in the stack. Sometimes the fruit is placed in temporary storage so that high-piling can be done by handing boxes up alongside of the rows being high-piled, thus eliminating the use of roller conveyors. 18/

When high-piling is done after regular working hours, using a 3-man crew, the wait time in the high-piling operation is kept to a nominal 0.03 man-hours per 1,000 boxes because the wait times that occur in other operations in the receiving cycle are not transmitted to high-piling operations. Moreover, the elapsed time required to receive a truckload is not increased by this method of high-piling. As shown in table 46, to receive 1,000 boxes by this method takes 10.31 man-hours using a 2-man high-piling crew and one hand trucker to supply the high-pilers.

Table 46.--Labor required for crews of specified sizes to unload from road trucks and move 1,000 boxes of apples into storage by use of a belt conveyor and clamp-type 2-wheel hand trucks, and to manually high-pile required volume of boxes 12-high after fruit has been received

Operation	Workers	Productive labor	Fatigue allowance	Wait time	Total labor
	Number	Man-hours	Man-hours	Man-hours	Man-hours
Unloading and placing in temporary storage:					
Set up and clean up	6	0.16	0.0	0.32	0.48
Place boxes on belt conveyor (conveyor moves boxes 50 feet)	2	1.28	.25	.33	1.86
Transfer boxes from belt conveyor to 6-high stacks	2	1.31	.26	.29	1.86
Pick up 6-high stacks by use of 2-wheel hand trucks	2	.29	.03	.0	.32
Transport 6-high stacks 50 feet by use of 2-wheel hand trucks	2	.97	.10	.08	1.15
Release 6-high stacks from 2-wheel hand trucks	2	.35	.04	.0	.39
Subtotal	-	4.36	.68	1.02	6.06
High-piling after regular hours:					
Pick up 6-high stacks by use of 2-wheel hand trucks	1	.29	.03	.0	.32
Transport 6-high stacks 30 feet by use of 2-wheel hand trucks	1	.62	.06	.0	.68
Release 6-high stacks from 2-wheel hand trucks	1	.35	.04	.03	.42
Manually high-pile boxes 12-high (500 boxes)	2	2.27	.56	.0	2.83
Subtotal	-	3.53	.69	.03	4.25
Total man-hours	-	7.89	1.37	1.05	10.31
Elapsed time--hours					1/ 1.01

1/ This size crew can receive 25 road truckloads of 288 boxes each during an 8-hour day.

18/ The time studies showed no significant difference in man-hours required to high-pile with the use of roller conveyor extensions.

A comparison of high-piling after receiving with high-piling during receiving shows that wait time is reduced 48 percent and total labor is increased by 8 percent. The elapsed time required to receive is less by 0.56 hours per 1,000 boxes or 10 minutes per truckload. Reduction of elapsed time is very significant, especially during the peak season when the warehouse may have difficulty in receiving fruit as fast as it arrives. High-piling after hours should permit about eight additional truckloads to be received per day.

The reduction in elapsed time also has the effect of reducing the length of time equipment is used during receiving. Consequently, equipment costs are reduced $0.52, but labor costs increase $1.00, with the result that total costs increase $0.48 net per 1,000 boxes received at current wage rates (table 47).

Table 47.—Comparative labor and equipment costs of unloading road trucks and moving 1,000 unpacked boxes of apples into storage by use of belt conveyor and clamp-type 2-wheel hand truck, and manually high-piling required volume 12 high during receiving and after receiving

Method	Elapsed time	Labor and equipment required			Labor and equipment costs			
		Equipment time	Wait time	Total labor	Equipment	Labor 1/	Total costs	
							Current wages	Assumed wages
	Hours	Machine-hours	Man-hours	Man-hours	Dollars	Dollars	Dollars	Dollars
Belt conveyor and 2-wheel hand truck:								
Two men high-pile boxes 12 high while receiving	1.57	2/ 6.28	2.00	9.44	1.45	10.86	12.31	14.67
Belt conveyor and 2-wheel hand truck:								
Two men high-pile boxes 12 high after receiving	1.01	3/ 4.04	1.05	10.31	.93	11.86	12.79	15.36

1/ Computed from "current" wage rates.
2/ Clamp-type 2-wheel hand truck 3.14 machine-hours, 100-foot belt conveyor 1.57 machine-hours, 15-foot gravity roller conveyor 1.57 machine-hours, total 6.28 machine-hours.
3/ Clamp-type 2-wheel hand truck 2.02 machine-hours, 100-foot belt conveyor 1.01 machine-hours, 15-foot gravity roller conveyor 1.01 machine-hours, total 4.04 machine-hours.

Another factor that should be considered is the necessity for paying "overtime" wages for after-hours work. If a crew is used overtime, the cost would be higher in proportion to the rates of pay. Furthermore, men working long hours during the day might not work at usual efficiency on an overtime basis. These two factors could easily offset other advantages of high-piling after hours.

An improved practice might involve the adoption of a combination of the two methods of high-piling, or to high-pile when the fruit is received if the work schedule permits, and during the time of the day when trucks are arriving frequently, part of the fruit would be set aside to be high-piled when intervals between truckloads permitted later in the day. After-hour high-piling would be performed when the crews were unable to do all the high-piling during the fill-in hours.

Industrial Fork-Lift Trucks and Pallets

Toward the end of World War II, labor shortages had become so acute that many Washington State apple houses were seeking means for reducing the need for manual labor. At that time, one plant constructed an addition to its facilities in which handling operations were performed with fork-lift trucks and pallets. Two years later, two or three additional plants were using fork-lift trucks. However, shifting to mechanized equipment involved many problems of plant remodeling. Consequently, the industrial-lift truck has not completely solved the industry's problems of handling apples except where new storages were built or additions were made to old storages.

Industrial fork-lift trucks used in Washington State apple houses usually are of 2,000-, 3,000-, and 4,000-pound capacity. Both gasoline-powered (fig. 43) and electric-powered (fig. 44) lift trucks currently are

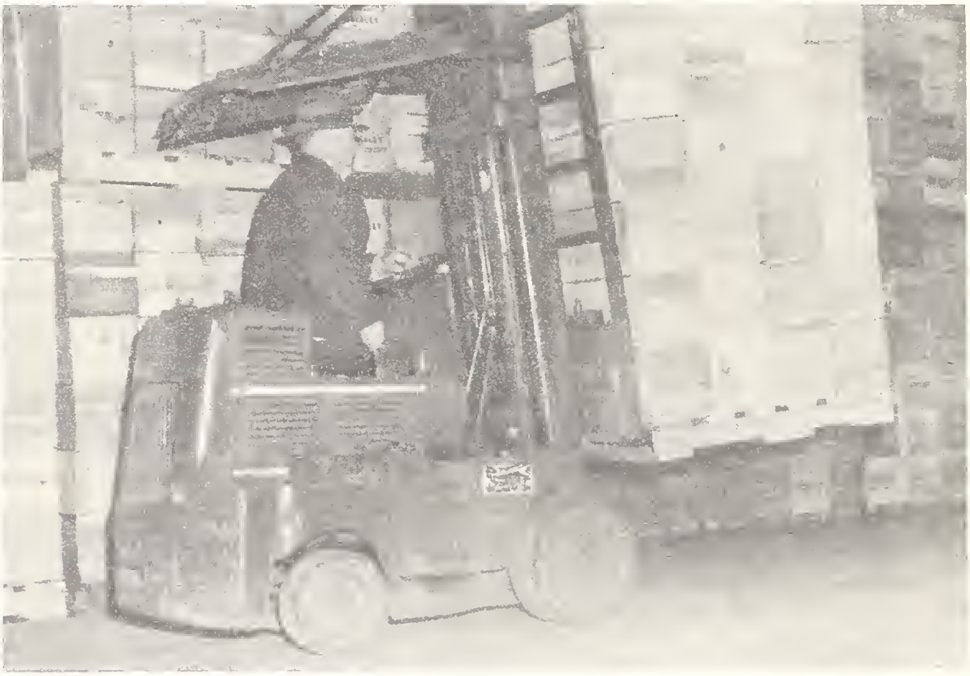

Figure 43.--A gasoline fork truck carrying a pallet load of boxes to storage. Driver beginning lift for second or third release in a stack.

in use and both are used to do essentially the same work. However, wise selection of equipment involves several considerations. Some of these are money available for capital outlay, interior or exterior operation, plant layout and operating conditions, tasks to be performed, and volume of work. Although it may be possible that both types of machines might work equally well in an individual plant, there usually are one or more controlling factors.

Figure 44.--Electric fork truck releasing a pallet load in a cold storage room.

The gasoline-powered truck requires less capital outlay than the electric-powered truck but the latter type is more economical to operate and has approximately twice the life of the former. In the cost estimates shown in table 2, the gasoline-powered trucks are depreciated over a period of 10 years, whereas the electric trucks are depreciated on a 20-year basis. Electric trucks should be operated a minimum of 200 days a year for optimum efficiency.

In apple-storage houses, electric trucks are more desirable for interior operations because gasoline-powered trucks, operating inside a plant for any appreciable time, may throw off dangerous fumes. There also is the unexplored effect these fumes might have on the fruit. However, a new inhibitor that is claimed to render exhaust gas harmless, odorless, and colorless to workers may make the gasoline truck suitable for interior use. Either gasoline or electric trucks are suitable for exterior operations. Long grades and rough surfaces favor the gasoline truck. It usually has faster lifting and lowering speed, and in general operation gasoline-powered trucks usually are faster than electric trucks. Gasoline trucks also exert the same power at the end of 8 hours of work that they do at the beginning.

Electric lift trucks excel in short distance hauls where there are many starts and stops. They are used to best advantage on small grades or inclines. The fact that the electric truck has relatively few moving parts and no gears or clutch makes it desirable for use under these conditions. Electric trucks do not have nearly as much "down time" for repairs and maintenance.

The workloads in individual plants are closely related to ownership costs. A plant that buys a single lift truck for handling a small volume usually cannot afford to buy an electric truck and charger if a gasoline truck could do the same work. However, if several machines are to be purchased, the unit cost of electric trucks and charging apparatus would tend to decrease.

Many of the first pallets used in apple houses were war surplus property. Their sizes varied from 40- by 36-inch to 48- by 64-inch pallets. As pallet sizes, and the consequent weight of pallet loads, vary, so must the capacities of fork-lift trucks used for handling loaded pallets.

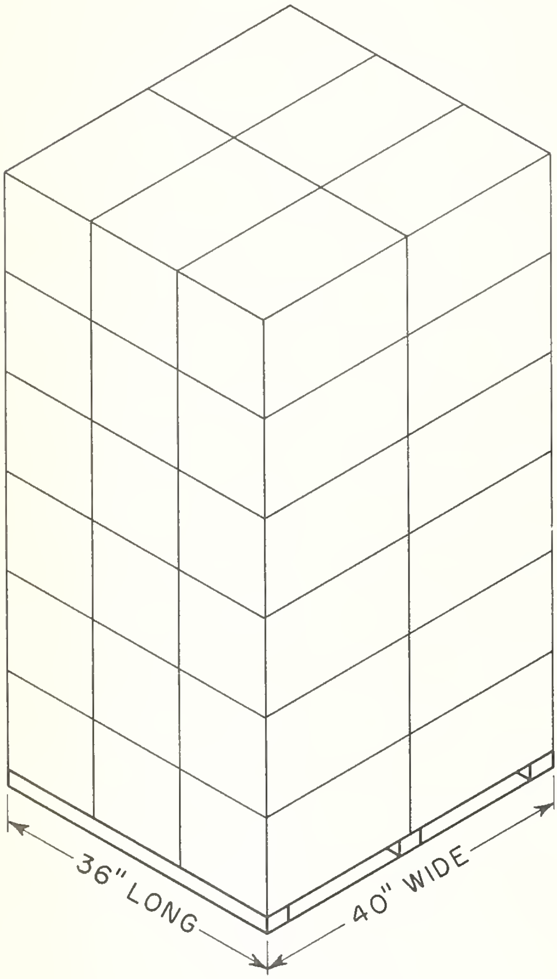

Figure 45.--36-box pallet load.

The trend has been to standardize on a 40- by 36-inch pallet (36-box load) and a 40- by 48-inch pallet (48-box load). 19/ Figures 45 and 46 show respectively the arrangement of apple boxes on the two different pallets. Studies of pallet handling show that labor and equipment requirements per 1,000 boxes on 48-box pallets and on 36-box pallets had a relationship of 4 to 3.

Stability of pallet loads has been an important factor in the selection of pallet sizes by individual plants. Unpacked boxes of apples are stacked 6-high on pallets. In the 48-box pallet load, the two middle rows of boxes stabilize the load, while in a 36-box load there is only one row of boxes in the center to give the load stability. Another factor in determining the pallet size for each plant is the structural strength of the floors. Handling a 36-box pallet load requires a fork-lift truck of at least 1-ton capacity. This capacity truck ranges in service weight from 3,200 to 5,100 pounds, depending on the make and model. A 1-$\frac{1}{2}$-ton to 2-ton capacity truck which weighs approximately 6,000 pounds is

19/ When the fruit is packed the load is reduced usually from 36 and 48 to 30 and 40 boxes. Apples received loose in boxes from the orchard weigh approximately 35 pounds per box. After they are packed the weight per box is increased to a gross of approximately 50 pounds. Thus, the total weight of the packed-box load with fewer boxes is approximately equal to the loose-box unit load.

required for handling 48-box pallet loads. Consequently, plants that have converted from belt conveyors and hand trucks to pallets and industrial fork-lift trucks usually prefer the smaller unit load and lighter lift truck, because of the structural strength of the floors. The smaller lift truck also has greater maneuverability which is an important factor in utilizing maximum storage capacity in the cold storage rooms. Use of smaller lift trucks permits savings in aisle space, space around posts, and space adjacent to air ducts.

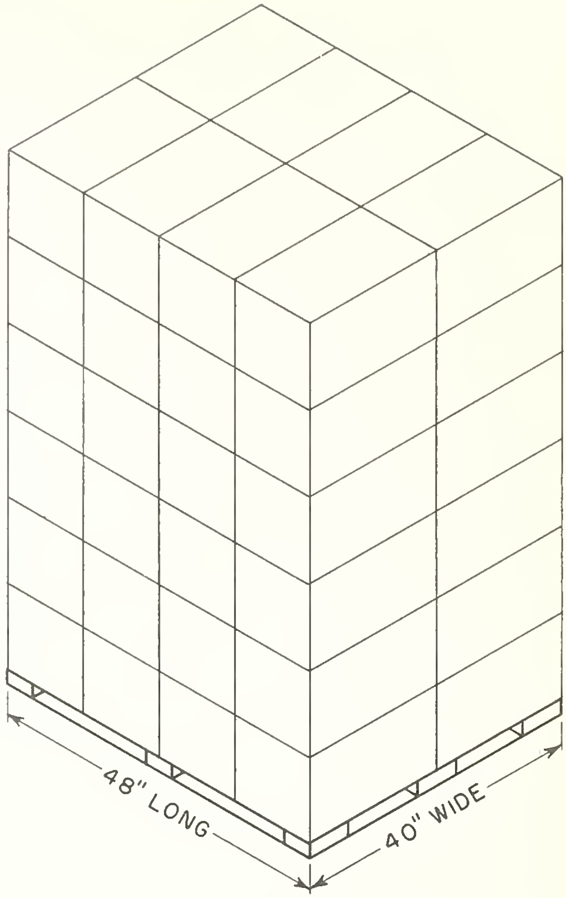

Figure 46.--48-box pallet load.

An important consideration in handling pallet loads is the different sides that a fork-lift truck can approach when the pallet is being picked up. Pallets are classified as 2-way and 4-way pallets, depending on whether the forks of the lift truck can enter from two sides or from all four sides of the pallet. Two-way pallets are more generally used in apple houses. When this type pallet is received on a road truck, the pallets must be placed across the bed of the truck so the fork-lift truck can remove the pallets from the side of the road truck (fig. 47).

When the 2-way pallet is used, each row of pallet loads across the bed of the truck must be tied with rope to the bed of the motortruck to

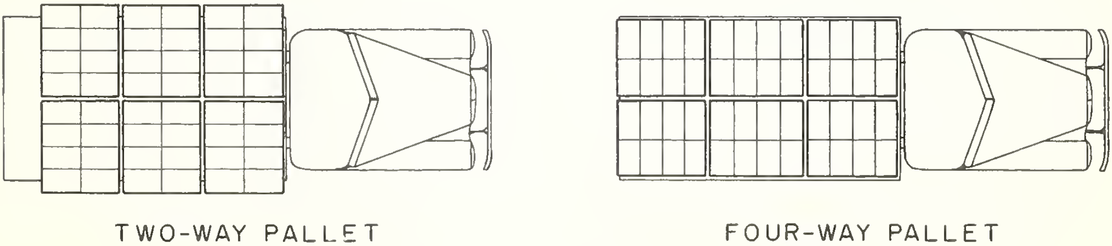

Figure 47.--The position of loaded pallets on a road truck.

prevent boxes from tipping off the pallets during their trip to the plant. These ropes are in addition to the two cables running the length of the truck bed.

Four-way pallets usually are of the 48-box size. When palletized loads are placed on road trucks, the pallets are placed lengthwise on the truck bed. Because the load is picked up from the side a "hold bar" is required during unloading operations to keep the stacked boxes from tipping off the 4-way pallet. 20/

Two cables running the length of the load hold the pallet loads in place during the trip from the orchard to the cold storage area.

Fruit is received at the plant by use of fork-lift trucks either palletized or unpalletized. When received, unpalletized boxes are placed on pallets after they arrive at the warehouse. When the palletized boxes of fruit arrive on road trucks, the fork-lift truck always removes the fruit from the sides of the truck, usually from the alternate sides. When unpalletized boxes are received on road trucks, which is rare, the fruit is placed on the pallets either on a receiving dock, or on the elevated forks of the lift truck while the first pallet load is being built, then on the road truck bed. When fruit is brought in on orchard trailers, loads either are unpalletized or only partially palletized, since trailers ordinarily carry fruit only three boxes high. The unit load, therefore, must be completed at the warehouse. When no part of the load is palletized, pallets are placed on the apron near the trailer and the boxes stacked one at a time onto the pallets.

At some plants when fruit is received on pallets the unit loads are lathed or tied. Laths are nailed the length of the unit load to prevent boxes from tipping off while handling the fruit (fig. 48). Other plants tie the load with heavy cord. When the unit loads are removed from the side of the road truck with the stacks across the forks, hold bars are placed on top of the boxes before the unit load is removed to the apron. There are a number of plants that neither lath nor tie the loads and reportedly handle pallet loads without difficulty. However, the boxes usually are newer and of more uniform construction.

For the purpose of analyzing methods of receiving apples by use of fork-lift trucks, total transportation distance is standardized at 100 feet, 48-box loads are the standard loads carried, and electric-powered equipment

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20/ A hold bar is a piece of iron pipe the length of a pallet load which has a metal plate the shape of a triangle or square welded to each end. The plates project over the sides of a pallet load and prevent the stacks from spreading.

is used. Analysis of labor and equipment requirements shows that there is little difference in the handling of the 36- or 48-box load other than those proportionately due to the size of the load. (See Appendix.) In addition, little variation in transportation time was found, there being only one instance in which a truck was found operating at a speed different than the standard. (In this instance, a gasoline truck was operating without a governor.)

It is assumed that fruit is tiered three pallet loads, or 18 boxes, high (fig. 49). The average times for tiering the three loads are consolidated in the tables. A breakdown of tiering times is shown in the Appendix.

When orchard trailers are used to haul fruit to a fork-lift truck pallet plant, boxes usually are not stacked on pallets until they arrive at the warehouse. In contrast when fruit is hauled on road trucks, it is placed on pallets at the orchard. When fork-lift truck and pallet handling was first introduced into apple houses, road trucks frequently hauled

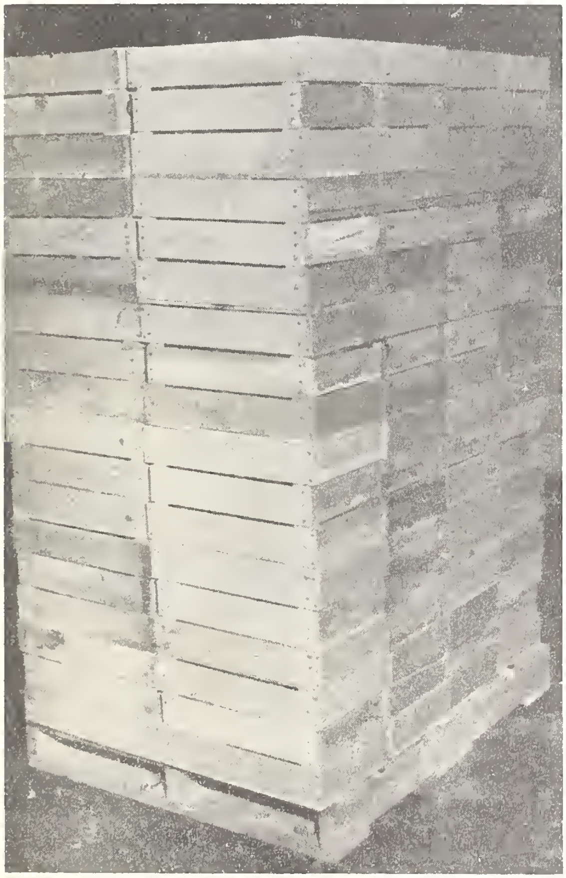

Figure 48.--A lathed pallet load of boxes.

Figure 49.--Placing the third tier on a stack in a pallet storage room.

unpalletized boxes of fruit to the warehouse. Although this practice is seldom followed now, a grower who brings his fruit to a fork-lift truck plant for the first time may bring in unpalletized loads.

Unloading from Road Trucks and Moving to Storage

Unpalletized loads.--After the road truck is backed up to the receiving platform, empty pallets are placed on the platform at the end of the truck. Boxes of fruit are stacked in unit loads on the pallets. The fork-lift truck operator removes these pallet loads as they are completed, leaving room for additional pallets. 21/ After the first two pallets have been removed the remainder of the pallets are placed on the road truck bed. Boxes of fruit are manually lifted and carried by the truck driver to the pallet. Thus, considerable effort is involved in building unit loads, especially on the last pallets.

This method of unloading road trucks to pallets at the warehouse required a total of 3.15 man-hours of labor to place 1,000 boxes on pallets, pick up, transport, and stack the pallet loads in storage by use of a fork-lift truck. Elapsed time required was 2.70 hours (table 48).

Table 48.--Labor required for a 2-man crew to unload and move 1,000 unpacked boxes of apples into storage from a road truck by use of pallets and fork-lift truck when boxes are received unpalletized

Operation	Workers	Productive labor	Fatigue allowance	Wait time	Total labor
	Number	Man-hours	Man-hours	Man-hours	Man-hours
Set up and clean up	1	0.12	0.0	0.0	0.12
Transfer boxes from road truck bed to 48-box pallets	1	2.15	.43	.0	2.58
Pick up 48-box pallet load by use of a fork-lift truck	1	.05	.0	.0	.05
Transport pallet load 100 feet	1	.29	.02	.0	.31
Release pallet load in cold storage room (average 1st, 2nd, and 3rd tier--18 boxes high)	1	.09	.0	.0	.09
Total man-hours	-	2.70	.45	1/ .0	3.15
Elapsed time--hours					2.70

1/ Although no wait time is shown, some wait time would occur by use of this method if the fork-lift truck and operator waited while pallet loads are built.

21/ It is possible that wait time would occur if the fork-lift truck operator should be busy when the pallet load is ready to be removed from the end of the road truck. Similarly, there could be considerable wait time on the part of the fork-lift truck driver if he stood by waiting for the worker to build the pallet load. On the studies taken there was an average of 0.40 man-hours of wait time per 1,000 boxes.

Palletized loads.--When boxes of apples are received palletized, the pallet loads are built on the road trucks at the temporary storage area in the orchard. On arrival at the warehouse, tie ropes and boards are removed from the road truck and the lift-truck operator unloads the fruit. In receiving loaded pallets from road trucks, two different methods are used. By use of one method all pallet loads are removed from the road truck and deposited on the receiving apron, thus freeing the road truck as promptly as possible for return to the orchard (fig. 50). Later, the fork-lift truck operator moves the unit loads into storage.

Figure 50.--Pallet loads of boxes resting on the receiving apron.

By use of the second method of receiving palletized loads, the lift truck operator removes pallet loads from the road truck one at a time and transports them directly to storage (fig. 51). Thus, when the road truck is ready to return to the orchard, all except the last unit load is already in storage.

Each method has its advantages and disadvantages. When pallet loads are unloaded to the apron one additional pickup and release is required of the fork-lift truck operator, thus using more of the lift truck operator's time (fig. 52). However, the time the road truck and its driver spend in unloading is reduced and the road truck is freed more promptly for return to the orchard. When the unit loads are moved directly into storage, the time of the fork-lift truck and its operator is conserved at the expense of the road truck driver.

Figure 51.--A fork truck removing a loaded pallet from a road truck preparatory to taking it directly to the storage area.

Figure 52.--A fork truck picking up a pallet load from the receiving apron.

As shown in table 49, when pallet loads are unloaded to the apron before they are transported the 100 feet into storage, a total of 0.96 of a man-hour is required to receive 1,000 boxes of apples. The largest part of the productive labor is used for transportation. When the fruit is unloaded and moved directly to storage, the fork-lift truck operator's time is reduced, but the road truck operator must stand by while pallet loads are transported to storage. If the road truck driver's time is included, the total man-hours are 0.24 greater, or 1.20 man-hours per 1,000 boxes.

The most significant comparison in the two methods is in the elapsed times for the two methods. The time the road truck is at the plant nearly

Table 49.--Comparative labor requirements for unloading and moving 1,000 unpacked boxes of apples into storage from road trucks by use of pallets and fork lift truck when specified methods are used for receiving palletized loads 1/

Operation	Unloading to apron, then to storage					Unloading and moving directly to storage				
	Workers	Productive labor	Fatigue allowance	Wait time	Total labor	Workers	Productive labor	Fatigue allowance	Wait time	Total labor
	Number	Man-hrs.	Man-hrs.	Man-hrs.	Man-hrs.	Number	Man-hrs.	Man-hrs.	Man-hrs.	Man-hrs.
Set up and clean up	1	0.13	0.0	0.19	0.32	2	0.13	0.0	0.47	0.60
Pick up a 48-box pallet load off the road truck bed by use of a fork lift truck	1	.07	.0	.0	.07	1	.07	.0	.13	.20
Transport pallet load 10 feet by use of a fork lift truck	1	.07	.01	.0	.08	-	-	-	-	-
Release pallet load on apron by use of fork lift truck	1	.04	.0	.0	.04	-	-	-	-	-
Pick up pallet load off the apron by use of fork lift truck	1	.05	.0	.0	.05	-	-	-	-	-
Transport pallet load 100 feet by use of fork lift truck	1	.29	.02	.0	.31	1	.29	.02	.0	.31
Release pallet load in the cold storage room (average 1st, 2nd and 3rd tier - 18 boxes high)	1	.09	.0	.0	.09	1	.09	.0	.0	.09
Total man-hours	-	0.74	0.03	0.19	0.96	-	0.58	0.02	0.60	1.20
Elapsed time -- hours					2/ 0.32					0.60

1/ The time of the road truck operator is included in this table during set up and clean up. Part of the time he is standing by waiting.
2/ Elapsed time to perform unloading and placing in storage is 0.77 hours per 1,000 boxes.

doubled when fruit is moved to storage directly from the road truck. However, during heavy receiving when road trucks are waiting and the apron is full of pallets, the elapsed time required to unload to the apron increases to 0.64 hour per 1,000 boxes, because pallet loads on the apron must be moved to storage before others can be deposited on it.

Comparison of receiving unpalletized and palletized loads.--On the basis of current wage rates, labor and equipment costs for unloading and moving 1,000 boxes of apples to storage were $4.05 when the fruit was unloaded from the truck and moved directly to storage, $3.95 when the fruit was unloaded to the apron and then to storage, and $5.64 when pallet loads were built at the plant (table 50). If a plant operator does not

Table 50.--Comparative labor and equipment costs of unloading and moving 1,000 unpacked boxes of apples into storage from road trucks by use of pallets and fork-lift trucks when 3 specified methods are used 1/

Method	Elapsed time	Labor and equipment required			Labor and equipment costs			
		Equipment time	Wait time	Total labor	Equipment	Labor 2/	Total costs: Current wages	Total costs: Assumed wages
	Hours	Machine-hours	Man-hours	Man-hours	Dollars	Dollars	Dollars	Dollars
Receiving unpalletized loads 1 worker stacks boxes on pallets, 1 fork-lift truck operator transports and stacks pallet loads	2.70	3/ 0.90	0.0	3.15	1.94	3.70	5.64	6.43
Receiving palletized loads to apron to storage using pallets and fork-lift truck	.32	4/ 1.28	.19	.96	2.75	1.20	3.95	4.19
Receiving palletized loads to storage using pallets and fork-lift truck	.60	5/ 1.20	.60	1.20	2.58	1.47	4.05	4.35

1/ The time of road truck operator during set up and clean up is included. Part of the time he is standing by, waiting.

2/ Computed from "current" wage rates.

3/ 4,000-pound capacity electric fork-lift truck and 20.8 pallets (48-box), 0.45 machine-hours each, total 0.90 machine-hours.

4/ 4,000-pound capacity electric fork-lift truck and 20.8 pallets (48-box), 0.64 machine-hours each, total 1.28 machine-hours.

5/ 4,000-pound capacity electric fork-lift truck and 20.8 pallets (48-box), 0.60 machine-hours each, total 1.20 machine-hours.

pay for the truck driver's time, it would be to his advantage to receive palletized loads directly to storage. From the grower's standpoint, it would be much more desirable to receive to the apron. The best practice appears to be to unload to the apron during slack receiving and to unload directly to storage during peak receiving or at times when the fork-lift trucks are rushed. The final decision as to which method would be the best during a slack period depends on whether it is desired to use the road trucks at the highest capacity. Sixty-six percent of the cost of receiving apples when truckloads were unpalletized was for labor.

Unloading from Orchard Trailers and Moving to Storage

Unpalletized loads.--Apples are more frequently received unpalletized on orchard trailers than on road trucks. Orchard trailers are seldom loaded more than 3 boxes high. Therefore, labor is required for building the 3-box-high pallet loads to 6 boxes high when the trailers are partially palletized. The trailer driver usually removes the fruit from the trailer by placing it on pallets after the load arrives at the warehouse.

When the loaded trailer arrives at the warehouse it is stopped at one of a number of different locations on the unloading apron. The tractor operator obtains empty pallets and places them around the trailer. 22/ (In practice he may only place one pallet at a time and build a unit load before he gets another empty pallet.) The tractor operator stands on the ground and removes the boxes from the edge of the trailer and places them on the pallets (fig. 53). After boxes on the pallet are built up to the height of the trailer bed, the worker then stands on the trailer bed, moves the boxes from the middle of the trailer with a swinging motion, and completes the unit loads (fig. 54).

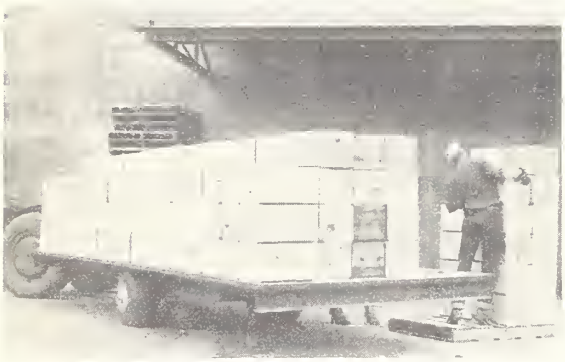

Figure 53.--Tractor driver stacks boxes from trailer to pallet.

Figure 54.--Boxes from the middle of the trailer are swung into place by the worker standing on the trailer.

The lift truck operator may move the pallet loads into storage as each load is completed, or he may perform other work until all of the unit loads have been completed and then place all of the unit loads into storage consecutively. As shown in table 51, this method of receiving fruit unpalletized on orchard trailers at the pallet plant required 2.48 man-hours per 1,000 boxes. None of this time was lost in waiting. 23/ Only a small

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22/ One operation was observed where the fork-lift truck operator trucked the empty pallets to the trailer and spread them.

23/ Some delays could occur on the part of the lift truck operator if he should stand by waiting for unit loads to be completed.

Table 51.--Labor required for a 2-man crew to unload and move 1,000 unpacked boxes of apples into storage from orchard trailer by use of pallets and fork-lift truck when boxes are received unpalletized

Operation	Workers	Productive labor	Fatigue allowance	Wait time	Total labor
	Number	Man-hours	Man-hours	Man-hours	Man-hours
Set up and clean up	1	0.24	0.0	0.0	0.24
Transfer boxes from orchard trailer to 48-box pallets	1	1.49	.30	.0	1.79
Pick up a 48-box pallet load with fork-lift truck	1	.05	.0	.0	.05
Transport pallet load 100 feet on fork-lift truck	1	.29	.02	.0	.31
Release pallet load in cold storage room (average 1st, 2nd, and 3rd tier—18 boxes high)	1	.09	.0	.0	.09
Total man-hours	-	2.16	.32	.0	2.48
Elapsed time—hours					1/ 2.03

1/ The elapsed time required to unload a 144-box trailer load is 18 minutes.

amount of time is required by the fork-lift truck operator--0.45 man-hour to handle 1,000 boxes. Most of this is used in transporting pallet loads. The elapsed time required for receiving by this method is 2.03 man-hours per 1,000 boxes.

Partially palletized loads.--Most pallet plants in Washington State receive road trucks at the warehouse with the boxes stacked into unit loads on pallets, which has proved to be the most efficient method of receiving. However, when fruit is hauled on trailers, the efficiency of palletizing in the orchard is not as readily apparent. Most orchard trailers now in use cannot haul fruit completely palletized, as trailer loads are stacked only 3 boxes high, but the unit load can be partly completed.

When boxes of fruit are partially palletized on orchard trailers, they are placed on the pallets between the tree rows, but the pallet loads are not completely built. Only half enough pallets are placed on the trailers to cover the surface of the bed, which permits enough unpalletized boxes to be hauled in so that the unit loads can be built from 3- to 6-boxes high after arrival at the warehouse (fig. 55). On arrival at the warehouse, the trailer operator drives onto the apron in a convenient location for unloading and completes the pallet load on the trailer. In some plants the partially palletized loads are lifted from the trailer bed by use of a fork-lift truck and deposited alongside the trailer bed, where the trailer operator completes building unit loads from the unpalletized boxes on the trailer. As shown in figure 56, pallet loads are then transported to storage by use of a fork-lift truck.

The total labor required to receive partially palletized boxes of apples is 1.56 man-hours per 1,000 boxes (table 52). Most of this labor

Figure 55.--A partially palletized trailer load of boxes.

is performed by the trailer operator to complete building the unit loads. By this method 1.11 hours elapsed time are required to receive 1,000 boxes.

Figure 56.--A fork truck transporting a loaded pallet into cold storage.

Table 52.--Labor required to unload and move 1,000 unpacked boxes of apples into storage from orchard trailers by use of pallets and fork-lift trucks when boxes are received partially palletized

Operation	Workers	Productive labor	Fatigue allowance	Wait time	Total labor
	Number	Man-hours	Man-hours	Man-hours	Man-hours
Set up and clean up	1	0.10	0.0	0.0	0.10
Transfer boxes from orchard trailer to 48-box pallets	1	.84	.17	.0	1.01
Pick up of pallet load by fork-lift truck	1	.05	.0	.0	.05
Transport pallet load 100 feet	1	.29	.02	.0	.31
Release unit load in cold storage room (average 1st, 2nd, and 3rd tier--18 boxes high)	1	.09	.0	.0	.09
Total man-hours	-	1.37	.19	.0	1.56
Elapsed time--hours					1.11

Completely palletized loads.--Completely loaded pallets are received from an orchard trailer at one plant in Washington State. This method involved the use of a special trailer which hauled fruit from the orchard with boxes in unit loads 5 boxes high. This trailer was constructed so that the trailer bed or frame was especially low (fig. 57). The spacing

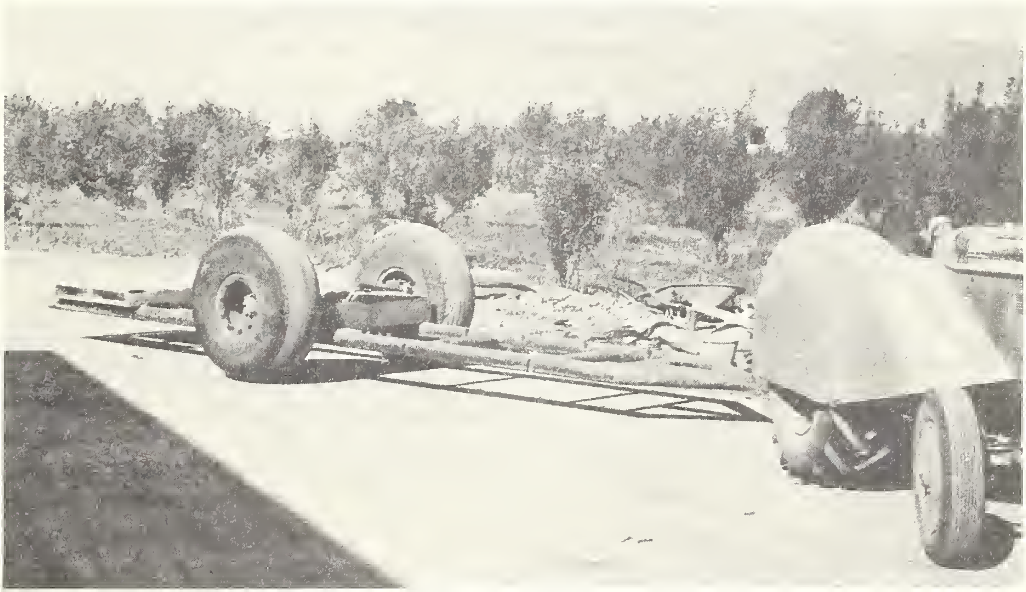


Figure 57.--The specially built pallet trailer.

between some of the tree rows and the terrain in the orchard must be favorable for a trailer of this type. In the orchard, between the tree rows, boxes are loaded onto pallets resting on the bed of the low trailer. The trailer is loaded from either side. Pallet loads are tied, to permit

Figure 58.--A pallet load being untied and another being removed from the special pallet trailer.

hauling to the warehouse. At the warehouse the fork-lift truck operator lifts the pallet loads directly from the trailer and moves them into storage (fig. 58).

By use of this method of receiving palletized boxes on an especially built trailer, only 1.22 man-hours per 1,000 boxes were required (table 53). The elapsed time required per 1,000 boxes was 0.61 hour. During the time the trailer was being unloaded, the driver stood by waiting, except for the brief period during which he prepared for unloading, and cleaned up afterward. 24/

Table 53.--Labor required to unload and move 1,000 unpacked boxes of apples into storage from orchard trailers by use of pallets and fork-lift truck in unit loads 5 boxes high (40 boxes) when boxes are received completely palletized

Operation	Workers	Productive labor	Fatigue allowance	Wait time	Total labor
	Number	Man-hours	Man-hours	Man-hours	Man-hours
Set up and clean up	1	0.23	0.0	0.38	0.61
Pick up 40-box pallet load off orchard trailer bed by use of fork-lift truck	1	.08	.0	.04	.12
Transport pallet load 100 feet to storage by use of fork-lift truck	1	.35	.03	.0	.38
Release pallet load in cold storage by use of fork-lift truck (average 1st, 2nd, and 3rd tier—15 boxes high)	1	.11	.0	.0	.11
Total man-hours	-	.77	.03	.42	1.22
Elapsed time--hours					.61

24/ This operation was observed at a plant owned by the growers. Sometimes the trailer driver engaged in some other activities during the unloading operation. In fact, with a slight addition in total time, the scale of their operations might have permitted the trailer driver to operate the fork-lift truck also and to move the fruit into storage.

Comparison of receiving unpalletized loads, partially palletized loads, and completely palletized loads.--The labor and machine costs of unloading apples at a pallet plant when fruit is received palletized or partially palletized on trailers show that receiving the fruit partially palletized can be done at less total expense, although it involves a slightly greater labor cost, than when the loads are completely palletized (table 54.) The extra cost of the trailer for handling the completely palletized trailer load raises the machine cost to a point where some advantage is offset. However, the elapsed time for unloading the completely palletized load is approximately one-half as great. This may have sufficient advantage to make it worthwhile where orchard conditions will permit using a special trailer.

Table 54.--Comparative labor and equipment costs of unloading and moving 1,000 unpacked boxes of apples into storage from orchard trailers by use of pallets and fork-lift truck when boxes are received unpalletized, partially palletized, and completely palletized 1/

Method	Elapsed time	Labor and equipment required: Equipment time	Wait time	Total labor	Labor and equipment costs: Equipment	Labor 2/	Total cost: Current wages	Assumed wages
	Hours	Machine-hours	Man-hours	Man-hours	Dollars	Dollars	Dollars	Dollars
Unpalletized--1 worker stacks boxes on pallets, 1 fork-lift truck operator transports and stacks unit loads	2.03	3/ 0.90	0.0	2.48	1.94	2.93	4.87	5.49
Partially palletized--part of the boxes are on a trailer stacked on pallets. At the warehouse the remainder of the boxes are stacked on the partially filled pallets and the loaded pallets moved into storage by fork-lift truck	1.11	3/ .90	.0	1.56	1.94	1.87	3.81	4.20
Completely palletized--a specially built trailer with pallet loads stacked 5 boxes high. Loads are untied at the plant and the fork-lift truck takes the pallet loads from the trailer into storage	.61	4/ 1.22	.42	1.22	2.62	1.49	4.11	4.42

1/ All methods involve the handling of 48-box pallet loads which are tiered 3 pallets, or 18 boxes, high, except when completely palletized loads are received. This method involves handling 40-box pallet loads (boxes are stacked 5 high rather than 6 high) and are tiered 3 pallets or 15 boxes high.

2/ Computed from "current" wage rates.

3/ 4,000-pound capacity electric fork-lift truck and 20.8 pallets (48-box) 0.45 machine-hours each, total 0.90 machine-hours.

4/ 4,000-pound capacity electric fork-lift truck and 20.8 pallets (48-box) 0.61 machine-hours each, total 1.22 machine-hours.

Industrial Clamp-Type Lift Trucks

The industrial clamp truck is similar to the industrial fork-lift truck except that the forks have been replaced by a pair of hydraulic arms. These arms extend to either side of the load and squeeze the stacks of boxes together so that they can be lifted and carried as a unit load. Industrial-clamp trucks used in Washington State apple houses at the time the study was conducted were of two sizes or capacities--1,000-pound trucks that handle a 24-box load, and 2,000-pound trucks that handle a 36-box load. Both the 1,000-pound and the 2,000-pound industrial-lift truck are powered by either gasoline or electricity. Both the gasoline and the electric power units were studied in the 1,000-pound size and no difference in the performance was observed. In the 2,000-pound size, only gasoline-powered trucks were studied, although one 2,000-pound electric clamp-type lift truck was used by one warehouse. The time required to handle boxes in 24-box and 36-box unit loads was found to be approximately the same per load. Thus, it requires two-thirds as much time to handle 1,000 boxes in 36-box units as in 24-box units.

The 1,000-pound capacity industrial-clamp truck, which handles a 24-box load of unpacked fruit, is lighter and more maneuverable than the larger industrial trucks (fig. 59). Because of its limited capacity and

Figure 59.--A 1,000-pound capacity industrial clamp-lift truck carrying a 24-box load.

the heavier weight of packed boxes, this truck can carry only 20 boxes of packed fruit. This truck can travel on floors that are not as heavily reinforced as the floors in the plants using the heavier truck. The lighter truck can maneuver more easily in storage rooms having a number of columns or posts. The 2,000-pound capacity truck carries 36 boxes of loose fruit per load or 30 boxes of packed fruit. It weighs approximately 40 percent more than the smaller truck and requires about a 20 percent larger area in which to maneuver (fig. 60).

Figure 60.--A 2,000-pound capacity industrial clamp-lift truck carrying a 36-box load.

By use of one method, the industrial-clamp truck can perform all receiving operations. By use of another method, it performs only part of the receiving work. When fruit is brought to the plant on trailers, the clamp truck is used to tier the 3-high stacks of boxes to unit loads 6 boxes high. This truck also is used to lift these unit loads off the trailer, or similar unit loads off a road truck bed if the truck bed has been stabilized, and transport them to storage. In the cold storage rooms, the truck releases the first tier or elevates the second tier, and in connection with the latter, performs all of the functions of a manual high-piling crew. The usual practice in stacking the second tier on the first tier is to place divider boards on top of the first tier in order to build a more stable base. These boards also prevent the second tier stacks from spreading.

Two types of dividers are used in industrial-clamp truck plants. One type consists of a sheet of plywood having the same dimensions as the top of the unit load (fig. 61). The other type consists of three wood slats placed between the tiers and on the box edges (fig. 62). The latter type is more economical, since scrap lumber can be used.

Figure 61.--Plywood divider to place between tiers.

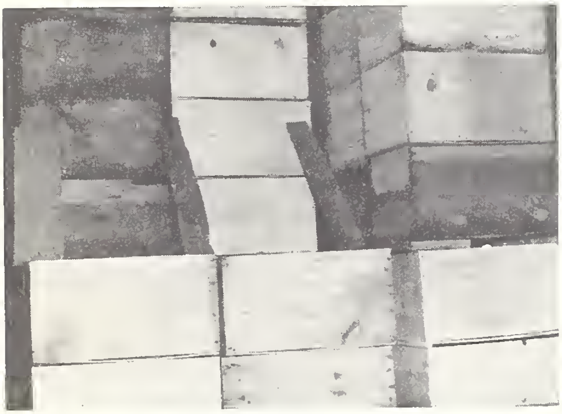


Figure 62.--Wood slats used as divider between tiers.

One plant uses a box grip instead of dividers. This grip was a metal plate, 3- by 1-3/4-inches, with four fingers extending from it, one from each corner. It is used on 24-box loads at the junction of the top four boxes, one finger grabbing the corner of each box.

With one exception, a standard transportation distance of 100 feet into storage is used in analyzing and comparing methods. The exception is when the industrial-clamp truck is used in combination with 2-wheel hand trucks for receiving. The industrial-clamp truck is assumed to transport 80 feet into cold storage and the hand trucks transport 30 feet from the road truck bed to a temporary bank. It is also assumed that all divider boards (scrap lumber) are placed between the first and second tiers by the industrial-clamp truck operator.

Cost data for the 24-box industrial-clamp truck are based on the ownership and operation of electric-powered machines. Costs of the 36-box industrial-clamp truck are based on gasoline-operated machines.

Unloading and Moving to Storage

There are two methods of receiving fruit at the plants using industrial-clamp trucks. One method involves the use of a clamp-type 2-wheel hand truck to unload the fruit from the road truck to the receiving platform, after which unit loads are picked up by the industrial truck and moved into cold storage. The other method is to stabilize road truck beds and have the industrial clamp truck roll directly on the bed of the road truck to pick up unit loads and move them to storage.

Industrial clamp-type trucks and clamp-type 2-wheel hand trucks.--The most widely used method of unloading apples and moving them into storage in industrial-clamp-truck plants is to back the road truck up to the receiving platform and remove the fruit from the truck bed by use of 2-wheel hand trucks. The hand truck operators release the fruit in blocks on the receiving platform where the industrial-clamp truck operator picks up 24-box unit loads, squeezing them close together with the clamping arms, and transports them to storage (figs. 63 and 64). The reason for using

Figure 63.--A hand trucker wheeling stacks to the platform where an industrial-clamp truck picks up a unit load and takes it into storage.

hand trucks to remove fruit from the road truck is that the weight of the industrial truck springs the road truck bed down as it rolls out onto it. Since the road truck bed is then several inches below the platform height,

Figure 64.--Stacking a unit load in storage with an industrial clamp-type lift truck.

the loaded industrial truck cannot move off the road truck bed to the platform.

By use of this method, one worker hand trucks boxes of apples from the road truck to the platform and one worker operates the industrial truck. A total of 2.86 man-hours of labor is required to receive 1,000 boxes of apples, in an elapsed time of 1.43 hours (table 55). Thus, a road truck (288 boxes) can be unloaded in 25 minutes. Half of the time required to move the fruit into storage is used in hand trucking the stacks onto the receiving platform. The small amount of wait time is due to the industrial truck operator waiting for unit loads to be made up by the hand trucker.

Table 55.--Labor required to unload and move 1,000 unpacked boxes of apples into storage from a road truck by use of clamp-type 2-wheel hand truck and 24-box capacity industrial clamp-type lift truck

Operation	Workers	Productive labor	Fatigue allowance	Wait time	Total labor
	Number	Man-hours	Man-hours	Man-hours	Man-hours
Set up and clean up	2	0.12	0.0	0.0	0.12
Pick up 6-high stacks on road truck bed by use of 2-wheel hand trucks	1	.39	.04	.0	.43
Transport stacks 30 feet by use of 2-wheel hand trucks	1	.62	.06	.0	.68
Release stacks from 2-wheel hand trucks on receiving platform	1	.24	.02	.0	.26
Pick up 24-box unit load by use of industrial clamp-type trucks	1	.16	.0	.21	.37
Transport unit load 80 feet by use of clamp-type lift trucks	1	.48	.06	.0	.54
Release unit load by use of clamp-type lift trucks (average 1st and 2nd tier--12 boxes high)	1	.39	.0	.0	.39
Place boards between 1st and 2nd tier	1	.07	.0	.0	.07
Total man-hours	-	2.47	.18	.21	2.86
Elapsed time--hours					1/ 1.43

1/ The 24-box industrial clamp-type lift truck and 2-wheel hand truck can receive 18-road truckloads of 288 boxes each during an 8-hour day.

Industrial clamp-type truck and truck bed stabilizer.--At a processing plant, research workers found a method of receiving in which the industrial-clamp truck rolled directly from the platform onto the road truck bed to pick up unit loads. This method involved the use of a hydraulic stabilizer which lifted the road truck bed up to the height of the receiving platform and held it at that height, thus preventing the truck bed from springing up and down. This method was tried for receiving apples and observations were made of the performance of industrial trucks at an apple packing and storage plant. By use of this method, the road truck backed into a depression in front of the receiving platform. A hydraulic lift of the type shown in figure 65, elevates the loaded road truck bed off the truck springs and holds it firmly underneath a metal plate projecting from the edge of the receiving platform. The truck operator drives the industrial truck onto the road truck bed to pick up unit loads (fig. 66). Unit loads are transported directly from the road truck to storage.

This operation proceeded with considerable dispatch--requiring 1.28 man-hours elapsed unloading time per 1,000 boxes or 22 minutes per truckload. Total labor requirements were 2.56 man-hours (table 56).

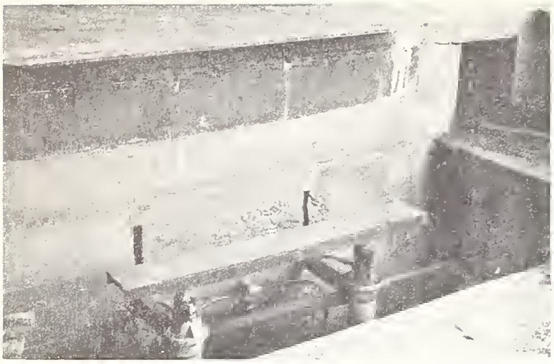


Figure 65.--The hydraulic stabilizer works by forcing the bed of a road truck up against a metal plate projecting from the receiving platform.

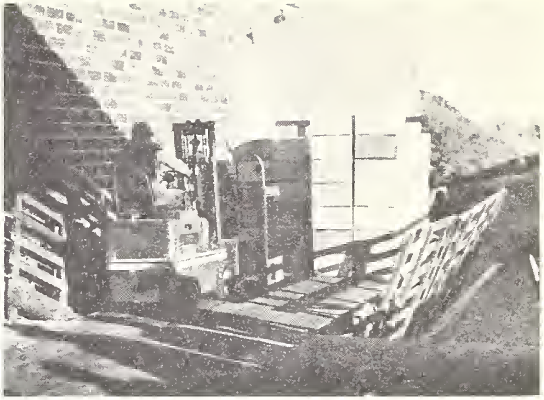


Figure 66.--The industrial clamp truck rolling onto a truck bed to pick up a unit load. After picking up a load, it backs off the truck bed and transports the load into storage.

Nearly half of this labor is wait time which occurs because the road truck operator stands by except for the time spent in setup and cleanup. 25/ Nearly half of the industrial-clamp-truck operator's time is used for transporting loads from the road truck to storage. A large part of the industrial-clamp-truck operator's time also is spent tiering. Placing the stabilizer boards on top of the

Table 56.--Labor required to unload and move 1,000 unpacked boxes of apples into storage from a road truck by use of 24-box capacity industrial clamp-type lift truck and a hydraulic stabilizer unit

Operation	Workers	Productive labor	Fatigue allowance	Wait time	Total labor
	Number	Man-hours	Man-hours	Man-hours	Man-hours
Set up and clean up	1	0.15	0.0	1.13	1.28
Pick up 24-box loads off road truck bed by use of industrial clamp truck	1	.11	.0	.09	.20
Transport 24-box unit load 100 feet by use of industrial truck	1	.56	.06	.0	.62
Release in cold storage by use of industrial truck (average 1st and 2nd tier--12 boxes high)	1	.39	.0	.0	.39
Place boards between first and second tier	1	.07	.0	.0	.07
Total man-hours	-	1.28	.06	1.22	2.56
Elapsed time--hours					1/ 1.28

1/ The industrial clamp-type lift truck used with a hydraulic stabilizer unit can receive 20 road truckloads of 288 boxes each during an 8-hour day.

25/ Some plants do not require the road truck operator to do productive work while the truck is unloaded so that some allowance for this time could justifiably be made.

first tier and releasing in a cold storage room with numerous posts and air ducts accounts for the relatively large percentage of time devoted to these operations.

Comparison of methods.--Labor and equipment costs of unloading road trucks by these methods show that the costs by hand truck and industrial-clamp-truck methods are less than the costs when the truck bed stabilizer is used--$5.72 per 1,000 boxes compared with $6.27 (table 57). The costs of the latter method are affected largely by extra machine costs. 26/ The older method, however, has a disadvantage of requiring a longer time to unload road trucks. Although the "stabilizer" method costs more, it results in the fruit having one less handling and it should be noted that the road truck operator is standing by most of the time.

Table 57.--Comparative labor and equipment costs of unloading and moving 1,000 unpacked boxes of apples into storage from road trucks by use of clamp-type 2-wheel hand truck in combination with 24-box capacity electric industrial clamp-type lift truck and by use of hydraulic stabilizing unit in combination with 24-box industrial clamp-type lift truck

Method	Elapsed time	Labor and equipment required: Equipment time	Labor and equipment required: Wait time	Labor and equipment required: Total labor	Labor and equipment costs: Equipment	Labor and equipment costs: Labor 1/	Total cost: Current wages	Total cost: Assumed wages
	Hours	Machine-hours	Man-hours	Man-hours	Dollars	Dollars	Dollars	Dollars
One worker hand trucks from road truck 30 feet. Clamp-type lift truck moves fruit 60 feet to storage	1.43	2/ 4.29	0.21	2.86	2.22	3.50	5.72	6.44
One worker and clamp-type lift truck transport 100 feet from road truck bed, stabilized by use of hydraulic unit, to storage	1.28	3/ 3.84	1.22	2.56	3.14	3.13	6.27	6.91

1/ Computed from "current" wage rates.
2/ Clamp-type 2-wheel hand truck, 1,000-pound capacity electric industrial clamp-type lift truck, and 41.6 board-feet of dunnage 1.43 machine-hours each, total 4.29 machine-hours.
3/ Clamp-type 2-wheel hand truck, 1,000-pound capacity electric industrial clamp-type lift truck, and 41.6 board-feet of dunnage 1.28 machine-hours each, total 3.84 machine-hours.

Unloading from Orchard Trailers and Moving to Storage

From conventionally loaded trailer.--When orchard trailers are loaded in conventional manner, that is, with no spacing between stacks, and

26/ The cost of the hydraulic stabilizer amounts to $0.92 per hour of use. Also, the road truck driver is idle except for setup and cleanup but his idle time is charged to the improved method.

moved to the warehouse, the boxes must be built into 6-high unit loads consisting of 36 boxes of unpacked fruit. This work is done by the tractor operator after the trailer has been parked on the receiving apron. These unit loads are moved by the industrial-clamp truck from the trailer bed 100 feet to storage where the boxes are tiered.

The total labor required to receive 1,000 boxes of apples by use of this method is 1.92 man-hours (table 58). An elapsed time of 1.26 hours, or 11 minutes per 144-box trailer load is required. Over half of the total labor, 1.16 man-hours, is required to build the boxes from 3-high to 6-high stacks.

Table 58.--Comparative labor requirements for unloading and moving 1,000 unpacked boxes of apples into storage by use of 36-box capacity clamp-type industrial lift truck when orchard trailers are loaded in specified arrangements

Operation	Conventionally loaded trailers					Specially loaded trailers				
	Workers	Productive labor	Fatigue allowance	Wait time	Total labor	Workers	Productive labor	Fatigue allowance	Wait time	Total labor
	Number	Man-hrs.	Man-hrs.	Man-hrs.	Man-hrs.	Number	Man-hrs.	Man-hrs.	Man-hrs.	Man-hrs.
Set up and clean up	1	0.10	0.0	0.0	0.10	1	0.10	0.0	0.93	1.03
Manually build 6-high stacks from 3-high stacks on trailer bed	1	.97	.19	.0	1.16	-	-	-	-	-
Clamp-type lift truck builds 6-high stacks from 3-high stacks on trailer bed	-	-	-	-	-	1	.35	.02	.0	.37
Pick up 36-box unit load by use of clamp-type lift truck	1	.12	.0	.0	.12	1	.12	.0	.0	.12
Transport unit load 100 feet by use of clamp-type lift truck	1	.40	.03	.0	.43	1	.40	.03	.0	.43
Release unit load with a clamp-type lift truck (average 1st and 2nd tiers - 12 boxes high)	1	.11	.0	.0	.11	1	.11	.0	.0	.11
Total man-hours	-	1.70	0.22	0.0	1.92	-	1.08	0.05	0.93	2.06
Elapsed time -- hours					1.26					1.03

From specially loaded trailer.--The industrial-clamp truck appears to be particularly efficient for receiving fruit if a relatively large volume of receipts arrive on orchard trailers, because this type truck can be used to tier boxes from 3 high to 6 high on the trailer bed.

When the fruit is to be tiered by an industrial-clamp truck, the trailer is loaded with sufficient space between unit blocks for the clamping arms of the lift truck to be inserted. Thus, the industrial-clamp truck can efficiently double tier the 3-high blocks, depending on the trailer dimensions and whether or not it has boxes built for wheel housings. Some of the larger trailers have boxes in the middle of the trailer bed beyond the reach of the industrial-clamp truck arms. 27/ These boxes must

27/ This occurs most often with a 24-box industrial-clamp truck because the arms are only 24 inches long while the 36-box clamp-lift truck has 36-inch arms.

be lifted to one side and built into unit loads by hand. Figures 67 to 72, inclusive, show, in sequence, the operations involved in unloading 36-box unit loads from specially loaded trailers by use of an industrial-clamp truck.

Some growers find it inconvenient to space the stacks in their trailer loads which may be due to the dimensions of the trailer. The dimensions of some trailers do not permit extra space between stacks without reducing the number of boxes that can be hauled per load. Also, there is the problem of maintaining this space while the trailer is in transit. At the plants studied, 3-high stacks rode fairly well on the trailer when separated into unit loads. However, there was a little less stability. One grower developed a small metal clip bent into a "U" which was inserted over the ends of boxes in the unit load to hold them in place until they arrived at the warehouse.

As shown in table 58, when the clamp-type lift truck builds the unit loads, 2.06 man-hours are required per 1,000 boxes which is a 7 percent increase above the requirements for the other method. However, the elapsed time is reduced to 1.03 man-hours per 1,000 boxes and there is no manual labor. The total labor required to unload the trailer would be reduced considerably if it did not include 0.93 man-hour per 1,000 boxes spent by the trailer driver standing by during the unloading operation.

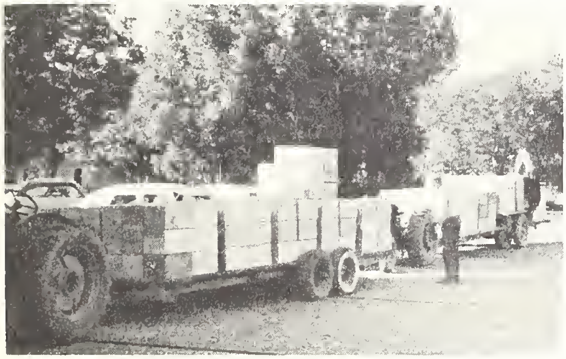


Figure 67.--Field trailers waiting at the warehouse to unload.

Figure 68.--Boxes are stacked from 3 high to 6 high on the trailer bed.

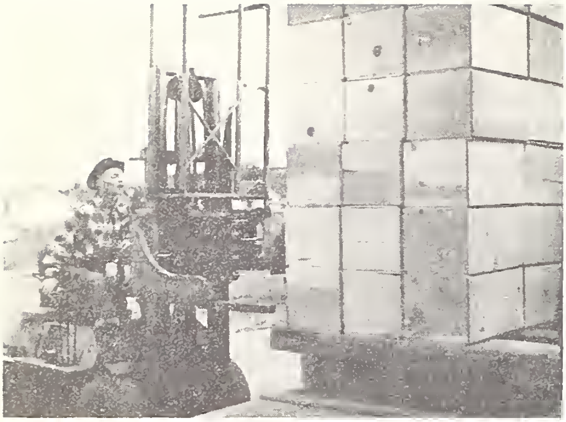


Figure 69.--The 36-box unit load in 6-high stacks is ready to be removed from the trailer.

Figure 70.--The 36-box unit load is picked up by industrial truck.

Figure 71.--The industrial clamp truck removes 36-box unit load from the trailer bed.

Figure 72.--The load is off the trailer bed and on its way to storage without manual handling.

Comparison of methods.--The labor and equipment costs of unloading and moving 1,000 boxes of apples to storage from trailers by use of industrial-clamp trucks are $3.58 when the boxes are stacked 6 high by hand (table 59). This is $0.93 less than when the industrial-clamp truck does the tiering. The total cost of the latter method is higher because the industrial-clamp truck was used 0.37 of an hour more, and because the trailer driver is idle and his time is included in the labor cost. The method in which the lift truck builds 6-high stacks reduces the elapsed time to unload a trailer, and by eliminating the manual stacking, which is relatively strenuous, does not require that regular orchard labor be used for driving the trailer to the warehouse. When the unit loads are built manually at the storage, the fruit as a whole is handled more roughly than when only one-half of the boxes are lifted and stacked into place one at a time.

Table 59.--Comparative labor and equipment costs of unloading and moving 1,000 unpacked boxes of apples into storage from orchard trailers using 36-box capacity gasoline clamp-type industrial truck when orchard trailers are loaded in specified arrangements

Method	Elapsed time	Labor and equipment required			Labor and equipment costs			
		Equipment time	Wait time	Total labor	Equipment	Labor 1/	Total cost: Current wages	Total cost: Assumed wages
	Hours	Machine-hours	Man-hours	Man-hours	Dollars	Dollars	Dollars	Dollars
Conventionally-loaded trailer clamp-type lift truck and 1 man stacking boxes from 3-high into 6-high stacks, 36-box unit loads stacked 2 loads or 12 boxes high	1.26	2/ 1.32	0.0	1.92	1.27	2.31	3.58	4.06
Specially-loaded trailer clamp-type lift truck stacking and moving the fruit, 36-box unit loads stacked 2 loads or 12 boxes high	1.03	3/ 2.06	.93	2.06	1.99	2.52	4.51	5.03

1/ Computed from "current" wage rates.

2/ 2,000-pound gasoline industrial clamp-type lift truck and 41.6 board-feet of dunnage 0.66 machine-hours, total 1.32 machine-hours.

3/ 2,000-pound gasoline industrial clamp-type lift truck and 41.6 board-feet of dunnage 1.03 machine-hours, total 2.06 machine-hours.

The costs of receiving fruit by use of industrial-clamp trucks from orchard trailers is not greatly different from those of receiving from road trucks. Because the elapsed time in unloading a road truck is roughly the same as the elapsed time in unloading an equivalent number of boxes from an orchard trailer, the relative advantage of either vehicle over the other lies in the costs of loading in the orchard and in the distance from the orchard to the warehouse.

Comparisons of Selected Methods and Types of Equipment for Receiving from Road Trucks

Comparative Labor and Equipment Costs

Table 60 shows the comparative labor and equipment costs, normally borne by the plants, of receiving 1,000 boxes of unpacked apples by use of the seven different basic types and combinations of types of equipment previously discussed. The costs of at least two different methods are shown for each equipment category. For the equipment types, other than industrial trucks, the methods for which cost data are shown present comparisons of manual and mechanical high-piling. For these equipment types, the methods selected for comparative purposes are not in all cases the most efficient methods, in terms of costs, either before or after mechanical high-piling is substituted for manual high-piling. The methods selected are those most generally used in Washington State plants based on: (1) Costs of performing operations, (2) rates of receiving, and (3) availability of equipment. As an illustration, the lowest cost method of using

Table 60.--Comparative labor and equipment costs for unloading from road trucks and moving to storage 1,000 unpacked boxes of apples by use of specified methods and types of equipment 1/

Type of equipment and method	Workers	Equipment cost 2/	Labor cost--current wage rates 3/	Total cost--current wage rates	Total cost--assumed wage rates 4/
	Number	Dollars	Dollars	Dollars	Dollars
Clamp-type 2-wheel hand trucks: 3 workers hand-truck 6-high stacks 100 feet from road truck and release in storage:					
1. 4 workers manually high-pile 12-box high stacks	7	0.07	8.43	8.50	10.33
2. 1 worker and mechanical lift high-pile 12-box high stacks 5/	4	.70	4.82	5.52	6.57
Belt conveyors and clamp-type 2-wheel hand trucks: 2 workers on road truck place boxes on conveyor, 2 workers remove boxes from conveyor and build 6-high stacks, 2 workers hand-truck 50 feet and release in storage:					
1. 4 workers manually high-pile 12-boxes high	10	.92	11.62	12.54	15.06
2. 1 worker and mechanical lift high-pile 12-box high stacks 5/	7	1.53	8.13	9.66	11.43
Floor chain conveyors and clamp-type 2-wheel hand trucks: 2 workers hand truck 6-high stacks of boxes 20 feet from road truck, release on conveyor, and 2 workers hand-truck 30 feet from conveyor and release in storage:					
1. 4 workers manually high-pile 12-box high stacks	8	1.10	8.05	9.15	10.90
2. 1 worker and mechanical lift high-pile 12-box high stacks	5	1.94	6.04	7.98	9.29
Belt conveyors, stackmaker, floor chain conveyor, and clamp-type 2-wheel hand trucks: 2 workers on road truck place boxes on belt conveyor, stackmaker builds 6-high stacks and releasesupon floor chain conveyor, 2 workers hand-truck 50 feet and release in storage:					
1. 4 workers manually high-pile 12-box high stacks	8	3.46	10.30	13.76	16.00
2. 1 worker and mechanical lift high-pile 12-box high stacks 5/	5	4.12	6.44	10.56	11.96
Elevators and clamp-type 2-wheel hand trucks: 6/ 2 workers hand-truck 6-high stacks 30 feet from road truck to temporary bank; 3 workers hand-truck 30 feet from bank into single elevator, ride elevator, and hand-truck 30 feet from elevator to temporary bank on storage floor; 2 workers hand-truck 60 feet and release in storage:					
1. 2 workers manually high-pile 12-box high stacks	9	5.00	13.71	18.71	21.69
2. 1 worker and mechanical lift high-pile 12-box high stacks 5/	8	4.92	11.41	16.33	18.81
Industrial fork-lift trucks and pallets:					
Unpalletized loads; 1 worker builds 48-box pallet loads on road truck:					
1. 1 worker and fork-lift truck transports pallet loads 100 feet, stacks 3-high (18 boxes)	2	1.94	3.70	5.64	6.43
Palletized loads: 48-box pallet loads made up in orchards:					
1. 1 worker and fork-lift truck transports 48-box pallet loads 100 feet from road truck directly to storage, stacks pallet loads 3-high (18 boxes), 1 worker mostly waits	2	2.58	1.47	4.05	4.35
2. 1 worker and fork-lift truck unloads 48-box pallets to apron (transports 10 feet) later transports 100 feet to apron to storage and stacks pallet loads 3-high (18 boxes), 1 worker mostly waits 7/	2	2.75	1.20	3.95	4.19
Industrial clamp-type lift trucks: (24 box capacity--unpacked fruit)					
1. 1 worker hand-trucks 6-high stacks 30 feet from road truck bed to platform, 1 worker and industrial clamp truck transports 24-box unit load 80 feet to storage and stacks 2-high (12 boxes) 8/	2	2.22	3.50	5.72	6.44
2. Road truck bed stabilized by use of hydraulic unit, 1 worker and industrial clamp truck transports 24-box unit load 100 feet from road truck bed to storage and stacks 2-high (12 boxes), 1 worker mostly waits	2	3.14	3.13	6.27	6.91

1/ Except as otherwise noted, all transportation distances are standardized at 100 feet. By use of conveyor methods, conveyor accounts for 50 feet of transportation distance.
2/ Equipment costs computed from data on ownership and operating costs shown in table 2.
3/ "Current" labor costs computed from wage rates of $1.15 per hour for unskilled labor and $1.30 per hour for semiskilled workers (key workers such as industrial truck operators).
4/ Assumed labor costs computed from wage rates of $1.40 per hour for unskilled labor and $1.55 per hour for semiskilled workers.
5/ Cost data for mechanical high-piling covers use of one 2-stack portable lift.
6/ Standardized transportation distance of 100 feet increased to 150 feet because of necessity for hand trucking into and out of two temporary banks of supply. Vertical transportation distance is not included.
7/ Ten feet additional transportation distance is necessary to move pallet loads 100 feet because of unloading to apron.
8/ Ten feet additional transportation distance is necessary to move boxes 100 feet because of unloading to platform by use of hand truck.

floor chain conveyors and clamp-type 2-wheel hand trucks involves the use of one worker for unloading, transporting (other than transportation on conveyors), and releasing 6-high stacks in storage, and one worker for mechanically high-piling boxes. However, the rate of receiving is relatively low and the method is not used except during slack receiving periods. A comparison of receiving rates is shown in the next section.

The highest cost method involves the use of elevators and hand trucks. Labor and equipment costs per 1,000 boxes, when boxes are manually high-piled 12 boxes high, are $18.71. These costs are reduced to $16.33 per 1,000 boxes when mechanical high-piling is substituted for the manual method. Obviously the use of the elevator-hand-truck method is applicable only to operations in multistory plants.

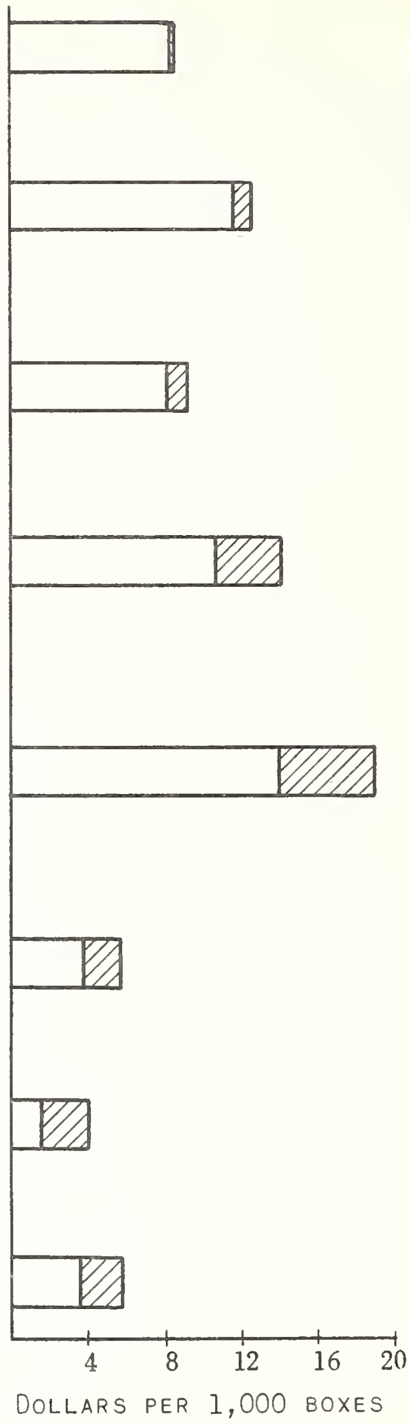
Of the older and more conventional types of equipment, the clamp-type 2-wheel hand truck used alone appears to be the most economical with labor and equipment costs of $8.50 per 1,000 boxes when boxes are manually high-piled 12 boxes high, and $5.52 per 1,000 boxes when mechanically high-piled to the same height. Some of the reasons for these relatively low costs follow: (1) Equipment costs are low; (2) except for high-piling manually, boxes are handled in unit loads consisting of 6-high stacks; (3) each worker in a crew works independently of other members and wait time is minimized; and (4) no movement of boxes between floors is involved. Obviously this method is applicable only in single story plants.

The lowest costs of all equipment types are incurred by use of industrial fork-lift trucks and pallets when boxes are received palletized. Total labor and equipment costs are $3.95 per 1,000 boxes when boxes are received in 48-box pallet loads, are unloaded to the apron and later transported to storage, and stacked 3 pallets high (18 boxes). When unloaded and moved directly to storage, these costs were $4.05 per 1,000 boxes.

With the exception of methods of receiving palletized loads by use of industrial fork-lift trucks, labor costs account for the larger part of the receiving costs. Equipment costs per 1,000 boxes of fruit ranged from $0.07 by use of hand trucks alone to $5.00 by use of elevators and hand trucks. For selected methods, labor costs and machine costs are presented graphically in figure 73.

In connection with each of the categories of equipment, except one, shown in table 60, the second described "improved" handling method proved less costly than the first described method. The single exception occurs where industrial-clamp trucks and hydraulic stabilizers are used. Costs were slightly higher with the stabilizer because of increased equipment costs, and the labor cost of the road truck driver who stood by while the trucks were being unloaded. However, the elapsed time required to unload was reduced three minutes per truckload.

EQUIPMENT AND METHOD	CREW SIZE
Clamp-Type 2-Wheel Hand Truck: 3 men hand truck 100 ft. to storage, 4 men high-pile.	7
Belt Conveyor and Hand Truck: 2 men place boxes on conveyor, 2 men transfer boxes from conveyor, 2 men hand truck 50 ft., 4 men high-pile.	10
Floor Chain Conveyor and Hand Truck: 2 men hand truck 20 ft. to chain, 2 men hand truck 30 ft. from chain, 4 men high-pile.	8
Belt Conveyor, Stackmaker, Floor Chain Conveyor and Hand Truck: 2 men place boxes on conveyor, 2 men hand truck 50 ft., 4 men high-pile.	8
Elevator and Hand Truck: 2 men hand truck 30 ft. to bank, 3 men hand truck 30 ft. from bank to elevator, ride elevator and hand truck 30 ft. from bank, 2 men hand truck 50 ft. to storage, 2 men high-pile.	9
Industrial Fork-Lift Truck, Unpalletized: 1 man builds pallet loads, fork-lift truck transports 100 ft. to storage.	2
Industrial Fork-Lift Truck, Palletized: Fork-lift truck transports 100 ft. to storage, 1 road-truck driver waits.	2
Industrial Clamp-Type Lift Truck and Hand Truck: 1 man hand trucks 30 ft. to bank, 1 industrial clamp truck transports 100 ft. to storage.	2



LABOR COST ▭▨ EQUIPMENT COST

Figure 73.--Labor and equipment costs, per 1,000 unpacked boxes of apples, for receiving from road trucks and high-piling or tiering by use of specified methods and types of equipment.

Improved methods (second method in each case) reduced labor costs of receiving fruit in all cases. This is a highly desirable objective, since the increasing scarcity of labor and rising wage rates emphasize the need for using labor more economically. The lowest labor cost per 1,000 boxes is $1.20. Even in the conventional plants, the labor saving by improved methods is large, amounting to as much as $3.61 per 1,000 boxes (43 percent) in hand truck operated plants. Improved methods in most cases reduced the amount of wait time, thus using labor more economically by keeping workers more fully occupied.

As shown in figure 74, except for the "improved method" of receiving by use of industrial-clamp trucks, reductions in the cost of receiving by the second method shown ranged from $0.10 to $3.26 per 1,000 boxes. In the "conventionally equipped" plants, savings ranged from $1.17 to $3.26 per 1,000 boxes. These savings resulted from the use of the mechanical high-piler in lieu of manual high-piling. This improvement should save over $500 annually in a medium-sized, conventionally equipped plant without modification of the facilities.

One of the important advantages in connection with the improved methods is the reduction of the number of workers in the receiving crew. The advantages of a smaller receiving crew are obvious when it is difficult to recruit and supervise workers during the harvest peak.

Comparative Rates of Receiving

One of the criteria for indicating the desirability of different types of equipment for receiving from road trucks is the elapsed time required to receive. One method of receiving by use of industrial fork-lift trucks when the fruit must be palletized at the warehouse requires more elapsed time to unload than any other method (fig. 75). However, when the fruit arrived at the warehouse palletized, the industrial fork-lift truck required the shortest elapsed time--only 10 minutes per truckload. By use of floor chain conveyors and 2-wheel hand trucks, a road truckload could be received in 15 minutes. The methods of receiving with the more conventional types of equipment require less elapsed time than the method of receiving unpalletized truckloads by use of fork-lift trucks and also less than the method of receiving with an industrial-clamp truck when fruit must be hand trucked to the platform. However, increasing the size of the hand trucking crew when the industrial-clamp truck is used would decrease the elapsed time. Figure 76 shows the elapsed times required with the various combinations of equipment after the methods were improved.

The number of boxes of apples that can be received per receiving crew during an 8-hour day, allowing two 15-minute rest periods, varies considerably with the different equipment and methods. The volumes range from 2,300 boxes in a fork-lift truck plant receiving fruit unpalletized to 8,600 boxes in a fork-lift truck plant receiving fruit palletized (fig. 77). The more conventional methods of receiving are somewhat

EQUIPMENT AND METHOD

<u>Clamp-Type 2-Wheel Hand Truck</u>: 3 men hand truck 100 ft., 4 men high-pile. Improved Method - 1 mechanical high-piler.

<u>Belt Conveyor and Hand Truck</u>: 2 men place boxes on conveyor, 2 men transfer boxes from conveyor, 2 men hand truck 50 ft., 4 men high-pile. Improved Method - 1 mechanical high-piler.

<u>Floor Chain Conveyor and Hand Truck</u>: 2 men hand truck 20 ft. to chain, 2 men hand truck 30 ft. from chain, 4 men high-pile. Improved Method - 1 mechanical high-piler.

<u>Belt Conveyor, Stackmaker, Floor Chain Conveyor and Hand Truck</u>: 2 men place boxes on conveyor, 2 men hand truck 50 ft., 4 men high-pile. Improved Method - 1 mechanical high-piler.

<u>Elevator and Hand Truck</u>: 2 men hand truck 30 ft. to bank, 3 men hand truck 30 ft. from bank to elevator, ride elevator, and hand truck 30 ft from elevator to bank, 2 men hand truck 50 ft. to storage, 2 men high-pile. Improved Method - 1 mechanical high-piler.

<u>Industrial Fork-Lift Truck, Unpalletized</u>: 1 man builds pallet loads, 1 fork-lift truck transports 100 ft. Improved Method - 1 fork-lift truck transports 100 ft.

<u>Industrial Fork-Lift Truck, Palletized</u>: 1 fork-lift truck transports 100 ft. to storage. Improved Method - 1 fork-lift truck transports to apron and later to storage.

<u>Industrial Clamp-Type Lift Truck</u>: 1 man hand trucks 30 ft. to bank, 1 industrial clamp truck transports 80 ft. to storage. Improved Method - hydraulic stabilizer unit.

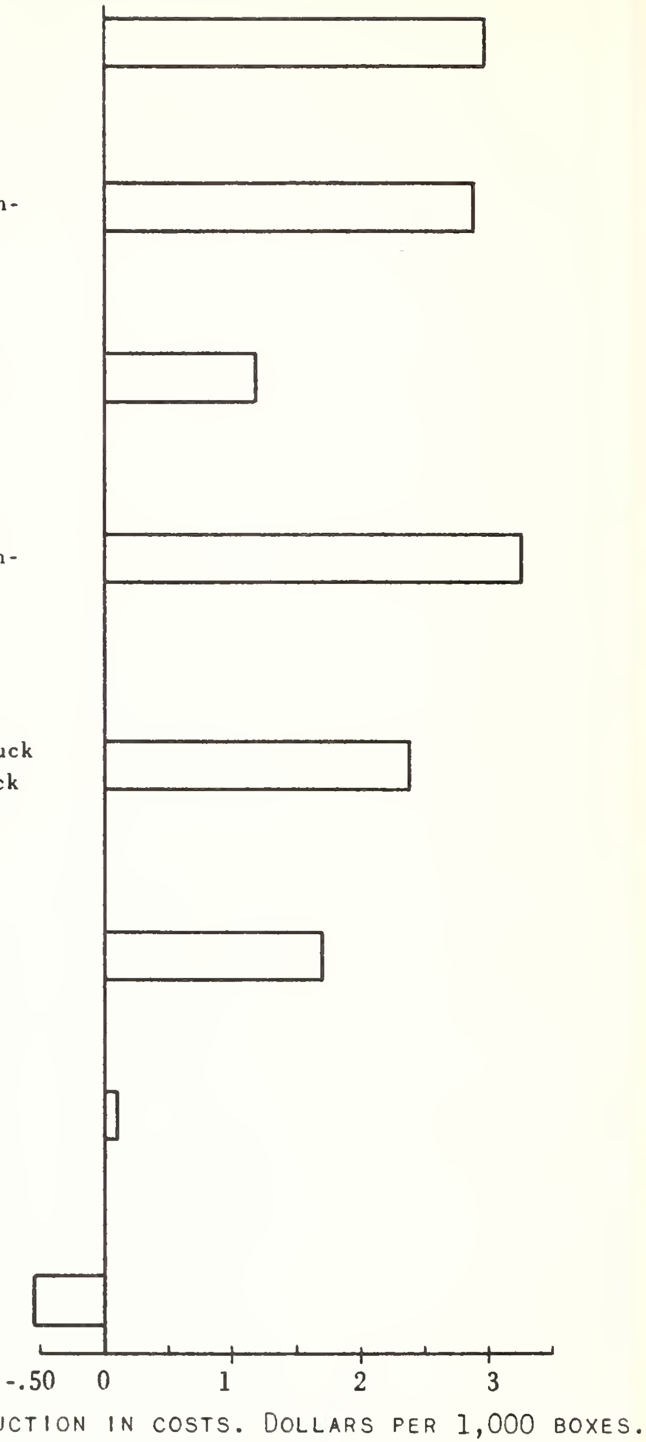


Figure 74.--Amount of reduction in labor and equipment costs for receiving 1,000 unpacked boxes of apples by use of specified methods and types of equipment.

EQUIPMENT AND METHOD

Clamp-Type 2-Wheel Hand Truck: 3 men hand truck 100 ft. to storage, 4 men high-pile.

Belt Conveyor and Hand Truck: 2 men place boxes on conveyor, 2 men transfer boxes from conveyor, 2 men hand truck 50 ft., 4 men high-pile.

Floor Chain Conveyor and Hand Truck: 2 men truck 20 ft. to chain, 2 men hand truck 30 ft. from chain, 4 men high-pile.

Belt Conveyor, Stackmaker, Floor Chain Conveyor and Hand Truck: 2 men place boxes on conveyor, 2 men hand truck 50 ft., 4 men high-pile.

Elevator and Hand Truck: 2 men hand truck 30 ft. to bank, 3 men hand truck 30 ft. from bank to elevator, ride elevator and hand truck 30 ft. from bank, 2 men hand truck 50 ft. to storage, 2 men high-pile.

Industrial Fork-Lift Truck, Unpalletized: 1 man builds pallet loads, 1 fork-lift truck transports 100 ft. to storage.

Industrial Fork-Lift Truck, Palletized: Fork-lift truck transports 80 ft. to storage, 1 road-truck driver waits.

Industrial Clamp-Type Lift Truck and Hand Truck: 1 man hand trucks 30 ft. to bank, 1 industrial clamp truck transports 100 ft. to storage.

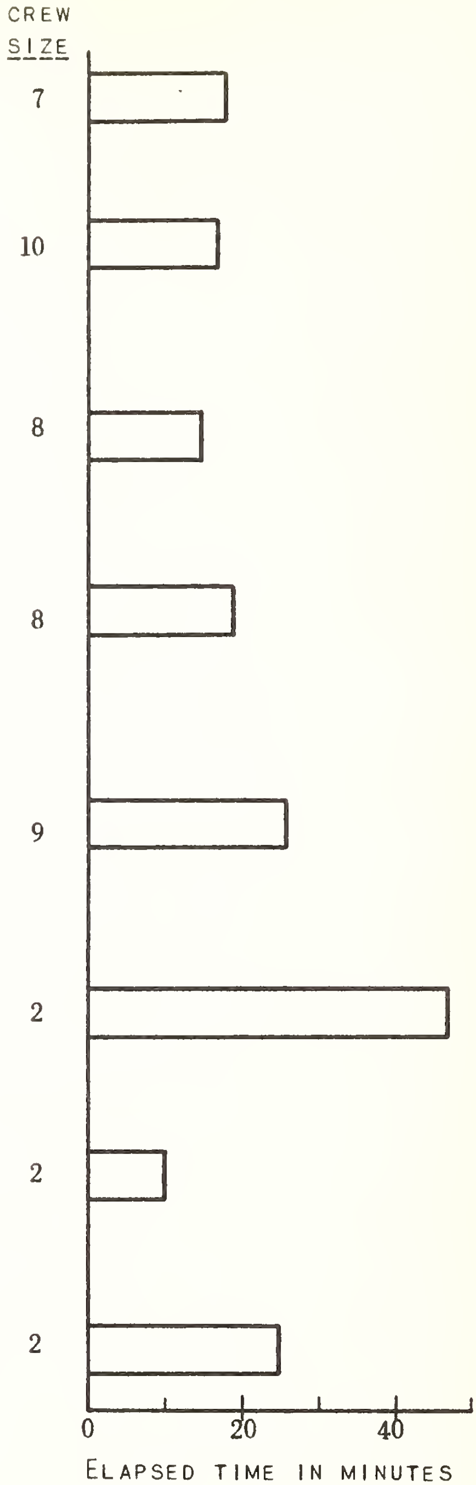
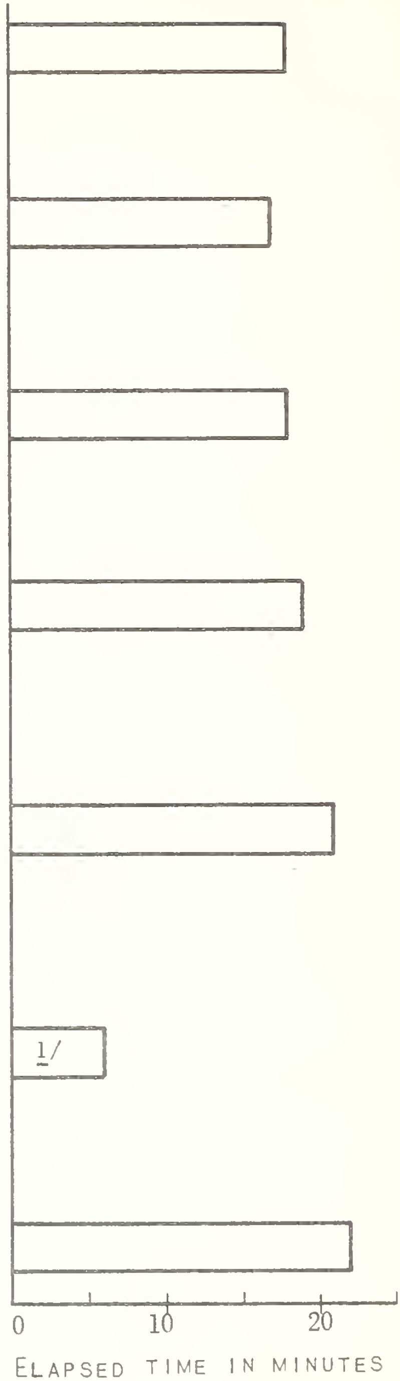


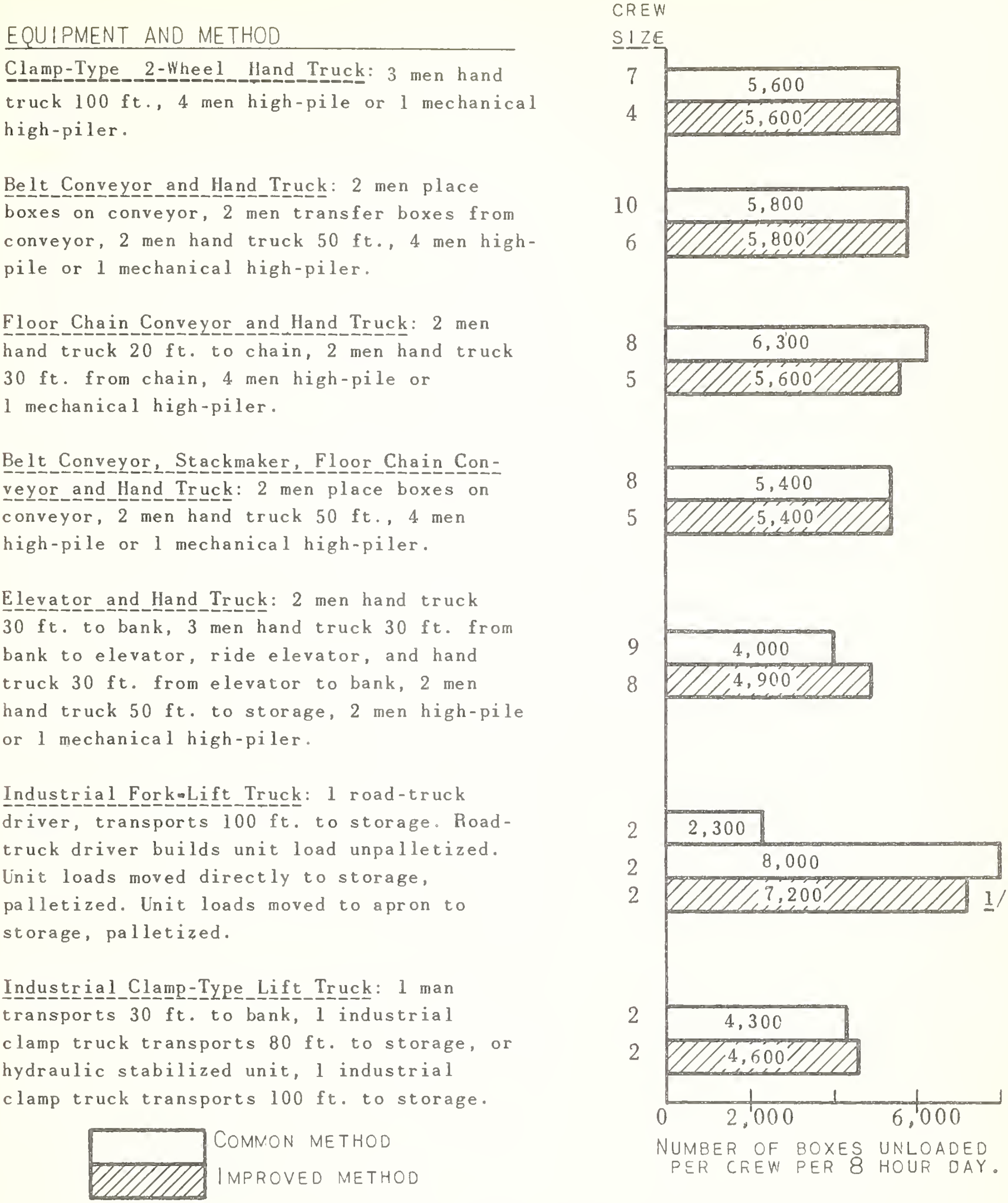
Figure 75.--Elapsed times required to receive one road truck load of 288 unpacked boxes of apples by use of specified methods and types of equipment before improvements were made.

EQUIPMENT AND METHOD	CREW SIZE
Clamp-Type 2-Wheel Hand Truck: 3 men hand truck 100 ft., 1 mechanical high-piler.	4
Belt Conveyor and Hand Truck: 2 men place boxes on conveyor, 2 men transfer boxes from conveyor, 2 men hand truck 50 ft., 1 mechanical high-piler.	7
Floor Chain Conveyor and Hand Truck: 2 men hand truck 20 ft. to chain, 2 men hand truck 30 ft. from chain, 1 mechanical high-piler.	5
Belt Conveyor, Stackmaker, Floor Chain Conveyor and Hand Truck: 2 men place boxes on conveyor, 2 men hand truck 50 ft., 1 mechanical high-piler.	5
Elevator and Hand Truck: 2 men hand truck 30 ft. to bank, 3 men hand truck 30 ft. from bank to elevator, ride elevator, and hand truck 30 ft. from elevator to bank, 2 men hand truck 50 ft. to storage, 1 mechanical high-piler.	8
Industrial Fork-Lift Truck, Palletized: Fork-lift truck transports to apron and later 100 ft. to storage. 1 road-truck driver waits.	2
Industrial Clamp-Type Lift Truck and Hydraulic Stabilizer: 1 industrial clamp truck transports 100 ft. to storage. 1 road-truck driver waits.	2



1/ Time to unload truck and place pallet loads on apron.

Figure 76.--Elapsed time required to receive one road truck load of 288 unpacked boxes of apples by use of specified methods and types of equipment after improvements were made.



1/ Based on 13 minutes elapsed time per truckload to unload and place in storage.

Figure 77.--Volumes of unpacked boxes of apples that can be received from road trucks per crew of specified size during an 8-hour day by use of specified methods and types of equipment. (Assumed 5 minutes between road trucks).

uniform in the amount of fruit that can be received daily, ranging from approximately 4,000 to 6,300 boxes.

Of equal importance is the volume of fruit that can be received per worker during an 8-hour day by use of various methods and types of equipment. These data are shown in figure 78. With the smaller crew, there is less interference among the crew members and less delay. The smaller crew also serves the industry better because of the decreasing labor supply.

Comparisons of Selected Methods and Types of Equipment for Receiving from Orchard Trailers

Comparative Labor and Equipment Costs

The decision as to whether fruit will be hauled to the warehouse on trailers or road trucks depends largely on the transportation distance involved. There are, of course, a number of different methods of receiving the fruit from orchard trailers by use of various types of materials-handling equipment. The older, more widely used methods (shown as method No. 1 under each equipment category in table 61), show total labor and equipment costs, at current wage rates, ranging from \$3.58 tc \$20.14 per 1,000 boxes received. These costs usually are higher than those when fruit is received by road trucks, because the unit load on the trailer is smaller, increasing the amount of setup and cleanup time per 1,000 boxes. Also, more hand labor is involved, especially in those plants using equipment for which the unit loads must be stacked by hand before transporting to storage. 28/ In belt conveyor and hand truck plants, a slight increase in labor is necessary to unload the trailer where all of the boxes are at a low level requiring the workers to do more lifting. Labor and equipment cost data on these methods are presented by graph in figure 79.

In the conventional plants, improved methods (shown as method No. 2 under each equipment category in table 61) made use of the mechanical high-piler. In the plants using industrial trucks, the improved methods used the most efficient methods of palletizing the fruit and the elimination of hand stacking with the industrial-clamp truck.

Improved methods of receiving fruit from orchard trailers reduced the costs per 1,000 boxes for receiving apples except that complete palletization of trailer loads and the building of 6-high stacks by use of an

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28/ Some handling of boxes is avoided in the orchard when fruit is hauled on trailers, thereby changing the relationship of the total work when hauling on trailers compared with road trucks.

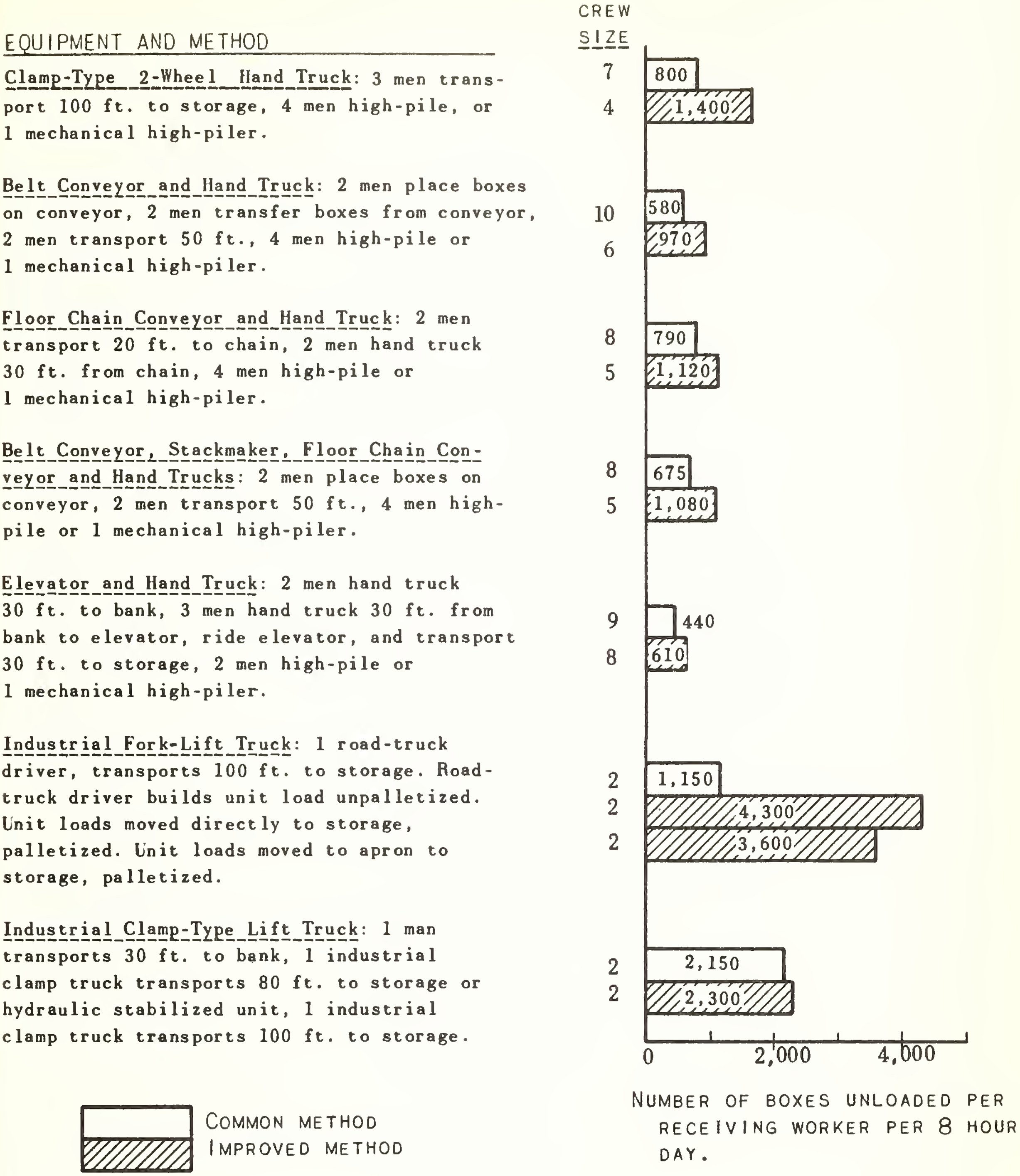


Figure 78.--Volumes of unpacked boxes of apples that can be received from road trucks per worker during an 8-hour day by use of specified methods and types of equipment.

industrial-clamp truck increased costs. The industrial-clamp truck method increased the labor cost because the tractor driver was standing by while the industrial-clamp truck tiered the stacks on the trailers to 6 high. This may not be an important disadvantage since the elapsed time to receive by this method was reduced and the fruit was handled more gently when tiered 6 high by the clamp-type lift trucks.

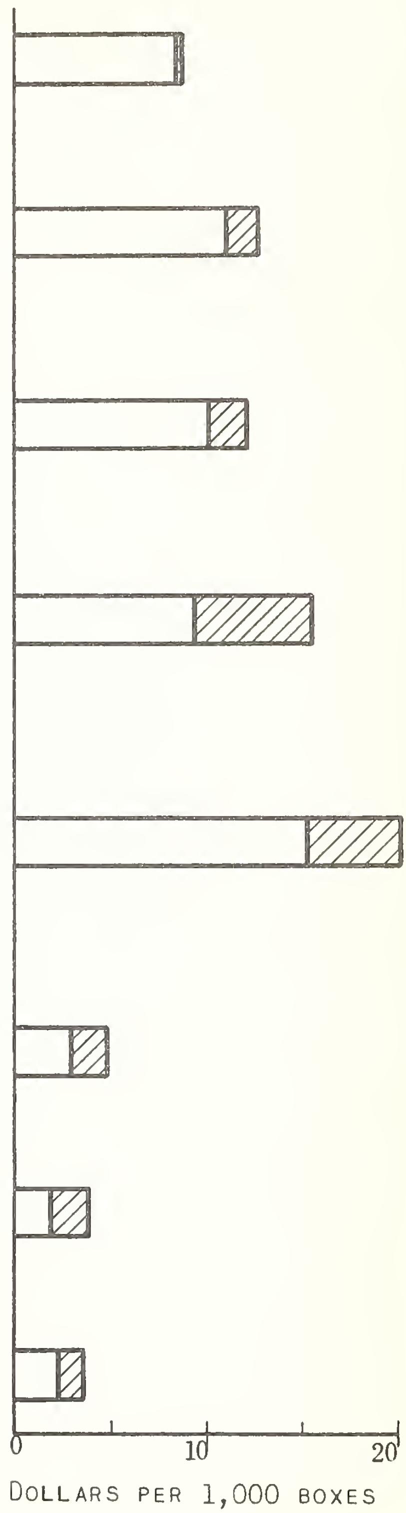
Reductions in costs per 1,000 boxes ranged from $0.76 to $1.54 (fig. 80). In the industrial truck plants no saving resulted. To the contrary, fruit

Table 61.--Comparative labor and equipment costs for unloading from orchard trailers and moving to storage 1,000 unpacked boxes of apples by use of specified methods and types of equipment 1/

Type of equipment and method	Workers	Elapsed time	Labor and equipment required: Equipment time	Labor and equipment required: Wait time	Labor and equipment required: Total labor	Labor and equipment costs: Equipment cost 2/	Labor and equipment costs: Labor cost current rates 3/	Labor and equipment costs: Total cost current rates	Labor and equipment costs: Total cost assumed rates 4/
	Number	Hours	Machine-hours	Man-hours	Man-hours	Dollars	Dollars	Dollars	Dollars
Clamp-type 2-wheel hand trucks: 1 worker builds 6-high stacks from 3-high stacks, 2 workers hand-truck 100 feet from trailer and release in storage:									
1. 2 workers manually high-pile--12-box high stacks	5	1.47	2.94	0.45	7.36	0.07	8.46	8.53	10.37
2. 1 worker and mechanical lift high-pile--12-box high stacks 5/	4	1.46	6/ 4.38	.92	5.84	.93	6.72	7.65	9.11
Belt conveyors and clamp-type 2-wheel hand trucks: 1 worker on trailer places boxes on conveyor, 1 worker removes boxes from conveyor and builds 6-high stacks, 1 worker hand-trucks 50 feet and releases in storage:									
1. 2 workers manually high-pile--12-box high stacks	5	1.92	7/ 5.76	2.11	9.60	1.72	11.04	12.76	15.16
2. 1 worker and mechanical lift high-pile--12-box high stacks 5/	4	1.92	8/ 7.68	2.13	7.68	2.85	8.83	11.68	13.60
Floor chain conveyors and clamp-type 2-wheel hand trucks: 1 worker builds 6-high stacks from 3-high stacks, 1 worker hand-trucks stacks 20 feet and releases on conveyor, 1 worker hand-trucks 30 feet from conveyor and releases stacks in storage:									
1. 2 workers manually high-pile--12-box high stacks	5	1.75	9/ 5.25	2.15	8.75	2.11	10.06	12.17	14.36
2. 1 worker and mechanical lift high-pile--12-box high stacks 5/	4	1.66	10/ 6.64	1.98	6.64	2.99	7.64	10.63	12.29
Belt conveyor, stackmaker, floor chain conveyor, and clamp-type 2-wheel hand trucks: 1 worker on trailer places boxes on belt conveyor, stackmaker builds 6-high stacks and releases on floor chain conveyor, 1 worker hand-trucks 50 feet and releases in storage:									
1. 2 workers manually high-pile--12-box high stacks	4	2.02	11/ 10.10	2.28	8.08	6.20	9.29	15.49	17.51
2. 1 worker and mechanical lift high-pile--12-box high stacks 5/	3	2.02	12/ 12.12	2.20	6.06	7.39	6.97	14.36	15.87
Elevator and clamp-type 2-wheel hand trucks: 1 worker builds 6-high stacks from 3-high stacks, 1 worker hand-trucks stacks 30 feet to bank at elevator; 3 workers hand-truck stacks 30 feet from bank into elevator, ride elevator, and hand-truck stacks 30 feet from elevator to bank, 2 workers hand-truck stacks 60 feet and release in storage; 13/									
1. 2 workers manually high-pile--12-box high stacks	9	1.47	14/ 10.29	3.03	13.23	4.93	15.21	20.14	23.45
2. 1 worker and mechanical lift high-pile--12-box high stacks 5/	8	1.47	15/ 11.76	3.50	11.76	5.80	13.52	19.32	22.26
Industrial fork-lift truck and pallets:									
Unpalletized loads; 1 worker builds 48-box pallet loads on apron.									
1. 1 worker and fork-lift truck transports pallet loads 100 feet, stacks 3-high (18 boxes)	2	2.03	16/ .90	.00	2.48	1.94	2.93	4.87	5.49
Palletized loads:									
1. Partially palletized loads--1 worker completes 48-box pallet loads on trailer bed, 1 worker and fork-lift truck transports pallet loads 100 feet and stacks 3-high (18 boxes)	2	1.11	16/ .90	.00	1.56	1.94	1.87	3.81	4.20
2. Completely palletized loads--(special trailer) 40-box pallet loads on trailer, 1 worker and fork-lift truck transports 100 feet and stacks 3-high (15 boxes)	2	.61	16/ 1.22	.42	1.22	2.62	1.49	4.11	4.42
Industrial clamp-type lift truck: (36-box capacity--unpacked fruit)									
1. 1 worker on trailer bed builds 6-high stacks from 3-high stacks, 1 worker and industrial clamp truck transports 36-box unit loads 100 feet and stacks 2-high (12 boxes)	2	1.26	17/ 1.32	.00	1.92	1.27	2.31	3.58	4.06
2. 1 worker and industrial clamp truck builds 6-high stacks from 3-high stacks on trailer bed, transports 36-box unit loads 100 feet and stacks 2-high (12 boxes), 1 worker mostly waits	2	1.03	17/ 2.06	.93	2.06	1.99	2.52	4.51	5.03

1/ Except as otherwise noted, all transportation distances are standardized at 100 feet. By use of conveyor methods, conveyor accounts for 50 feet of transportation distance.
2/ Equipment costs computed from data on ownership and operating costs shown in table 2.
3/ "Current" labor costs computed from wage rates of $1.15 per hour for unskilled labor and $1.30 per hour for semiskilled labor (key workers such as industrial truck operators).
4/ Assumed labor costs computed from wage rates of $1.40 per hour for unskilled labor and $1.55 per hour for semiskilled labor.
5/ Cost data for mechanical high-piling covers use of one 2-stack portable lift.
6/ Clamp-type 2-wheel hand truck 2.92 machine-hours, mechanical lift 1.46 machine-hours, total 4.38 machine-hours.
7/ Clamp-type 2-wheel hand truck, 15 foot gravity roller conveyor and 100 foot belt conveyor 1.92 machine-hours each, total 5.76 machine-hours.
8/ Clamp-type 2-wheel hand truck, 15 foot gravity roller conveyor, 100 foot belt conveyor, and mechanical lift 1.92 machine-hours each, total 7.68 machine-hours.
9/ Clamp-type 2-wheel hand truck 3.50 machine-hours, 100 foot floor chain conveyor 1.75 machine-hours, total 5.25 machine-hours.
10/ Clamp-type 2-wheel hand truck 3.32 machine-hours, 100 foot floor chain conveyor 1.66 machine-hours, mechanical lift 1.66 machine-hours, total 6.64 machine-hours.
11/ Clamp-type 2-wheel hand truck, 15 foot gravity roller conveyor, 50 foot belt conveyor, stackmaker and 50 foot floor chain conveyor 2.02 machine-hours each, total 10.10 machine-hours.
12/ Clamp-type 2-wheel hand truck, 15 foot gravity roller conveyor, 50 foot belt conveyor, stackmaker, 50 foot floor chain conveyor, and mechanical lift 2.02 machine-hours each, total 12.12 machine-hours.
13/ Fifty feet additional transportation distance is necessary to move 6-high stacks of boxes 100 feet because of two temporary banks which increase hand truck distance. Vertical transportation distance is not included.
14/ Clamp-type 2-wheel hand truck 8.82 machine-hours, 8,000-pound capacity elevator 1.47 machine-hours, total 10.29 machine-hours.
15/ Clamp-type 2-wheel hand truck 8.82 machine-hours, 8,000-pound capacity elevator 1.47 machine-hours, mechanical lift 1.47 machine hours, total 11.76 machine-hours.
16/ For equipment time see table 54.
17/ For equipment time see table 59.

EQUIPMENT AND METHOD	CREW SIZE
Clamp-Type 2-Wheel Hand Truck: 1 man builds stacks, 2 men hand truck 100 ft., 2 men high-pile.	5
Belt Conveyor and Hand Truck: 1 man places boxes on conveyor, 1 man transfers boxes from conveyor, 1 man hand trucks 50 ft., 2 men high-pile.	5
Floor Chain Conveyor and Hand Truck: 1 man builds stacks, 1 man hand trucks 20 ft. to chain, 1 man hand trucks 30 ft. from chain, 2 men high-pile.	5
Belt Conveyor, Stackmaker, Floor Chain Conveyor and Hand Truck: 1 man places on conveyor, 1 man hand trucks 50 ft., 2 men high-pile.	4
Elevator and Hand Truck: 1 man builds stacks, 1 man hand trucks 30 ft. to bank, 3 men hand truck 30 ft. from bank to elevator, ride elevator, and hand truck 30 ft. to bank, 2 men hand truck 60 ft. to storage, 2 men high-pile.	9
Industrial Fork-Lift Truck, Unpalletized: 1 man builds unit load on pallets from orchard trailer, 1 man transports 100 ft.	2
Industrial Fork-Lift Truck, Palletized: 1 man builds unit load on pallets on orchard trailer, 1 man transports 100 ft.	2
Industrial Clamp-Type Lift Truck: 1 man builds unit loads on the orchard trailer, 1 man transports 100 ft.	2



LABOR COST — EQUIPMENT COST

Figure 79.--Labor and equipment costs per 1,000 unpacked boxes of apples for receiving from orchard trailers and high-piling or tiering by use of specified methods and types of equipment.

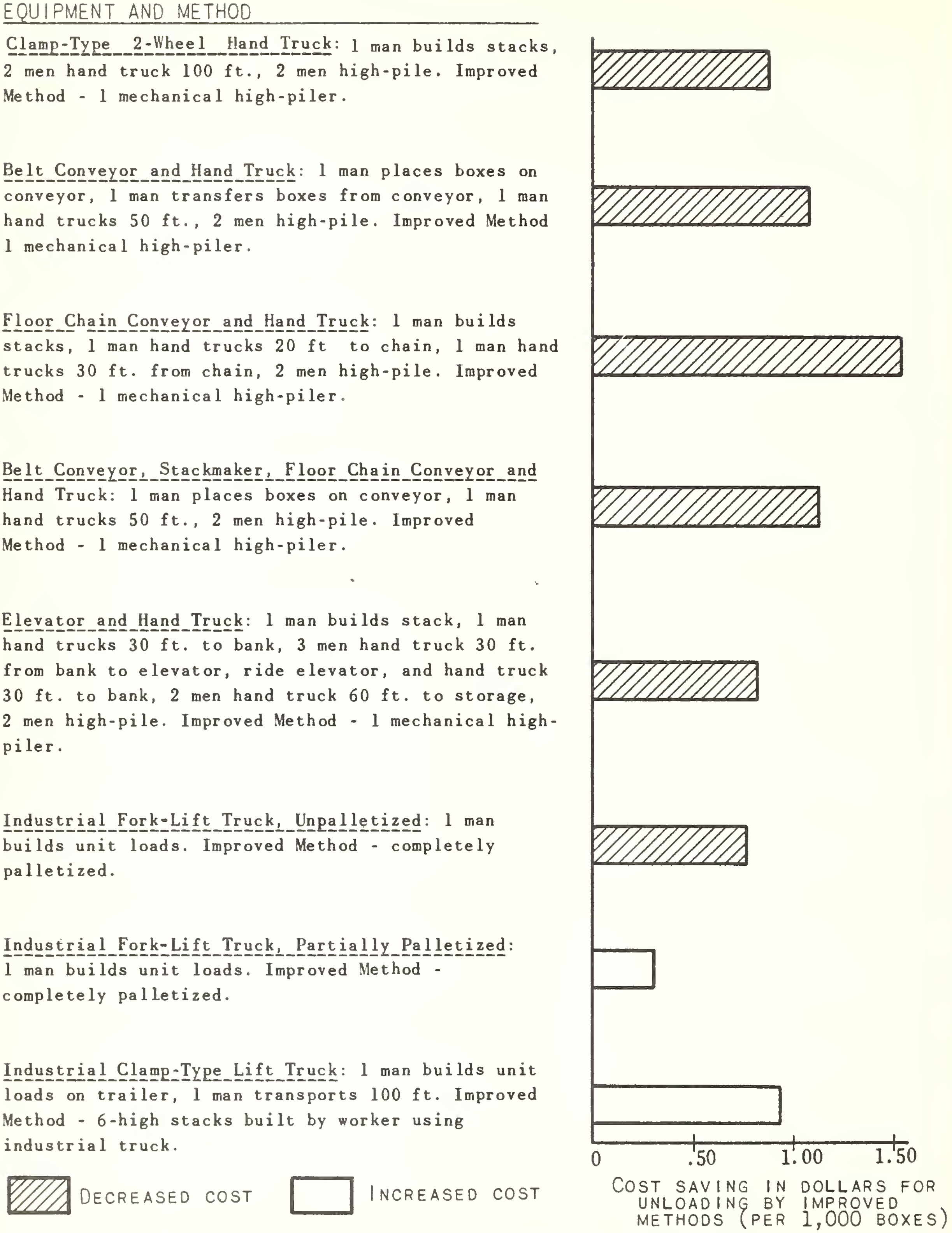


Figure 80.--Amount of reduction in labor and equipment costs for receiving 1,000 unpacked boxes of apples by use of specified methods and types of equipment.

was received from the trailers at an additional cost of $0.30 per 1,000 boxes in the fork-lift truck plants and $0.93 per 1,000 boxes in the clamp-truck plants. These increases resulted because longer use was made of the machine. If it were assumed that the industrial truck was already available and that the improvement consisted of using it more fully, no added capital charge should be made for the improved operation. In that event, the improved method would show no increase in equipment costs, nor would an increase in labor cost be shown if the idle time of the trailer driver was not included as a cost figure.

Comparative Rates of Receiving

As shown in figure 81, there were no appreciable differences in the elapsed times required to receive fruit by use of the two methods listed under each equipment category, except in the case of completely unpalletized loads received in plants using fork-lift trucks.

The quantity of fruit received per crew from orchard trailers by use of different methods did not vary greatly. The relationship between methods is shown in figure 82.

The advantages of the improvements are found in the reduction of one in number of workers needed on the receiving crew in all of the improvements except those using industrial equipment. By use of industrial trucks an increased quantity of fruit was handled by the same size crew. Therefore, all of the improved methods increased the quantity of fruit handled per receiving worker. This greater efficiency in the use of labor is desirable, not only from the standpoint of reducing costs, but also in increasing the ease of supervising receiving operations (fig. 83).

Comparative Costs of Receiving by Various Methods When Orchard-Handling Costs Are Added

Receiving operations at apple storage and packing plants ordinarily are considered to cover only the work carried on at the plant. Actually, additional time and labor may be required in arranging the load in the orchard so that it could be received by certain methods at the plant. Thus, the receiving of apples from road trucks by use of 2-wheel hand trucks required 4.19 man-hours per 1,000 boxes, but when the orchard-handling operations were included, 5.77 man-hours of labor were added, making the total 9.96 man-hours (table 62).

When the orchard phases of the receiving cycle are added, the elapsed time required to handle 1,000 boxes of apples is increased about three times, regardless of the method used, and all of the costs are about doubled or more than doubled except for the belt-conveyor-hand-truck operation, and the floor-chain-conveyor-hand-truck operation.

EQUIPMENT AND METHOD

Clamp-Type 2-Wheel Hand Truck: 1 man builds stacks, 2 men hand truck 100 ft., 2 men high-pile or 1 mechanical high-piler.

Belt Conveyor and Hand Truck: 1 man places boxes on conveyor, 1 man transfers boxes from conveyor, 1 man hand trucks 50 ft., 2 men high-pile or 1 mechanical high-piler.

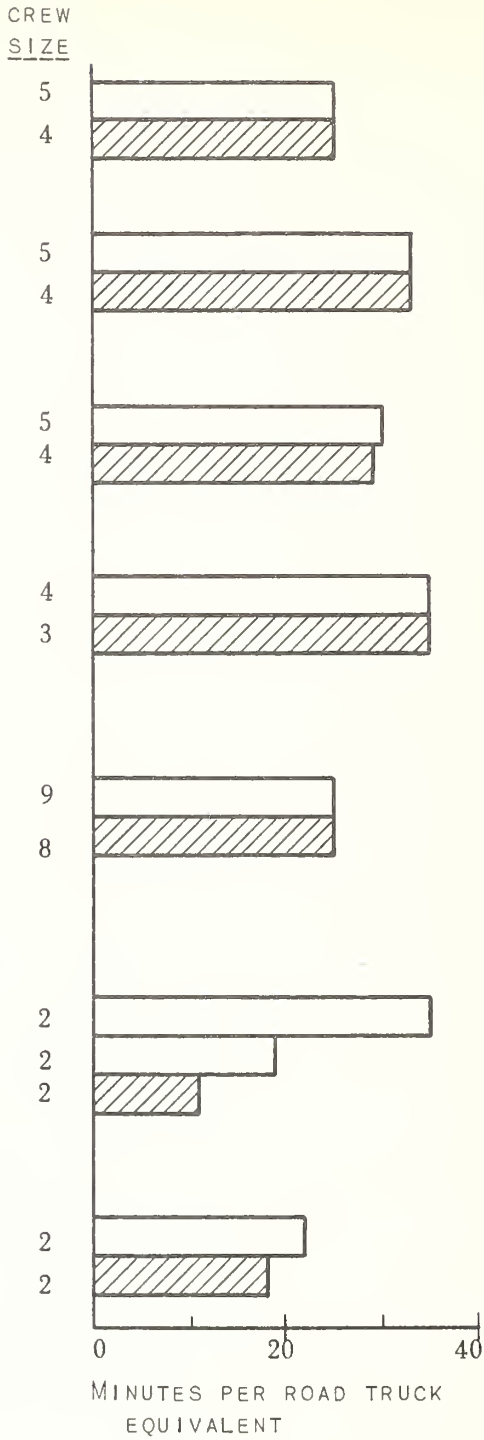
Floor Chain Conveyor and Hand Truck: 1 man builds stacks, 1 man hand trucks 20 ft. to chain, 1 man hand trucks 30 ft. from chain, 2 men high-pile or 1 mechanical high-piler.

Belt Conveyor, Stackmaker, Floor Chain Conveyor and Hand Truck: 1 man places boxes on conveyor, 1 man hand trucks 50 ft., 2 men high-pile or 1 mechanical high-piler.

Elevator and Hand Truck: 1 man builds stack, 1 man hand trucks 30 ft. to bank, 3 men hand truck 30 ft. from bank to elevator, ride elevator, and hand truck 30 ft. to bank, 2 men hand truck 60 ft. to storage, 2 men high-pile or 1 mechanical high-piler.

Industrial Fork-Lift Truck and Pallet: 1 tractor operator, transports 100 ft. to storage. Tractor operator builds unit loads, unpalletized. Tractor operator builds unit loads, partly palletized. Tractor operator waits, palletized.

Industrial Clamp-Type Lift Truck: 1 man builds unit loads. Industrial truck transports 100 ft. the 6-high stacks built by worker using industrial truck.



COMMON METHOD

IMPROVED METHOD

Figure 81.--Elapsed time per road truck equivalent by common and improved methods to unload from orchard trailers, move boxes to storage and tier by use of specified types and combinations of types of materials-handling equipment.

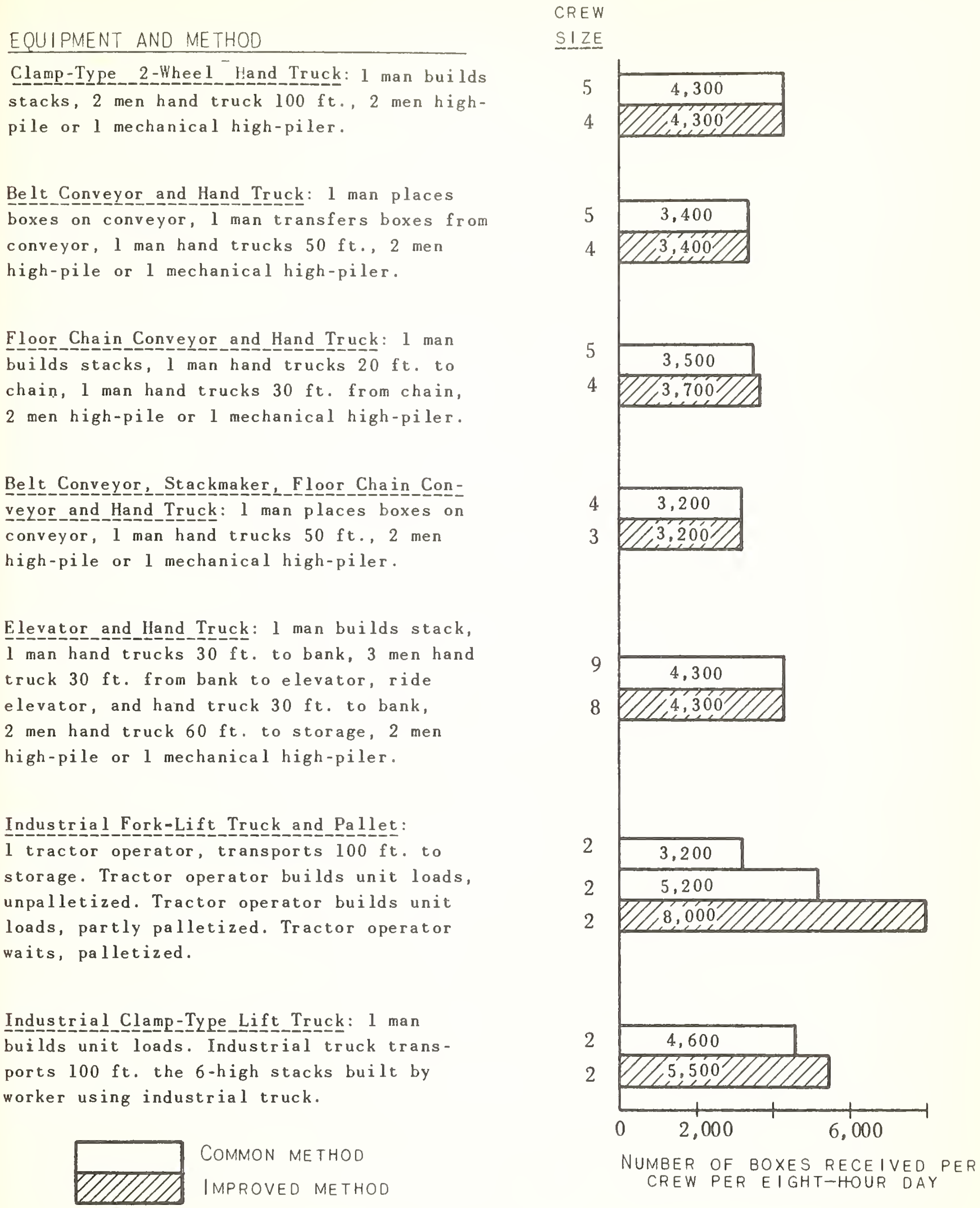


Figure 82.--Volumes of unpacked boxes of apples that can be received from orchard trailers per crew of specified size during an 8-hour day by use of specified methods and types of equipment. (An allowance of 5 minutes was made for each equivalent road truckload of 288 boxes.)

EQUIPMENT AND METHOD

Clamp-Type 2-Wheel Hand Truck: 1 man builds stacks, 2 men hand truck 100 ft., 2 men high-pile or 1 mechanical high-piler.

Belt Conveyor and Hand Truck: 1 man places boxes on conveyor, 1 man transfers boxes from conveyor, 1 man hand trucks 50 ft., 2 men high-pile or 1 mechanical high-piler.

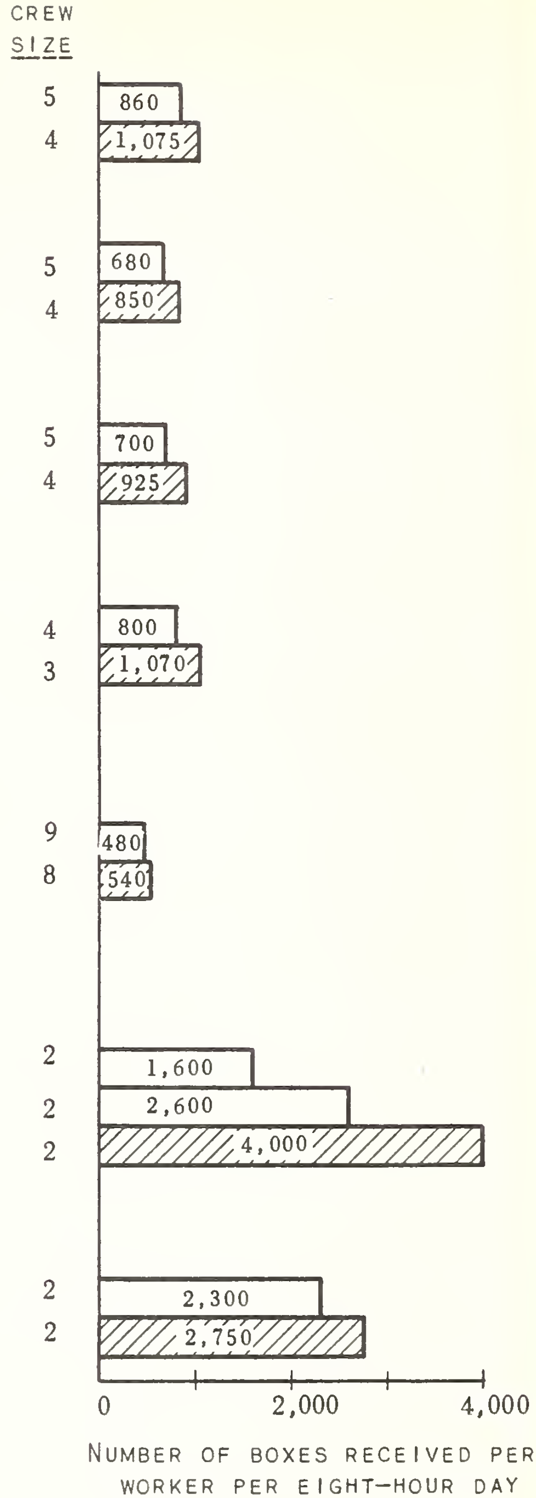
Floor Chain Conveyor and Hand Truck: 1 man builds stacks, 1 man hand trucks 20 ft. to chain, 1 man hand trucks 30 ft. from chain, 2 men high-pile or 1 mechanical high-piler.

Belt Conveyor, Stackmaker, Floor Chain Conveyor and Hand Truck: 1 man places boxes on conveyor, 1 man hand trucks 50 ft., 2 men high-pile or 1 mechanical high-piler.

Elevator and Hand Truck: 1 man builds stack, 1 man hand trucks 30 ft. to bank, 3 men hand truck 30 ft. from bank to elevator, ride elevator, and hand truck 30 ft. to bank, 2 men hand truck 60 ft. to storage, 2 men high-pile or 1 mechanical high-piler.

Industrial Fork-Lift Truck and Pallet: 1 tractor operator, transports 100 ft. to storage. Tractor operator builds unit loads, unpalletized. Tractor operator builds unit loads, partly palletized. Tractor operator waits, palletized.

Industrial Clamp-Type Lift Truck: 1 man builds unit loads. Industrial truck transports 100 ft. the 6-high stacks built by worker using industrial truck.



COMMON METHOD

IMPROVED METHOD

Figure 83.--Volumes per worker of unpacked boxes of apples that can be received from orchard trailers during an 8-hour day by use of specified methods and types of equipment.

Table 62.--Comparative elapsed time, labor requirements, and labor and equipment costs, for assembling and loading onto road trucks in the orchard, and unloading and moving to storage at the plant, 1,000 unpacked boxes of apples, by use of specified methods and types of equipment 1/

Type of equipment and method	Workers	Elapsed time 2/	Labor requirements	Labor and equipment costs: Equipment 3/	Labor and equipment costs: Labor at current wage rates 4/	Labor and equipment costs: Total costs: current wage rates	Labor and equipment costs: Total costs assumed wage rates 5/
	Number	Hours	Man-hours	Dollars	Dollars	Dollars	Dollars
Orchard: 2 workers stack boxes on edge of trailer and slide stacks into position, unload on orchard platform. Stacks built 6-boxes high on trailer and hand-trucked to platform. Later hand-trucked to road truck	2	2.86	5.77	0.06	6.64	6.70	8.14
Plant: Clamp-type 2-wheel hand trucks; 3 workers hand-truck 6-high stacks 100 feet and release in storage, 1 worker mechanically high-piles 6/	4	1.05	4.19	.70	4.82	5.52	6.57
Total	6	3.91	9.96	0.76	11.46	12.22	14.71
Orchard: 2 workers stack boxes on edge of trailer and slide stacks into position, unload on orchard platform. Stacks built 6-high on trailer and hand-trucked to platform. Later hand-trucked to road trucks	2	2.86	5.77	0.06	6.64	6.70	8.14
Plant: Belt conveyors and clamp-type 2-wheel hand trucks; 2 workers on road truck place boxes on conveyor, 2 workers remove boxes and build 6-high stacks, 2 workers hand-truck 50 feet and release in storage, 1 worker mechanically high-piles 6/	7	1.01	7.07	1.53	8.13	9.66	11.43
Total	9	3.87	12.84	1.59	14.77	16.36	19.57
Orchard: 2 workers stack boxes on edge of trailer and slide stacks into position, unload on orchard platform. Stacks built 6-high on trailer and hand-trucked to platform. Later hand-trucked to road trucks	2	2.86	5.77	0.06	6.64	6.70	8.14
Plant: Floor chain conveyors and clamp-type 2-wheel hand trucks; 2 workers hand-truck 6-high stacks 20 feet from road truck release on conveyor, 2 workers hand-truck 30 feet from conveyor and releases in storage, 1 worker mechanically high-piles 6/	5	1.05	5.25	1.94	6.04	7.98	9.29
Total	7	3.91	11.02	2.00	12.68	14.68	17.43
Orchard: 2 workers stack boxes on edge of trailer and slide stacks into position, unload on orchard platform. Stacks built 6-high on trailer and hand-trucked to platform. Stacks hand-trucked onto pallets on road truck and pallet loads tightened by use of box jack	2	3.67	7.35	0.22	8.46	8.68	10.51
Plant: Industrial fork-lift truck and pallets; 1 worker and fork-lift truck unloads 48-box pallet loads to apron (transports 10 feet), later transports 100 feet apron to storage and stacks loads 3-high (18 boxes). 1 worker mostly waits. 7/	2	.32	.96	2.75	1.20	3.95	4.19
Total	4	3.99	8.31	2.97	9.66	12.63	14.70
Orchard: 2 workers stack boxes on edge of trailer and slide stacks into position, unload on orchard platform. Stacks built 6-boxes high on trailer and hand-trucked to platform. Later hand-trucked to road truck	2	2.86	5.77	0.06	6.64	6.70	8.14
Plant: Industrial clamp-type lift truck (24-box capacity); road truck bed stabilized by use of hydraulic unit, 1 worker and industrial clamp truck transports 24-box unit loads 100 feet from road truck bed to storage and stack 2-high (12 boxes). One worker mostly waits.	2	1.28	2.56	3.14	3.13	6.27	6.91
Total	4	4.14	8.33	3.20	9.77	12.97	15.05

1/ Except as otherwise noted, all transportation distances in plant standardized at 100 feet. By use of conveyor methods, conveyor accounts for 50 feet of transportation distance. Costs of orchard handling operations are from unpublished data supplied by the Washington State Apple Commission.

2/ Does not include time road truck is in transit.

3/ Equipment costs computed from data on ownership and operating costs shown in table 2.

4/ "Current" labor costs computed from wage rates of $1.15 per hour for unskilled labor and $1.30 per hour for semiskilled labor.

5/ Assumed labor costs computed from wage rates of $1.40 per hour for unskilled labor and $1.55 per hour for semiskilled labor.

6/ Cost data for mechanical high-piling covers use of one 2-stack portable lift.

7/ Ten feet additional transportation distance is necessary to move pallet loads 100 feet because of unloading to apron.

The use of industrial trucks for receiving fruit at the warehouse shows definite advantages over the use of older and more conventional types of equipment. However, when the cost of orchard operations is included some of these advantages are lost. The orchard cycle of operation increased the total labor time when receiving at the warehouse by use of pallets and fork-lift truck, but the clamp-type lift truck required the same orchard work as the more conventional warehouse receiving equipment. It is particularly significant that when the costs of orchard-handling operations, including the palletization of loads, is added to the costs of receiving by use of industrial fork-lift trucks and pallets, total costs exceed the costs when 2-wheel hand trucks alone are used.

A comparison of the costs of receiving apples on road trucks and on orchard trailers when orchard-handling costs are added is shown for various methods in figure 84.

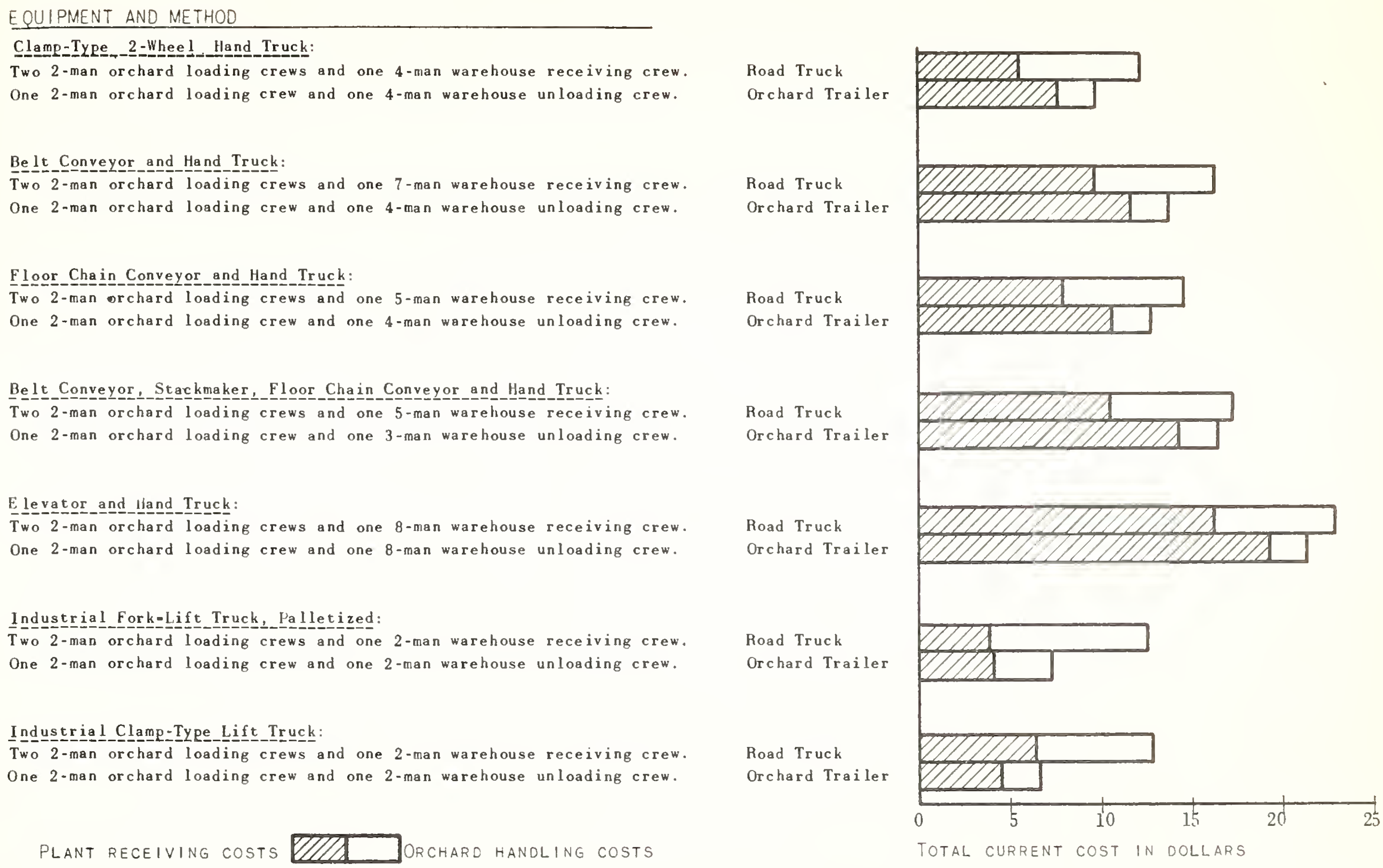


Figure 84.--Comparative labor and equipment costs of orchard-handling and plant-receiving operations when 1,000 unpacked boxes are delivered to plants by use of road trucks and by orchard trailers by use of specified methods for performing handling operations. (No allowance made in these figures for driving time to and from the orchard).

METHODS AND EQUIPMENT FOR UNLOADING AND MOVING APPLES DIRECTLY TO THE PACKING LINE

Most Washington State apples are first moved into cold storage before going to the packing line and the trend continues in that direction. Physiologically it is desirable to move apples into cold storage before packing to remove the field heat from the fruit. Research results show that precooled fruit has less tendency to develop decay. These advantages of first moving fruit into storage must be weighed against the added expense involved as compared with that of moving the fruit directly to the packing line.

Orchard-packing plants can move fruit directly to the packing line before it goes into cold storage more successfully than the larger plants, because they can schedule the flow of fruit from the orchard better. There are, however, many large plants, particularly in the northern part of the State, with sufficient packing equipment to receive a larger proportion of their fruit directly to the packing line for packing "hot." This practice not only keeps costs at a minimum but permits economies in the use of storage space, since large early shipments can be made, enabling the plant to handle a greater tonnage of fruit.

For most types of equipment, the operations involved in unloading apples and moving them directly to the packing line are similar to those involved in moving the fruit to storage. The main difference is that when the fruit is moved directly to the packing line it usually is placed in a temporary bank of supply rather than in permanent storage. When the belt conveyor is used to receive directly to the packing line a temporary bank of supply may be built by hand truckers before the fruit is placed on the conveyor, or the road truck may be unloaded to a belt conveyor in the usual manner and the boxes taken off the belt and placed in temporary storage. Boxes of fruit are moved from the temporary storage banks to the dumper as they are needed.

One of the important advantages of moving fruit directly to the packing line is that it reduces the number of handlings, thereby reducing handling costs. Fewer handlings tend to preserve the quality of the fruit. In a belt-conveyor plant three handlings are involved when the apples are moved directly to the packing line, as compared with eight handlings by the prevailing practice of moving them into and out of storage before packing (fig. 85).

In moving fruit to the packing line, the pattern of work is governed considerably by the fact that packing lines utilize fruit at a relatively slow rate. For this report a packing line rate of 300 boxes an hour has been assumed. Since boxes of fruit can be hand trucked or placed on a belt conveyor at more rapid rates than they can be dumped, workers performing handling operations either must slow down the rate of their operations or wait for the dumper to catch up. The effect of these delays may be

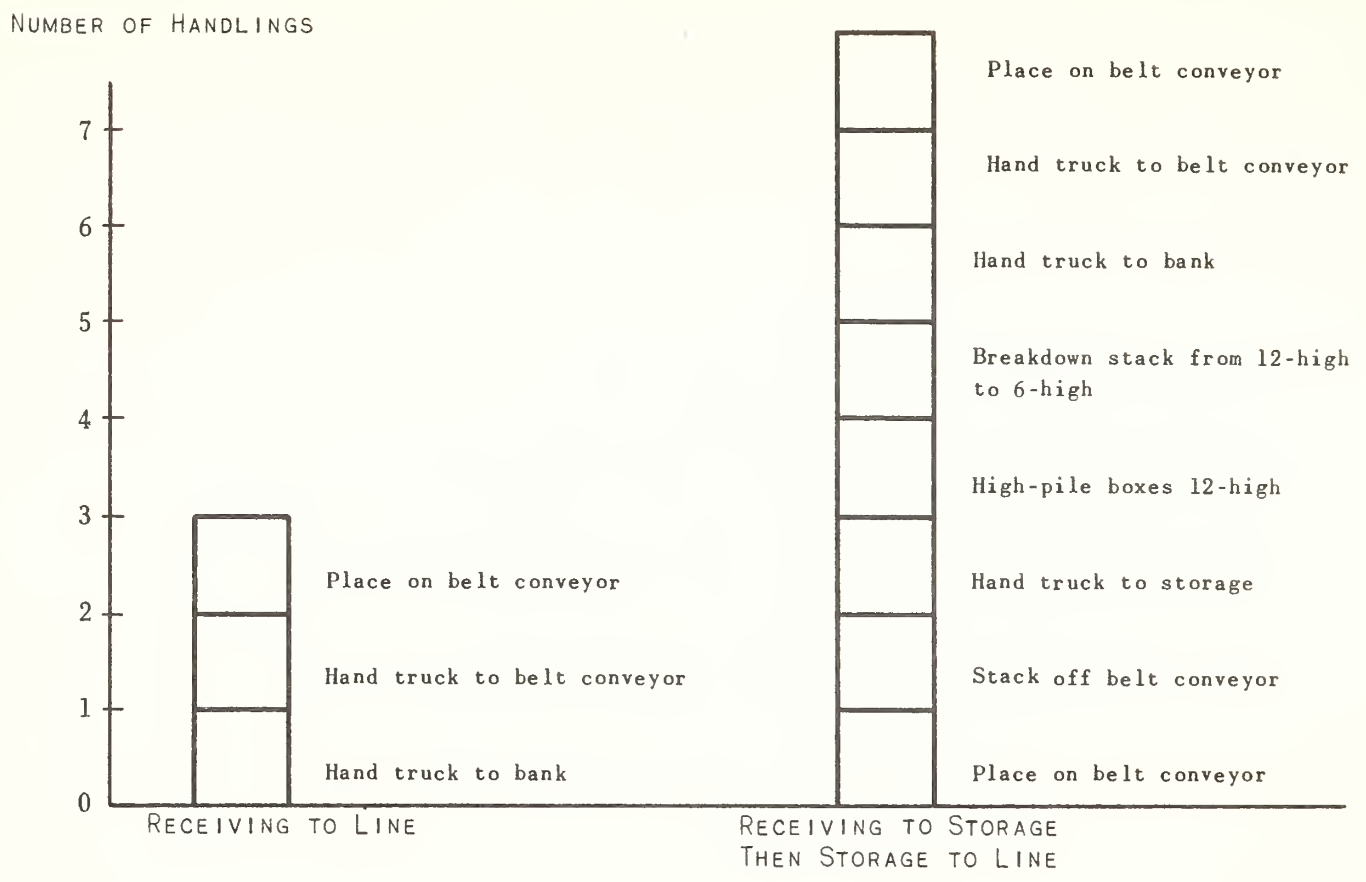


Figure 85.--Five additional handlings are required by use of the belt conveyor method when apples are moved to storage first rather than directly to the packing line.

offset by use of temporary banks of supply or by other devices which intermittently provide the worker with odd jobs.

For this cycle of operations it is assumed that the average transportation distance is 70 feet from the road truck or orchard trailer to the dumper at the beginning of the packing line.

Except for unloading from orchard trailers, using clamp-type 2-wheel hand trucks, gravity roller-type conveyors, and industrial fork-lift trucks and pallets, this section is confined to unloading from road trucks.

Clamp-Type 2-Wheel Hand Truck Alone

The most widely used method of unloading and moving fruit directly to the packing line involves the use of clamp-type 2-wheel hand trucks--a method that maintains unit loads intact. In nearly all plants the transportation distance between the receiving platform and that part of the plant in which the washing and packing line is housed is relatively short. Although this cycle of operations is used in a number of plants, receiving directly to the line by use of hand trucks is more common in orchard type or smaller packing plants.

Sometimes the operations of moving fruit to the packing line with hand trucks are combined with other work such as moving empty boxes away from the dumping area, utilizing some of the extra time of the hand trucker. The use of hand trucks to receive directly to the line is varied by changes in crew size and arrangement. 29/ Some of the small plants use only one worker for receiving fruit directly to the line. The larger plants nearly always use more workers in the crew to reduce the elapsed time required for unloading.

Unloading from Road Trucks and Moving to the Packing Line

Two workers unload a road truck by use of 2-wheel hand trucks. After putting a bridgeplate in place, the hand truckers pick up 6-high stacks of boxes on the road truck bed and release the stacks in a temporary storage area approximately 50 feet from the road truck. A third worker moves the fruit 20 feet from the temporary storage area to keep the dumper supplied. The work of the third worker must be coordinated closely with that of the dumper because a large bank of supply cannot be built within easy reach of the dumper. Since the dumper uses the fruit at a comparatively slow rate, this hand truck operator is idle a considerable part of the time.

29/ The crew arrangement is related more to distance than to any other factor. For detail on the effect of distance, see the Appendix.

As shown in table 63, by use of a 3-man crew, 1,000 boxes of apples are received in 5.35 man-hours, but 44 percent of this is idle time. Nearly all of the idle time occurs because the worker supplying the dumper from the temporary bank is paced by the washing and packing line. Part of this idle time could be avoided if odd jobs were assigned to the worker, as is done in some plants. Thirty-eight percent of the labor is used for unloading the road truck in an elapsed time of 1.01 hours per 1,000 boxes (17-½ minutes per truck). Labor and equipment costs for this method are shown in the summary for this section.

Table 63.--Labor required for a 3-man crew to unload and move 1,000 unpacked boxes of apples to the washing and packing line from a road truck by use of clamp-type 2-wheel hand trucks

Operation	Workers	Productive labor	Fatigue allowance	Wait time	Total labor
	Number	Man-hours	Man-hours	Man-hours	Man-hours
Set up and clean up	2	0.12	0.0	0.0	0.12
Pick up 6-high stacks on road truck by use of hand trucks	2	.39	.04	.0	.43
Transport 50 feet to bank by use of hand trucks	2	.97	.10	.08	1.15
Release in bank	2	.29	.03	.0	.32
Pick up 6-high stacks in bank by use of hand trucks	1	.29	.03	.0	.32
Transport 20 feet by use of hand trucks	1	.45	.05	.0	.50
Release at dumper	1	.24	.02	2.25	2.51
Total man-hours	-	2.75	.27	2.33	5.35
Elapsed time--hours					1/ 1.01

1/ Truck unloading only.

Unloading from Orchard Trailers and Moving to the Packing Line

As previously pointed out, 2-wheel hand trucks are used more frequently to move fruit directly to the packing line when the packing house is in the orchard area. This practice coincides with circumstances under which orchard trailers are more frequently being used to haul to the packing house.

When fruit is hauled to the plant on trailers, the most widely used method of unloading and moving to the packing line employs a 4-man crew. One worker, usually the tractor driver, builds 6-high stacks from 3-high stacks on the trailer bed while two workers place a bridgeplate and begin hand trucking the stacks 50 feet to a temporary storage bank in the dumping area. The fourth worker moves the fruit 20 feet from the temporary storage area to the dumper.

As shown in table 64, when fruit is moved directly to the packing line from trailers 7.01 man-hours of labor per 1,000 boxes are required, or 1.66 man-hours more than when the fruit is moved from road trucks. The total amount of delay time in unloading from a trailer is 2.85 man-hours or 41 percent of the total labor, which is greater than when unloading from a road truck. Most of the delay, 79 percent, is due to the slow dumping rate. If the work arrangement in the plant permits, some of this lost time may be avoided by assigning odd jobs to the worker.

Table 64.--Labor required for a 4-man crew to unload and move 1,000 unpacked boxes of apples to the washing and packing line from an orchard trailer by use of clamp-type 2-wheel hand trucks

Operation	Workers	Productive labor	Fatigue allowance	Wait time	Total labor
	Number	Man-hours	Man-hours	Man-hours	Man-hours
Set up and clean up	2	0.10	0.0	0.10	0.20
One worker builds boxes into 6-high stacks	1	.97	.19	.0	1.16
Pick up 6-high stacks off trailer bed by use of 2-wheel hand truck	2	.39	.04	.42	.85
Transport 50 feet by use of 2-wheel hand truck	2	.97	.10	.08	1.15
Release in bank by use of 2-wheel hand truck	2	.29	.03	.0	.32
Pick up 6-high stacks in bank by use of 2-wheel hand truck	1	.29	.03	.0	.32
Transport 20 feet by use of 2-wheel hand truck	1	.45	.05	.0	.50
Release near dumper by use of 2-wheel hand truck	1	.24	.02	2.25	2.51
Total man-hours	-	3.70	.46	2.85	7.01
Elapsed time--hours					1/ 1.26

1/ Truck unloading only.

Gravity Roller-Type Conveyors

Some plants that receive fruit directly to the packing line by use of clamp-type 2-wheel hand trucks might reduce handling costs by use of an improved method observed in one packing plant which employs four sections of gravity (dead) roller-type conveyors behind the dumper making up four separate conveyor lines (fig. 86). These conveyor sections were placed at an incline so that by gravity the boxes would roll to the dumper. The dumper picks up the boxes off the conveyor, turns, and dumps the apples into the washer. When he has emptied one 50-foot section of the dead roller he begins dumping from another.

The standardized 70-foot transportation distance is reduced to 50 feet in this illustration. However, it is possible that the layout of the plant would permit using 70-foot sections of roller conveyor. The four 50-foot sections of conveyors used provide enough conveyor space to accommodate 1-1/3 to 1-½ trailer loads and approximately a full road truckload.

By use of this method, one worker on the trailer places boxes on the conveyor sections. No other workers are used. In practice, a warehouse could use more than one worker to place fruit on the conveyors to reduce the elapsed unloading time.

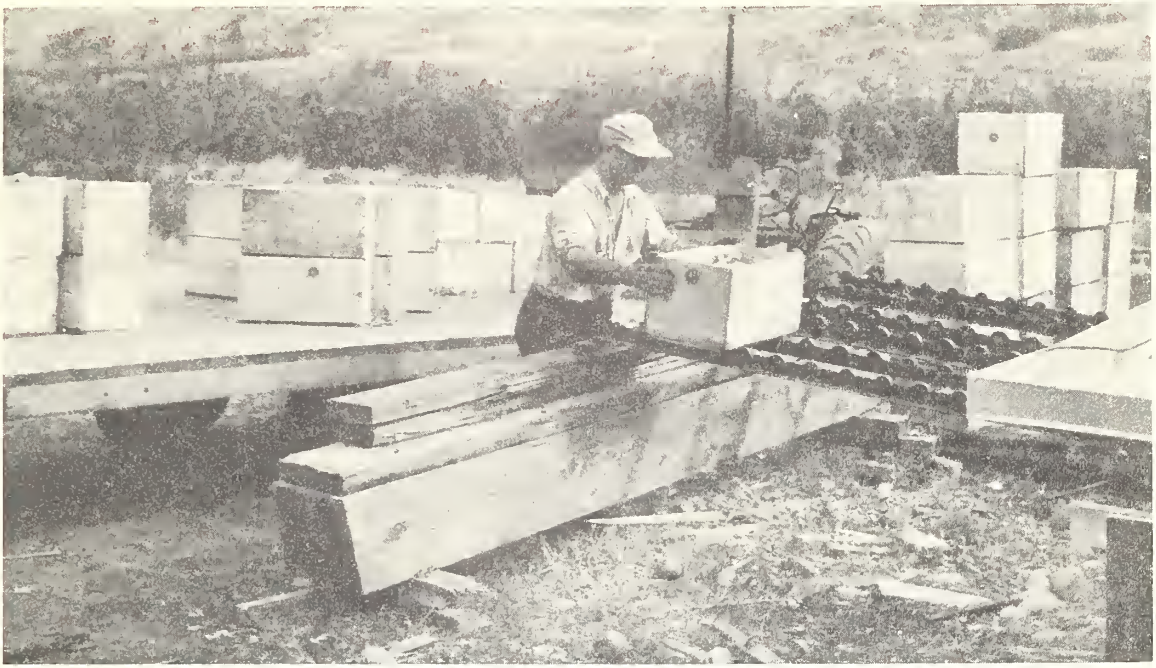


Figure 86.--Transferring boxes from an orchard trailer to gravity conveyors leading to the dumper.

Table 65 shows that by use of the improved method, 1,000 boxes of apples can be moved to the washing and packing line from trailers with 1.52 man-hours of labor. With the use of only one worker no delay time resulted, making this a highly efficient operation. Furthermore, the number of handlings was reduced, since the boxes were handled only once when they were lifted onto the conveyors.

Table 65.--Labor required for 1 worker to unload and move 1,000 unpacked boxes of apples to the packing line from an orchard trailer by use of gravity roller conveyors

Operation	Workers	Productive labor	Fatigue allowance	Wait time	Total labor
	Number	Man-hours	Man-hours	Man-hours	Man-hours
Set up and clean up	1	0.10	0.0	0.0	0.10
One worker places boxes on gravity roller-type conveyors	1	1.18	.24	[illegible]	1.42
Total man-hours	-	1.28	.24	.0	1.52
Elapsed time--hours					1.52

Clamp-Type 2-Wheel Hand Truck and Belt Conveyor

More Washington State apple plants are equipped with belt conveyors than any other type of equipment. The belt conveyor brings boxes of apples to the packing line one at a time which is convenient for hand dumping of fruit--the most common method of dumping fruit. By use of manual dumping, the only method used until the last few years, boxes of fruit were lifted one at a time.

When fruit is being received to storage by use of belt conveyors the first operation is to place boxes of fruit on the belt. However, when apples are moved directly to the packing line the first operation is hand trucking the boxes to temporary storage a distance of approximately 30 feet from the road truck. Two workers usually do this. Later, one worker hand trucks the fruit approximately 10 feet from temporary storage area and places the boxes on the belt conveyor. A 3-man crew is used; one worker works rather continuously, the other two only during unloading.

In moving the fruit to and from the bank of supply, 40 feet of transportation distance is covered. The remaining 30 feet of transportation is on the belt conveyor. In practice, the distance on the belt conveyor may be much greater. Although this added distance would not affect the length of time to carry on the operations, it would affect the machine cost.

Using the hand trucks and belt conveyor to unload and move fruit directly to the packing line requires 4.99 man-hours of labor per 1,000 boxes (table 66). A little more than one-fourth of this labor is lost

Table 66.--Labor required for a 3-man crew to unload and move 1,000 unpacked boxes of apples to the packing line from a road truck by use of clamp-type 2-wheel hand truck and belt conveyor

Operation	Workers	Productive labor	Fatigue allowance	Wait time	Total labor
	Number	Man-hours	Man-hours	Man-hours	Man-hours
Set up and clean up	2	0.12	0.0	0.0	0.12
Pick up 6-high stacks on road truck bed by use of 2-wheel hand trucks	2	.39	.04	.0	.43
Transport 30 feet to bank by use of 2-wheel hand trucks	2	.62	.06	.11	.79
Release in bank by use of 2-wheel hand trucks	2	.29	.03	.0	.32
Pick up 6-high stacks in bank by use of 2-wheel hand trucks	1	.29	.03	.0	.32
Transport 10 feet to belt conveyor	1	.28	.03	.0	.31
Release at conveyor by use of 2-wheel hand trucks	1	.24	.02	.0	.26
Place boxes on belt conveyor	1	.90	.18	1.36	2.44
Total man-hours	-	3.13	.39	1.47	4.99
Elapsed time--hours					1/ .83

1/ Truck unloading only.

when the man placing fruit on the belt must wait to keep pace with the packing line. It is possible that part of this wait time would be avoided if the transportation distance from the temporary storage to the belt conveyor were greater, the transportation distance for the truck-unloading operation shorter, and the two unloaders were assigned to other work. The elapsed time required to unload by this method is 0.83 hour per 1,000 boxes, less than by the other method. The worker placing fruit on the belt conveyor moves continuously at the pace of the machine which would require 3.33 hours to receive 1,000 boxes to the washing and packing line. Since the man supplying the dumper usually works on another floor level or at a distant point from the washing and packing line, the problem of utilizing his wait time is difficult. Most of the odd jobs are in the vicinity of the packing line. For this reason, the usual arrangement of the belt conveyor with roller extension going onto the road truck bed, allows the bank of supply to be in the dumper area which provides more opportunity for assigning work to the hand trucker supplying the dumper.

Clamp-Type 2-Wheel Hand Trucks and Floor Chain Conveyor

Floor chain conveyors in combination with 2-wheel hand trucks are used to move fruit directly to the packing line. The floor chain conveyor is installed as a means of feeding the mechanical stackdumper. Usually these floor chain conveyors are relatively short, approximately 15 feet. However, there undoubtedly would be advantages to using a longer chain. The advantages of a longer conveyor are explored in the improved method in which it is assumed that 100 feet of floor chain conveyor is installed. From the standpoint of labor required the floor chain is a means of evening out the work load and of keeping pace with the packing line.

3-Man Crew and 15-Foot Conveyor

The most widely used method of receiving to the packing line by use of hand trucks and floor chain conveyor involves a total transportation distance of 70 feet. Forty-five feet of this distance is covered by two men hand trucking fruit to a temporary bank of supply. A third worker moves the fruit an additional 10 feet onto a 15-foot floor chain conveyor. (When the chain is nearly empty he transports the full distance of the chain conveyor.) After the two workers have unloaded the road truck into a bank of supply, they either move to other productive work or begin unloading a second road truck.

By use of this method 5.25 man-hours of labor are required to receive 1,000 boxes (table 67). Nearly one-half of this labor is lost through waiting, due almost entirely to delays in moving fruit from the temporary bank of supply to the floor chain conveyor. It is possible that assignment of odd jobs to this worker would reduce the wait time.

Table 67.--Labor required for a 3-man crew to unload and move 1,000 unpacked boxes of apples directly to the packing line from a road truck by use of clamp-type 2-wheel hand trucks and a 15-foot floor chain conveyor

Operation	Workers	Productive labor	Fatigue allowance	Wait time	Total labor
	Number	Man-hours	Man-hours	Man-hours	Man-hours
Set up and clean up	2	0.12	0.0	0.0	0.12
Pick up 6-high stacks on road truck by use of hand truck	2	.39	.04	.0	.43
Transport 45 feet to bank by use of hand truck	2	.88	.09	.08	1.05
Release in bank by use of hand truck	2	.29	.03	.0	.32
Pick up 6-high stacks in bank by use of hand truck	1	.29	.03	.0	.32
Transport 10 feet to floor chain by use of hand truck	1	.28	.03	.0	.31
Release on floor chain by use of hand truck	1	.24	.02	2.44	2.70
Total man-hours	-	2.49	.24	2.52	5.25
Elapsed time--hours					1/ .96

1/ Truck unloading only.

2-Man Crew and 100-Foot Conveyor

An improved method of moving fruit to the packing line with floor chain conveyor uses a 2-man crew and a 100-foot floor chain conveyor. These men work only intermittently while the road truck is being unloaded. They move the fruit a distance of 70 feet by use of hand trucks and release it on the floor chain conveyor. When the conveyor is nearly empty the transportation distance is 100 feet, when it is partly full this distance is proportionately less. After unloading the road truck to the floor chain conveyor, the two workers are assigned to other work.

The improvement in this method centers around the installation and use of a much longer floor chain conveyor. A 100-foot floor chain contains space for approximately 600 boxes of apples in 6-high stacks, a little more than two road truckloads and an amount sufficient to keep the packing line supplied for two hours. The bank of supply on the floor chain conveyor feeding the packing line permits the workers to move to other work rather than having one of them continuously employed supplying the packing line. Because the distance between the packing line and the receiving platform must be a straight distance of 100 or more feet, few plants could utilize this method.

This method of unloading and moving apples to the packing line reduces the labor requirement 56 percent. Only a nominal amount of wait time occurs. It will be noted from table 68 that the elapsed time of 1.16 hours required to unload the road truck is greater than for the common method since the hand truckers must transport fruit a longer distance. This elapsed time could be reduced through the use of a 3-man crew.

Table 68.--Labor required for a 2-man crew to unload and move 1,000 unpacked boxes of apples to the packing line from a road truck by use of clamp-type 2-wheel hand trucks and a 100-foot floor chain conveyor

Operation	Workers	Productive labor	Fatigue allowance	Wait time	Total labor
	Number	Man-hours	Man-hours	Man-hours	Man-hours
Set up and clean up	2	0.12	0.0	0.0	0.12
Pick up 6-high stacks on road truck by use of hand truck	2	.39	.04	.0	.43
Transport 70 feet to bank by use of hand truck	2	1.31	.13	.08	1.52
Release on floor chain conveyor	2	.24	.02	.0	.26
Total man-hours	-	2.06	.19	.08	2.33
Elapsed time--hours					1.16

Comparison of Hand Truck--Floor Chain Conveyor Methods

Labor and equipment costs incurred by the method of using a temporary bank of supply and short length of floor chain conveyor to supply apples directly to the packing line are $6.75 per 1,000 boxes handled (table 69). Most of this cost is labor cost. The improved method reduced total cost only $0.15 per 1,000 boxes, but reduced labor cost by more than 50 percent. Thus, the advantage of the improved method largely is in reducing the size of the crew. Moreover, the elapsed time with the improved method is greater than with the common method.

Table 69.--Comparative labor and equipment costs of 2 specified methods of unloading and moving 1,000 unpacked boxes of apples to the packing line from road trucks by use of 2-wheel hand trucks and floor chain conveyor

Method	Elapsed time	Labor and equipment required: Equipment time	Labor and equipment required: Wait time	Labor and equipment required: Total labor	Labor and equipment costs: Equipment	Labor and equipment costs: Labor 1/	Total cost: Current wages	Total cost: Assumed wages
	Hours	Machine-hours	Man-hours	Man-hours	Dollars	Dollars	Dollars	Dollars
Two men hand truck 45 feet to bank, 1 man hand trucks 10 feet to 15-foot floor chain conveyor	2/ 0.96	3/ 8.58	2.52	5.25	0.71	6.04	6.75	8.06
Two men hand truck 70 feet to 100-foot floor chain conveyor	1.16	4/ 5.66	.08	2.33	3.92	2.68	6.60	7.18

1/ Computed from "current" wage rates.
2/ Truck unloading only.
3/ Clamp-type 2-wheel hand truck 5.25 machine-hours, 15-foot floor chain conveyor 3.33 machine-hours, total 8.58 machine-hours.
4/ Clamp-type 2-wheel hand truck 2.33 machine-hours, 15-foot floor chain conveyor 3.33 machine-hours, total 5.66 machine-hours.

Industrial Fork-Lift Truck and Pallets

The use of industrial trucks and pallets to move fruit directly to the packing line is rather limited. When fruit is received unpalletized from orchard trailers, pallet loads are built on the receiving apron at the warehouse before the fruit is moved to the packing line. Apples received at pallet plants on road trucks usually are on pallets or in palletized loads which are built in the orchard.

Unloading from Road Trucks and Moving to the Packing Line

Fruit may arrive at the warehouse on pallets on road trucks or partially palletized on trailers. Usually, completely palletized loads of fruit arrive at the plant only on road trucks. The usual method of moving palletized loads of fruit directly to the packing line is for the fork-lift truck operator to lift a unit load from the road truck, transport it approximately 50 feet to the dumping area, and place it in a temporary bank of supply. Usually pallet loads are tiered two unit loads, or 12 boxes high, in the temporary storage area. Later, another worker, or the same lift-truck operator, moves the unit loads from the bank of supply to the dumper, a distance of approximately 20 feet.

By this method of using fork-lift trucks to move 48-box pallet loads of fruit directly to the washer, 1.21 man-hours of labor are required per 1,000 boxes (table 70). Of the total labor, 33 percent is lost in waiting. Most of the wait time, 80 percent, is attributed to the road truck driver standing by while the road truck is being unloaded. The elapsed time to unload 1,000 boxes is relatively low, 0.45 of an hour.

Table 70.--Labor required to unload and move 1,000 unpacked boxes of apples directly to the packing line from a road truck by use of pallets and industrial fork-lift truck when boxes are received in 48-box pallet loads

Operation	Workers	Productive labor	Fatigue allowance	Wait time	Total labor
	Number	Man-hours	Man-hours	Man-hours	Man-hours
Set up and clean up	1	0.13	0.0	0.32	0.45
Pick up 48-box pallet loads off road truck bed by use of fork-lift truck	1	.07	.0	.08	.15
Transport 50 feet to temporary bank	1	.22	.02	.0	.24
Release or tier unit loads in temporary storage--average 2-pallet loads high	1	.06	.0	.0	.06
Pick up unit loads in temporary bank	1	.06	.0	.0	.06
Transport 48-box pallet loads 20 feet to dumper area	1	.13	.02	.0	.15
Release unit load at dumper	1	.10	.0	.0	.10
Total man-hours	-	.77	.04	.40	1.21
Elapsed time--hours					1/ .45

1/ Truck unloading only.

Unloading from Orchard Trailers and Moving to the Packing Line

When apples are hauled to the warehouse on orchard trailers, pallet loads are built by the trailer operator after the pallets have been placed around the trailer. (Sometimes the fork-lift truck operator assists in placing empty pallets around the trailer. In other cases, the tractor operator obtains and manually carries each empty pallet from the plant to the trailer after he has finished building the previous pallet load.) The fork-lift truck operator picks up completed pallet loads and moves them either directly to the packing line or to a temporary storage area. In the method shown, it has been assumed that the lift-truck operator does not place the empty pallets. The trailer driver builds unit loads on the trailer and the lift-truck operator moves the unit loads approximately 50 feet to the temporary storage area. Later, the lift-truck transports the fruit the additional 20 feet keeping the dumper supplied.

This method of using the lift truck requires 2.69 man-hours of labor to unload and move 1,000 boxes to the packing line (table 71). Because

Table 71.--Labor required to unload and move 1,000 unpacked boxes of apples into storage from an orchard trailer by use of pallets and industrial fork-lift truck when boxes are received unpalletized

Operation	Workers	Productive labor	Fatigue allowance	Wait time	Total labor
	Number	Man-hours	Man-hours	Man-hours	Man-hours
Set up and clean up	1	0.24	0.0	0.0	0.24
One man builds unit loads from orchard trailer	1	1.49	.30	.0	1.79
Pick up 48-box unit load by use of fork-lift truck	1	.05	.0	.0	.05
Transport unit load 50 feet to bank	1	.22	.02	.0	.24
Release or tier unit load in bank of supply—average 2 pallet loads high	1	.06	.0	.0	.06
Pick up 48-box unit load by use of fork-lift truck	1	.06	.0	.0	.06
Transport unit load 20 feet to dumper	1	.13	.02	.0	.15
Release unit load at dumper	1	.10	.0	.0	.10
Total man-hours	-	2.35	.34	.0	2.69
Elapsed time—hours					1/ 2.03

1/ Truck unloading only.

the work involved in building pallet loads occupies the time of the trailer operator, there is little delay time. It has been assumed that the fork-lift truck and operator are occupied in other work between times when moving fruit to the dumper. This assumption is based upon the fact that some plants have one fork-lift truck supplying the line, moving packed fruit away from the line, moving empty boxes to storage, and transporting the culls to a storage point somewhere in the warehouse.

Industrial Clamp-Type Lift Truck

By use of industrial clamp-type lift trucks, fruit arriving at the plant on road trucks is unloaded and moved to a bank of supply in the dumping area. 30/ Hand trucks are used to move fruit from the temporary bank of supply to packing line. This method is the most widely used method because most industrial clamp-truck plants have been converted from belt conveyor or hand-truck operations.

A second method of moving fruit directly to the packing line with industrial clamp-lift trucks is to use a set of accumulation conveyors (gravity-type). The lift-truck operator places part of the boxes as they are unloaded on the conveyor and builds a temporary bank of supply for the remaining boxes. Later the lift-truck operator removes the fruit from the temporary bank to the rollers. This operation is in many ways not the most practical, for few plants in the industry have sufficient industrial-clamp trucks and it is difficult to coordinate the supply of fruit unless a large lot of fruit is going directly to the packing line. If the grower's lot of fruit is large, it would probably necessitate building a large bank of supply anyway, so the operation would usually be one of working from the bank.

When the clamp-type industrial-lift truck is used in combination with 2-wheel hand trucks to move fruit directly to the packing line, the industrial truck moves fruit approximately 50 feet from a road truck bed that has been stabilized by use of a hydraulic lift. The hand truck operator moves the boxes from this temporary bank of supply 20 feet to the dumper. By use of this method, 4.93 man-hours are required to receive 1,000 boxes (table 72). Sixty-one percent of this labor is accounted for by idle or

Table 72.--Labor required for a 2-man crew to unload and move 1,000 unpacked boxes of apples to the packing line from a road truck by use of industrial clamp-type lift truck and 2-wheel hand truck

Operation	Workers	Productive labor	Fatigue allowance	Wait time	Total labor
	Number	Man-hours	Man-hours	Man-hours	Man-hours
Set up and clean up	1	0.15	0.0	0.65	0.80
Pick up 24-box unit load on road truck bed by use of industrial clamp truck	1	.11	.0	.09	.20
Transport 50 feet to bank by use of industrial clamp truck	1	.38	.03	.0	.41
Release in bank by use of industrial clamp truck	1	.19	.0	.0	.19
Pick up 6-high stack by use of 2-wheel hand truck	1	.29	.03	.0	.32
Transport 20 feet with 2-wheel hand truck	1	.45	.05	.0	.50
Release at dumper area with 2-wheel hand truck	1	.24	.02	2.25	2.51
Total man-hours	-	1.81	.13	2.99	4.93
Elapsed time--hours					1/ .80

1/ Truck unloading only.

30/ Industrial clamp-type trucks are either of 24- or 36-box capacity.

wait time. Most of the wait time arises from the hand truck operator waiting to bring fruit to the dumper because the packing line does not utilize the fruit as rapidly as the hand trucker can move it to the dumper. Assignment of odd jobs would reduce wait time. Twenty-two percent of the wait time results from the road truck operator standing by while the road truck is being unloaded.

Industrial Fork-Lift Truck, Low-Lift Pallet Transporter, and Pallets

The low-lift pallet transporter is not widely used in the Washington State apple plants. At the time field work was under way, there was only one plant that occasionally used this type of materials-handling equipment. This plant did not follow the practice of stabilizing truck beds. Instead, a fork-lift truck removed unit loads from the road truck bed, transported the load 20 feet and released it on the receiving platform. The low-lift pallet transporter picked up the unit load and transported it approximately 50 feet to the dumper.

By use of the industrial fork-lift truck in combination with the low-lift pallet transporter, 3.99 man-hours of labor were required to move 1,000 boxes to the packing line (table 73). Seventy-six percent of

Table 73.--Labor required to unload and move 1,000 unpacked boxes of apples directly to the packing line from a road truck by use of pallets, industrial fork-lift truck, and low-lift pallet transporter

Operation	Workers	Productive labor	Fatigue allowance	Wait time	Total labor
	Number	Man-hours	Man-hours	Man-hours	Man-hours
Set up and clean up	2	0.13	0.0	0.20	0.33
Pick up 48-box pallet load off road truck bed by use of fork-lift truck	1	.07	.0	.08	.15
Transport 20 feet to bank on platform	1	.13	.01	.0	.14
Release pallet load on platform by use of fork-lift truck	1	.04	.0	.0	.04
Pick up 48-box pallet from bank on platform by use of low-lift pallet transporter	1	.11	.01	.0	.12
Transport 50 feet by use of low-lift pallet transporter	1	.28	.03	.0	.31
Release at dumper by use of low-lift pallet transporter	1	.12	.01	2.77	2.90
Total man-hours	-	.88	.06	3.05	3.99
Elapsed time--hours					1/ .33

1/ Truck unloading only.

this labor was accounted for by wait time. Most of the wait time, 91 percent, resulted from the low-lift pallet transporter standing by waiting to keep the dumper supplied. Part of this wait time could be avoided if the operations in the plant could be so arranged that the low-lift pallet transporter and operator could be assigned to intermittent odd jobs.

Comparison of Methods and Types of Equipment for Unloading from Road Trucks and Moving Directly to the Packing Line

Of the different methods and types of equipment previously discussed for unloading from road trucks and moving boxes of apples directly to the packing line, the most economical is fork-lift trucks and pallets, with labor and equipment costs of $4.78 per 1,000 boxes (table 74). The second

Table 74.--Comparative labor and equipment costs for unloading from road trucks and moving 1,000 unpacked boxes of apples to the packing line by use of specified methods and types or combinations of types of equipment 1/

Types of equipment and method	Workers	Elapsed time	Labor and equipment required: Equipment time	Labor and equipment required: Wait time	Labor and equipment required: Total labor	Labor and equipment costs: Equipment 2/	Labor and equipment costs: Labor 3/	Total costs: Current wages	Total costs: Assumed wages 4/
	Number	Hours	Machine-hours	Man-hours	Man-hours	Dollars	Dollars	Dollars	Dollars
Clamp-type 2-wheel hand truck: 2 workers hand-truck 50 feet to bank, 1 worker hand-trucks 20 feet to dumper	3	5/ 1.01	5.35	2.33	5.35	0.13	6.15	6.28	7.62
Belt conveyor and hand truck: 2 workers hand-truck 30 feet to bank. 1 man hand-trucks 10 feet to belt conveyor and places on conveyor 6/	3	5/ .83	7/ 8.32	1.47	4.99	.95	5.74	6.69	7.94
Floor chain conveyor and hand truck: 2 workers hand-truck 45 feet to bank, 1 man hand-trucks 10 feet to 15-foot floor chain conveyor	3	5/ .96	8/ 8.58	2.52	5.25	.71	6.04	6.75	8.06
Floor chain conveyor and hand truck: 2 workers hand-truck 70 feet to a 100-foot floor chain conveyor 9/	2	1.16	10/ 5.66	.08	2.33	3.92	2.68	6.60	7.18
Industrial fork-lift truck, palletized: 1 worker and fork-lift truck transport 48-box pallet loads 50 feet to bank and then 20 feet to dumper. 1 worker mostly waits.	2	5/ .45	11/ 1.52	.40	1.21	3.27	1.51	4.78	5.08
Industrial clamp-type lift truck: 1 worker and industrial-clamp truck transport 50 feet to bank, 1 worker hand-trucks 20 feet from bank to dumper	2	5/ .80	12/ 4.93	2.99	4.93	1.96	5.79	7.75	8.98
Industrial fork-lift truck, low-lift pallet transporter and pallets: 1 worker and fork-lift truck transport 20 feet to bank, 1 worker and low-lift pallet transporter transport 50 feet to dumper	2	5/ .33	13/ 4.55	3.05	3.99	7.54	4.64	12.18	13.18

1/ Except as otherwise noted, all transportation distances are standardized at 70 feet.
2/ Equipment costs computed from data on ownership and operating costs shown in table 2.
3/ "Current" labor costs computed from wage rates of $1.15 per hour for unskilled labor and $1.30 per hour for semiskilled labor (key workers such as industrial truck operators).
4/ Assumed labor costs computed from wage rates of $1.40 per hour for unskilled workers and $1.55 per hour for semiskilled labor.
5/ Truck unloading only.
6/ Conveyor transports fruit 30 feet.
7/ 30-foot belt conveyor 3.33 machine-hours, clamp-type 2-wheel hand truck 4.99 machine-hours, total 8.32 machine-hours.
8/ 15-foot floor chain conveyor 3.33 machine-hours, clamp-type 2-wheel hand truck 5.25 machine-hours, total 8.58 machine-hours.
9/ Transportation distance increased to 170 feet, 100 feet of which is by use of floor chain conveyor. Conveyor serves as an accumulator. Increased distance adds equipment costs but does not increase labor costs.
10/ 100-foot floor chain conveyor 3.33 machine-hours, clamp-type 2-wheel hand truck 2.33 machine-hours, total 5.66 machine-hours.
11/ 4,000-pound capacity electric fork-lift truck 0.76 machine-hours, 20.8 pallets (48-box) 0.76 machine hours, total 1.52 machine hours.
12/ 1,000-pound (24-box) capacity electric clamp-type truck 0.80 machine-hours, hydraulic stabilizer unit 0.80 machine-hours, clamp-type 2-wheel hand truck 3.33 machine hours, total 4.93 machine-hours.
13/ A 4,000-pound capacity electric fork-lift truck 0.33 machine hours, 4,000-pound capacity electric low-lift pallet transporter 3.33 machine-hours, 20.8 pallets (48-box) 0.89 machine-hours, total 4.55 machine-hours.

most economical method uses the 2-wheel hand truck. There is a marked contrast in labor and machine costs of hand truck and fork-lift truck methods. Receiving by use of hand trucks had the highest labor cost of all methods, a factor that should be considered when there is difficulty hiring sufficient workers to operate a plant. The highest cost method of receiving was the combination of equipment using a fork-lift truck and low-lift pallet transporter.

With the exception of fork-lift truck and pallet methods, floor chain conveyor plants use less labor to move fruit to the packing line than any other method. Other methods of moving apples directly to the line incurred labor costs of from $5.00 to $7.00 per 1,000 boxes received.

When fork-lift trucks are used to move fruit directly to the packing line, the elapsed time required, as well as the costs, was relatively low. However, the use of the pallet transporter with the fork-lift truck reduced the elapsed time, so that only 0.33 of an hour was needed to unload 1,000 boxes from road trucks. The floor chain conveyor which showed relatively low labor cost had the disadvantage of requiring the longest elapsed time to unload.

Comparison of Methods and Types of Equipment for Unloading from Orchard Trailers and Moving Directly to the Packing Line

The method of unloading apples from trailers and moving directly to the packing line, in which gravity roller conveyors replace the hand trucks, resulted in a large saving. At current wage rates, the total labor and equipment costs by the improved method were $2.60 per 1,000 boxes compared with $8.23 by the hand truck method (table 75). Savings in labor with the improved method were greater than the actual savings because there was additional machine cost; yet this machine cost is not great, amounting to only $0.85 per 1,000 boxes. The greater efficiency of the improved method

Table 75.--Comparative labor and equipment costs for unloading from orchard trailers and moving 1,000 unpacked boxes of apples to the packing line by use of specified methods and types of equipment 1/

Method	Elapsed time	Labor and equipment required: Equipment time	Labor and equipment required: Wait time	Labor and equipment required: Total labor	Labor and equipment costs: Equipment 2/	Labor and equipment costs: Labor 3/	Total costs: Current wages	Total costs: Assumed wages 4/
	Hours	Machine-hours	Man-hours	Man-hours	Dollars	Dollars	Dollars	Dollars
One worker builds stacks on trailer, 2 workers hand truck 50 feet to bank, 1 worker hand trucks 20 feet from bank to dumper	5/ 1.26	7.01	2.85	7.01	0.17	8.06	8.23	9.98
One worker transfers boxes from trailer to 50-foot long roller conveyors 6/	1.52	7/ 1.52	.0	1.52	.85	1.75	2.60	2.98
One worker builds unit loads or pallets, 1 fork-lift truck transports 50 feet to bank, 20 feet to dumper	5/ 2.03	8/ 1.32	.0	2.69	2.83	3.19	6.02	6.69

1/ Except as otherwise noted, all transportation distances are standardized at 70 feet.
2/ Equipment costs computed from data on ownership and operating costs shown in table 2.
3/ "Current" labor costs computed from wage rates of $1.15 per hour for unskilled labor and $1.30 per hour for semiskilled labor (key workers such as industrial truck operators).
4/ Assumed labor costs computed from wage rates of $1.40 per hour for unskilled workers and $1.55 per hour for semiskilled labor.
5/ Trailer unloading only.
6/ Transportation distance is 50 feet. Decrease of 20 feet in standard distance does not affect labor costs.
7/ Four 50-foot roller conveyors 1.52 machine hours.
8/ 4,000-pound electric fork-lift truck 0.66 machine-hours, 20.8 pallets (48-box) 0.66 machine-hours, total 1.32 machine-hours.

also is shown by the elimination of all wait time. It would appear desirable to use gravity roller conveyors in place of 2-wheel hand trucks in all plants that can make use of this method of receiving. If it is impossible to install conveyors with sufficient incline, the worker who removes culls and empty boxes may need to assist in moving the boxes on the rollers to the dumper.

Labor and equipment costs per 1,000 boxes by use of industrial-lift truck and 48-box pallets are $6.02 at current wage rates. These costs are about equally divided between labor and equipment.

Comparison of Costs for Unloading, Moving to Storage, and then to the Packing Line with Costs for Unloading and Moving Directly to the Line

To a limited extent, apple houses have a choice of moving fruit directly to the packing line or into storage and then to the packing line. From the cost standpoint, it is much more economical to move fruit directly to the packing line. However, to handle a relatively large volume of fruit in this way requires a much larger investment in packing house facilities. The decision on the amount of fruit that can and should be moved directly to the line should be made in light of this and other factors previously discussed.

To illustrate comparative labor and equipment requirements and their costs, a belt-conveyor-hand-truck operation requires a total of 4.99 man-hours to move fruit directly to the packing line. If the fruit is moved into storage first and then to the packing line, approximately 3-$\frac{1}{2}$ times as much labor is required, 17.42 man-hours per 1,000 boxes (table 76). In addition, the number of handlings the fruit must undergo is greatly increased.

The time spent waiting when the fruit is moved to storage and then from storage to the packing line is 2-$\frac{1}{2}$ times as much as when the fruit is moved directly to the packing line. However, percentagewise the wait time involved in moving fruit to storage and later to the packing line is 21 percent of its total man-hours, while the wait time in moving fruit directly to the packing line is 29 percent of the total man-hours.

When using belt conveyors and hand trucks, labor and equipment costs are increased $18.24 (at current wage rates) per 1,000 boxes by moving fruit to storage before it is brought to the packing line (table 77). Offsetting this extra cost, less packing house equipment is required, the fruit is cooled more promptly, and packing operations are spread through a longer season.

Table 76.--Comparative labor requirements for unloading from road trucks and moving 1,000 unpacked boxes of apples directly to the packing line and for moving boxes of apples to storage and then to the packing line by use of belt conveyor and 2-wheel hand trucks

Operation	Workers	Productive labor	Fatigue allowance	Wait time	Total labor
	Number	Man-hours	Man-hours	Man-hours	Man-hours
Move apples directly to washing and packing line					
Set up and clean up	2	0.12	0.0	0.0	0.12
Hand truck 30 feet to bank	2	1.30	.13	.11	1.54
Hand truck 10 feet to belt conveyor	1	.81	.08	.0	.89
Place boxes on belt conveyor 1/	1	.90	.18	1.36	2.44
Total man-hours	-	3.13	.39	1.47	4.99
Move apples to storage first and then to washing and packing line					
Set up and clean up	10	.16	.0	.69	.85
Place boxes on belt conveyor	2	1.28	.25	.33	1.86
Transfer boxes from belt conveyor 2/	2	1.31	.26	.29	1.86
Hand truck 50 feet to storage	2	1.61	.17	.08	1.86
High-pile boxes to 12-high	4	2.27	.56	.89	3.72
Break down stack from 12-high to 6-high	2	2.02	.40	.0	2.42
Hand truck 35 feet to bank	2	1.29	.13	.10	1.52
Hand truck 15 feet to belt conveyor	1	.90	.09	.0	.99
Place boxes on belt conveyor 3/	1	.90	.18	1.26	2.34
Total man-hours	-	11.74	2.04	3.64	17.42

1/ Conveyor transports fruit 30 feet.
2/ Conveyor transports fruit 50 feet.
3/ Conveyor transports fruit 140 feet.

Table 77.--Comparative labor and equipment costs for unloading and moving 1,000 unpacked boxes of apples directly to the packing line from a road truck and for moving apples into storage and then to the packing line by use of belt conveyor and 2-wheel hand trucks 1/

Method	Workers	Labor and equipment required			Labor and equipment costs			
		Equipment time	Wait time	Total labor	Equipment 2/	Labor 3/	Total costs: Current wages	Total costs: Assumed wages 4/
	Number	Machine-hours	Man-hours	Man-hours	Dollars	Dollars	Dollars	Dollars
Unload road truck and move boxes of apples directly to washing and packing line	3	5/ 8.32	1.47	4.99	0.95	5.74	6.69	7.94
Unload road truck, move boxes of apples into storage and tier, and later move to washing and packing line	13	6/12.22	3.64	17.42	4.90	20.03	24.93	29.29

1/ Transportation distance when apples are moved directly from the road truck to the packing line is 70 feet. When moved to storage and then to the packing line the total transportation distance is 290 feet.

2/ Equipment costs computed from data on ownership and operating costs shown in table 2.

3/ "Current" labor costs computed from wage rates of $1.15 per hour for unskilled labor and $1.30 per hour for semiskilled labor (key workers such as industrial truck operators).

4/ Assumed labor costs computed from wage rates of $1.40 per hour for unskilled workers and $1.55 per hour for semiskilled labor.

5/ Clamp-type 2-wheel hand truck 4.99 machine-hours, 30-foot belt conveyor 3.33 machine-hours, total 8.32 machine-hours.

6/ Clamp-type 2-wheel hand truck 6.87 machine-hours, 100-foot belt conveyor 1.01 machine-hours, 140-foot belt conveyor 3.33 machine hours, 15-foot gravity roller conveyor 1.01 machine-hours, total 12.22 machine-hours.

METHODS AND EQUIPMENT FOR MOVING APPLES FROM STORAGE TO THE PACKING LINE

The practice in Washington State of placing most apples in cold storage before they are packed has led to the construction of ample storage facilities in most areas. As a result, most apples are received into cold storage, even when the apples are not to be held long, since many firms precool fruit before packing. Precooling takes the field heat out of the apples and slows down the ripening process. Precooling involves no special processes other than moving the fruit into cold rooms where it will be held briefly, usually a few days. Since much of the tonnage is moved into cold storage prior to packing, moving fruit out of cold storage to the packing line is an important and costly cycle of handling operations.

Moving fruit from storage to the packing line is not done under the pressure of harvest season operations. This work is spread over the packing season which varies in length with the size of the crop, the nature of the market, and practices in different localities.

During some seasons, a number of firms do not find it desirable to pack a great quantity of fruit in advance of sale, so that buyers can be provided the type of pack or the variety of fruit demanded. Frequently, to meet market demand, apple houses pack intermittently for the first few months of the season and then shut down for a few weeks. Some firms stop and start their packing operations several times in a season. In the Wenatchee and Okanogan areas, most firms pack as rapidly as possible in the hope of completing operations before the onset of cold weather.

Unpacked fruit is moved from storage to the packing line either in standard boxes, which are later used for packed fruit, or in field boxes. In either case, these are the boxes in which apples are received. Generally, moving apples from storage to the line involves the following cycle of operations: (1) Picking up boxes; (2) transporting boxes from the stacking or storage point to the packing line; (3) releasing the boxes in a temporary bank or in the dumping area; and (4) returning empty with the materials-handling equipment to pick up the next load. Where boxes of fruit are stacked in storage more than 6-boxes high and are to be handled with materials-handling equipment other than industrial fork-lift type or clamp-type trucks, all boxes above the 6-high stacks must first be removed or "broken out."

When industrial fork-lift trucks are used in combination with clamp-type 2-wheel hand trucks, these operations are repeated to complete the entire cycle. When belt conveyors are used in combination with other equipment, there are two additional operations--placing boxes on and removing them from the conveyor.

As used in this report, the operation of picking-up boxes is identical with that described for the cycle of operations performed in unloading and moving apples into storage. Pickup time starts when the operator begins positioning his equipment and ends when he is in position to move to or start the next operation in the cycle.

Transporting boxes to the packing line begins as soon as the worker with the hand truck is in position to move or the unit load clears its original position and ends when the worker with the hand or industrial truck reaches the temporary bank or the area adjacent to the dumper and starts to maneuver to release the stack or unit load.

Releasing the boxes in the temporary bank or at the dumper consists of setting the boxes down in position either for subsequent movement or for dumping. The operation begins when the worker starts to maneuver the truck into position and ends when the hand trucker begins to return empty or when the forks or clamps of the industrial truck clear the load.

Returning empty with materials-handling equipment begins when the hand truck operator has completed his backing and turn and starts his return to pick up the next load or when the forks or clamps of the industrial truck clear the load and ends when he begins positioning the forks or clamps to pick up a load. For purposes of this report, labor incurred in transporting boxes to the packing line and returning empty is combined and shown as transportation labor.

A single packing line utilizes from 2,000 to 4,000 boxes of loose or unpacked fruit per day. Handling operations involved in moving apples from storage to the line are paced by the rate of the packing line. Fruit handling crews frequently are delayed waiting for the packing line to use the fruit. As a result of delays and other wait time, supplying fruit to the line is a relatively costly operation. However, there are possibilities for improving methods to avoid delays and reduce costs. Crews moving fruit to the packing line usually are made up of more experienced workers and are smaller than the crews used for some other operations, facilitating supervision.

The most widely used equipment for moving fruit from storage to the packing line is the clamp-type hand trucks in combination with belt conveyors. Some plants that use hand trucks entirely during the receiving operation use belt conveyors to move fruit to the packing line. Part of the advantage of belt conveyors is that in dumping boxes the loads or stacks must be broken down for dumping one box at a time. There is little difference in the labor required to break the stacks in the cold room when the boxes are placed on the belt and that required when the stacks are transported to the dumper and broken as part of the dumping operation. Some of the smaller plants use the hand trucks for supplying dumpers. Except for new methods of handling by use of industrial equipment, the use of other types of equipment for moving fruit to the line is not widespread in Washington State plants.

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Moving fruit to the packing line may involve breaking out high-piled boxes in the storage room. In high-piling plants, the fruit moved to the packing line by equipment other than industrial trucks first must be removed from above the 6-high stacks. (The upper boxes are lowered to the floor and built into 6-high stacks so that they can be hand trucked to the packing line or belt conveyor.) Stackbreaking is discussed as a separate operation for all types of equipment except industrial trucks. The types and combinations of types of equipment used for moving apples to the packing line covered in this report are:

1. Clamp-type 2-wheel hand trucks alone.

2. Clamp-type 2-wheel hand truck and belt conveyor.

3. Clamp-type 2-wheel hand truck and floor chain conveyor.

4. Clamp-type 2-wheel hand truck, floor chain conveyor and stackbreaker.

5. Clamp-type 2-wheel hand truck, belt conveyor, stackmaker and floor chain conveyor.

6. Clamp-type 2-wheel hand truck and elevator.

7. Industrial clamp-type truck.

8. Industrial fork-lift truck and pallets.

9. Industrial fork-lift truck, low-lift pallet transporter, and pallets.

The methods of using these types or combinations of equipment are discussed in the following sections of the report. It is assumed that the packing line uses approximately 300 boxes of loose fruit per hour. The rate at which the packing line handles fruit determines the elapsed time required to supply 1,000 boxes to the line, in this case 3.33 hours. Therefore, elapsed time is not shown in the analysis of the method of moving fruit to the packing line from storage. Except as noted in connection with certain methods, a standardized transportation distance of 190 feet is used for analytical purposes.

Clamp-Type 2-Wheel Hand Trucks Alone

Hand trucks alone are used to move fruit to the packing line only when relatively short transportation distances are involved. When the distance is great, most plants have installed belt conveyors which they use in combination with 2-wheel hand trucks. However, for purposes of analysis and to provide comparative data, the 190-foot distance is adhered to for all discussions in this section. 31/

When apples are moved to the packing line by hand truckers, a crew of two or more workers picks up 6-high stacks of boxes in the storage area and releases them to build a bank of supply near the dumper. Another hand trucker moves the fruit from the temporary bank or block into position for the worker dumping fruit into the washer (fig. 87). In practice there are two variations of this method. One in which a large bank of supply is

Figure 87.--A hand trucker supplies a dumper from a temporary bank.

built and the crew trucking from storage is assigned to other work while boxes are supplied to the dumper. The other is to have a small crew continuously bringing fruit to the bank of supply. The work elements in the two variations are similar and for that reason the most widely used method of building large banks of supply is used in the analysis that follows.

In plants having more than one packing line, one worker may be used to supply two lines, but he works from two banks of supply, since one grower's lot of fruit is seldom run over two lines at the same time. Supplying two lines at once is not a method widely used. So, it is assumed that the hand trucker supplying the dumper works at only one packing line.

31/ Transportation distance will not alter the organization of the method materially, except that at a shorter distance fewer hand truckers will be needed.

The time of the hand trucker supplying the dumper usually is not fully occupied because the packing line does not use fruit at as rapid a rate as it can be hand trucked to the dumper from a nearby bank of supply. The resulting wait time might be eliminated by locating the temporary banks of supply a little farther from the dumper or nearer to the original storage point. However, because of the layout of most plants, this cannot be done. Elimination of wait time, therefore, depends on arranging the work so that the hand trucker may be assigned odd jobs of short duration. Some of the odd jobs that might be assigned to him are moving empty boxes away from the dumper, handling culls from the packing line, and removing leaves from the washer. Since the assignment of odd jobs varies by packing houses, it is assumed that the wait time of the hand trucker supplying the dumper is not productively utilized.

For a distance of 170 feet from the storage point to the dumping area, two hand truckers are usually employed. Six-high stacks of boxes are picked up in storage, hand trucked 170 feet, and released in a temporary bank of supply near the dumper. (Although some of the fruit trucked to the dumping area may be broken down from high-piled stacks, breaking out high-piled boxes is not considered here as part of this group of operations.) Supplying the dumper is completed when a third worker picks up the 6-high stacks from the temporary storage area and moves them 20 feet into position for the worker dumping the fruit (fig. 88). After the temporary bank of supply is built large enough to keep the packing line supplied for the desired period, the two workers moving fruit from storage are assigned other work.

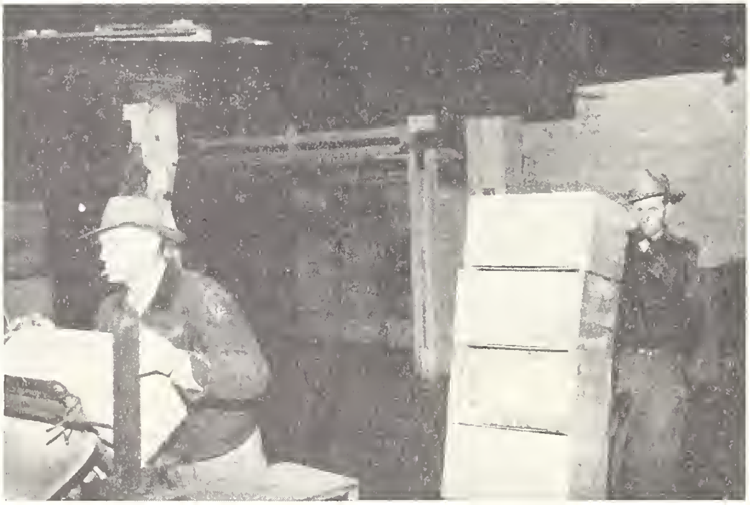

Figure 88.--Worker hand trucking stacks from a bank of supply to a dumper.

The labor required by this method is 7.28 man-hours per 1,000 boxes (table 78)--a little more than 50 percent in transportation, and 31 percent

Table 78.--Labor required for a 3-man crew to move 1,000 unpacked boxes of apples from storage to the packing line by use of clamp-type 2-wheel hand trucks 1/

Operation	Workers	Productive labor	Fatigue allowance	Wait time	Total labor
	Number	Man-hours	Man-hours	Man-hours	Man-hours
Pick up 6-high stacks by use of hand truck	2	0.29	0.03	0.0	0.32
Transport stacks 170 feet to temporary bank	2	3.01	.30	.0	3.31
Release stacks at temporary bank	2	.29	.03	.0	.32
Pick up 6-high stacks by use of hand truck at temporary bank	1	.29	.03	.0	.32
Transport stacks 20 feet to dumper	1	.45	.05	.0	.50
Release stacks at dumper	1	.24	.02	2.25	2.51
Total man-hours	-	4.57	.46	2.25	7.28

1/ Labor requirements do not include breaking out boxes above 6-high stacks in storage rooms.

in wait time. A large part of the wait time is due to delays of the man supplying the dumper. Depending on the practices and layouts of individual plants, part of this wait time might be utilized by assigning this worker odd jobs. Labor and equipment costs by use of this method are shown in table 79.

Table 79.--Labor and equipment costs for a 3-man crew to move 1,000 unpacked boxes of apples from storage to the packing line by use of clamp-type 2-wheel hand trucks 1/

Method	Labor and equipment required			Labor and equipment costs			
	Equipment time	Wait time	Total labor	Equipment	Labor 2/	Total costs: Current wages	Total costs: Assumed wages
	Machine-hours	Man-hours	Man-hours	Dollars	Dollars	Dollars	Dollars
Two workers hand truck stacks 170 feet from storage to build up a day's supply in bank near the dumper, then move to another job, 1 worker supplies dumper from the bank 20 feet away by use of hand truck	7.28	2.25	7.28	0.18	8.37	8.55	10.37

1/ Costs do not include breaking out boxes above 6-high stacks in storage rooms.
2/ Computed from "current" wage rates.

Clamp-Type 2-Wheel Hand Trucks and Belt Conveyors

Most of the older type plants in Washington State use hand trucks in combination with the belt conveyor to move fruit to the packing line. Belt conveyors are arranged so that the fruit can be conveyed from all parts of the storage plant with only a short transportation distance by use of hand trucks. This distance is assumed to be 50 feet. The belt conveyor moves boxes the remaining 140 feet to the dumper. Moving fruit to the packing line with this equipment combination consists of hand trucking 6-high stacks of boxes from the storage point, or from the stack-breaking crew, to the belt conveyor and placing boxes, one at a time, on the conveyor. Boxes are removed from the conveyor by the dumper. One variation of the method uses a crew to move up a large temporary bank of supply close to the belt, after which the crew does other work, while another worker trucks the boxes the remaining distance and places them on the belt, keeping the dumper supplied. By another variation in the method, a small crew (the size depending on the distance) brings fruit up to the belt (50 feet) as it is placed on the conveyor, but at the expense of an additional wait time of about 2.50 man-hours per 1,000 boxes. Only the first of these variations is presented here.

3-Man Crew Using Temporary Bank

By use of this method, two workers hand truck fruit 35 feet from the storage point or from the "stackbreakers," and release loads in a temporary bank of supply near a belt conveyor. 32/ When sufficient boxes are in the bank, these workers are assigned to other jobs. A third worker hand trucks stacks 15 feet to the belt conveyor and places boxes on the conveyor which moves them 140 feet to the dumper (fig. 89).

This method requires 4.85 man-hours for moving 1,000 boxes to the packing line--27 percent of it (1.29 hours) for transportation and 28 percent for wait time (table 80). Almost all of this wait time is incurred by the worker placing boxes on the belt conveyor--the work being done in the cold storage room where it would be impractical to fill in with other assignments. If the plant layout permits and if there is vacant space in the storage room the transportation distance to the temporary bank of supply can be decreased, leaving more distance for the worker supplying the belt to cover. This increase might decrease the delay time by shifting more work from the men building the bank of supply to the third worker. The extent to which such a shift could be made is governed by the fact that boxes must be placed on the belt at regular intervals to avoid the dumper being supplied intermittently which would result in a delay in the operations of the grading crew.

Figure 89.--Placing boxes from 6-high stacks onto a belt conveyor.

32/ The term "stackbreakers" refers to the men manually lowering the previously high-piled boxes to a stack height which can be moved by 2-wheel hand truck.

Table 80.--Labor required for a 3-man crew to move 1,000 unpacked boxes of apples from storage to the packing line by use of clamp-type 2-wheel hand trucks and belt conveyor 1/

Operation	Workers	Productive labor	Fatigue allowance	Wait time	Total labor
	Number	Man-hours	Man-hours	Man-hours	Man-hours
Pick up 6-high stacks at storage position by use of hand trucks	2	0.29	0.03	0.0	0.32
Transport stacks 35 feet to temporary bank	2	.71	.07	2/ .10	.88
Release stacks at bank	2	.29	.03	.0	.32
Pick up 6-high stacks from bank by use of hand truck	1	.29	.03	.0	.32
Transport stacks 15 feet to belt	1	.37	.04	.0	.41
Release stacks at belt conveyor	1	.24	.02	.0	.26
Place boxes from single row stacks on belt conveyor	1	.90	.18	1.26	2.34
Total man-hours	-	3.09	.40	1.36	4.85

1/ Labor requirements do not include breaking out boxes above 6-high stacks in storage rooms.
2/ Wait time caused by crew interference.

One Worker and Accumulator Device

A method for moving boxes of apples to the packing line might be developed by building accumulator space on the belt conveyor near the dumper in which a supply of fruit could be accumulated to supply the packing line for a short period. 33/ It is assumed that such an accumulation device would permit the hand trucker placing fruit on the belt to transport fruit a distance of 50 feet. The remaining 140 feet of transportation would be by use of the belt conveyor. This device should permit the crew size to be reduced to one worker who would transport several stacks from the storage point to the belt and place the boxes from these stacks on the belt conveyor moving to the packing line. Accumulator space on the belt conveyor should permit the worker to place the boxes from several stacks on the conveyor before repeating the cycle. By this method the total labor required to supply the dumper should be reduced to 3.33 man-hours per 1,000 boxes, the rate at which the dumper uses the fruit (table 81). Theoretically, no additional reduction in labor could be achieved, even though 18 percent of the total labor would be wait time.

Comparison of 3-Man Crew and One Worker

At current wage rates, the method employing only one worker, might reduce total labor and equipment costs of moving fruit to the packing line by $1.79 per 1,000 boxes, or from $9.56 to $7.77 (table 82). Perhaps more

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33/ Although such an accumulator is not used for this purpose in the industry, small sections are used in supplying some of the mechanical dumpers.

Table 81.--Labor required for 1 worker to move 1,000 unpacked boxes of apples from storage to the packing line by use of clamp-type 2-wheel hand truck, belt conveyor, and accumulator 1/

Operation	Workers	Productive labor	Fatigue allowance	Wait time	Total labor
	Number	Man-hours	Man-hours	Man-hours	Man-hours
Pick up 6-high stacks at storage position by use of hand truck	1	0.29	0.03	0.0	0.32
Transport 50 feet to side of belt conveyor	1	.97	.10	.0	1.07
Release stacks at belt conveyor	1	.24	.02	.0	.26
Place boxes on belt conveyor from single-row stacks	1	.90	.18	.60	1.68
Total man-hours	-	2.40	.33	.60	3.33

1/ Labor requirements shown were developed from standard data. These requirements do not include breaking out boxes above 6-high stacks in storage rooms.

Table 82.--Comparative labor and equipment costs of 2 specified methods of moving 1,000 unpacked boxes of apples from storage to the packing line by use of clamp-type 2-wheel hand trucks and belt conveyors 1/

Method	Labor and equipment required			Labor and equipment costs			
	Equipment time	Wait time	Total labor	Equipment	Labor 2/	Total costs: Current wages	Total costs: Assumed wages
	Machine-hours	Man-hours	Man-hours	Dollars	Dollars	Dollars	Dollars
Three-man crew							
Two hand truckers move stacks 35 feet from storage to build up a day's supply in bank near the belt, then move to another job. One man places boxes on belt to dumper and hand trucks stacks 15 feet to belt	3/ 8.18	1.36	4.85	3.98	5.58	9.56	10.77
One worker							
One hand trucker wheels stacks 50 feet from storage position to a place beside belt, then places boxes on belt to dumper. Accumulator device used on belt	4/ 6.66	.60	3.33	3.94	3.83	7.77	8.60

1/ Costs do not include breaking out boxes above 6-high stacks in storage rooms.
2/ Computed from "current" wage rates.
3/ Clamp-type 2-wheel hand truck 4.85 machine-hours, 140-foot belt conveyor 3.33 machine-hours, total 8.18 machine-hours.
4/ Clamp-type 2-wheel hand truck and 140-foot belt conveyor 3.33 machine-hours each, total 6.66 machine-hours. No allowance included for accumulator device.

important is the reduction in the number of men required for this work. Although the method using a belt conveyor accumulating device might permit one hand trucker to supply the dumper, its use would be limited if the distance from the belt to the storage point is greater than 50 feet. The distance the fruit is hand trucked from storage points to the belt conveyor may vary considerably during a day. Therefore, although one hand trucker might be able to handle the work at one time, he might not be able to keep up with the packing line if the distance became greater. The widely used method of building a temporary bank of supply by a 2-man crew affords management a rather standard procedure to offset the effects of changing transportation distances. However, the installation of an accumulator device would be beneficial in most plants since it should bring about the consolidation of what otherwise would be idle time into intervals long enough to permit other productive work to be done.

Clamp-Type 2-Wheel Hand Trucks and Floor Chain Conveyors

Hand trucks and floor chain conveyors are used in only a few Washington State plants for moving boxes of apples from storage to the packing line. None of these plants use this equipment for the standard distance of 190 feet. Usually floor chains are used only to supply mechanical dumpers. However, they could be used to supply a manual dumper. The length of a floor chain conveyor used for supplying a dumper is rarely more than 50 feet.

The current method of supplying the packing line by use of a floor chain conveyor involves the use of hand trucks for transporting stacks to the conveyor. Workers build a temporary bank of supply near the floor chain conveyor and another worker places the stacks on the floor chain. A second method, which is not in use, is to use a hand trucking crew of one or more men to place stacks on the conveyor and use it as an accumulation device. After filling the chain conveyor these workers could be assigned for a short period to other work.

3-Man Crew Using Temporary Bank

When a temporary bank of supply is built near the floor chain conveyor, two workers hand truck 6-high stacks of boxes from storage 170 feet to a temporary bank in the dumping area. After accumulating part or all of a day's supply, these hand truckers are assigned to other work. One hand trucker in the dumping area moves the stacks from the temporary bank 20 feet to the floor chain conveyor, thus continuously supplying the dumper (fig. 90).

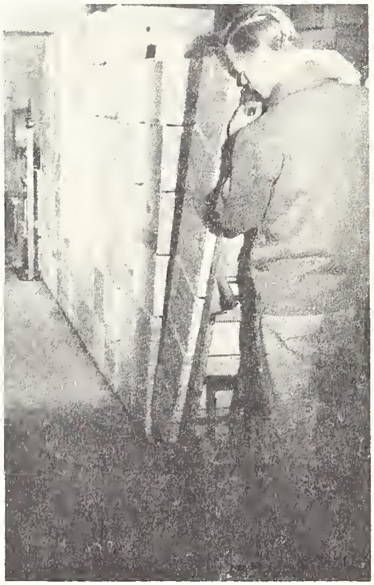

Figure 90.--Hand trucking a stack to a floor chain from a temporary storage bank.

Wait time by use of this method makes up almost one-third of the total labor required. Total labor required is 7.28 man-hours per 1,000 boxes of which transportation requires 3.31 man-hours or 45 percent of the total (table 83).

Table 83.--Labor required for a 3-man crew to move 1,000 unpacked boxes of apples from storage to the packing line by use of clamp-type 2-wheel hand trucks and floor chain conveyor 1/

Operations	Workers	Productive labor	Fatigue allowance	Wait time	Total labor
	Number	Man-hours	Man-hours	Man-hours	Man-hours
Pick up 6-high stacks by use of hand trucks	2	0.29	0.03	0.0	0.32
Transport 170 feet to temporary bank	2	3.01	.30	.0	3.31
Release stacks at temporary bank	2	.29	.03	.0	.32
Pick up 6-high stacks at temporary bank by use of hand trucks	1	.29	.03	.0	.32
Transport 20 feet to floor chain	1	.45	.05	.0	.50
Release stacks on floor chain	1	.24	.02	2.25	2.51
Total man-hours	-	4.57	.46	2.25	7.28

1/ Labor requirements do not include breaking out boxes above 6-high stacks in storage rooms.

2-Man Crew Using Conveyor as an Accumulator

A floor chain conveyor-hand-truck method that might be used for moving fruit to the packing line would be to use the floor chain as accumulation space for stacks of boxes. This method should permit all productive work to be performed at a normal pace and at one time, thus avoiding delays. By this method two workers would hand truck stacks 170 feet from the storage and release them on the floor chain conveyor. A 50-foot length of chain conveyor would provide space for approximately one hour's supply of fruit. After filling the chain, the two hand truckers would be assigned to other work such as carloading or breaking down stacks.

This method should reduce the total labor required to 3.89 man-hours per 1,000 boxes, or 47 percent less than the common method (table 84). Wait time is eliminated and the elapsed time is reduced below the rate at which the dumping machine operates, or 1.95 hours compared with 3.33 hours per 1,000 boxes.

Table 84.--Labor required for a 2-man crew to move 1,000 unpacked boxes of apples from storage to the packing line by use of clamp-type 2-wheel hand truck and floor chain conveyor 1/

Operation	Workers	Productive labor	Fatigue allowance	Wait time	Total labor
	Number	Man-hours	Man-hours	Man-hours	Man-hours
Pick up 6-high stacks by use of hand truck	2	0.29	0.03	0.0	0.32
Transport 170 feet to floor chain conveyor	2	3.01	.30	.0	3.31
Release stacks on floor chain conveyor	2	.24	.02	.0	.26
Total man-hours	-	3.54	.35	.0	3.89

1/ Labor requirements do not include breaking out boxes above 6-high stacks in storage rooms.

Comparison of 3-Man Crew and 2-Man Crew

By use of the 2-man crew for moving fruit to the packing line in which the floor chain conveyor serves as an accumulator, labor requirements might be reduced from 7.28 man-hours to 3.89 man-hours per 1,000 boxes (table 85). This represents a dollar saving of 38 percent at current wage rates. In addition, the crew size would be reduced from three to two men. The same crew could be used to break out high-piles for there is sufficient time to add this operation to their duties. Thus, the use of the chain conveyor as an accumulator should even out the work load and consolidate time that might otherwise be idle.

Table 85.--Comparative labor and equipment costs of two specified methods of moving 1,000 unpacked boxes of apples from storage to the packing line by use of clamp-type 2-wheel hand trucks and floor chain conveyor 1/

Method	Labor and equipment required			Labor and equipment costs			
	Equipment time	Wait time	Total labor	Equipment	Labor 2/	Total costs: Current wages	Total costs: Assumed wages
	Machine-hours	Man-hours	Man-hours	Dollars	Dollars	Dollars	Dollars
Three-man crew							
Two hand truckers move stacks 170 feet from storage to build up day's supply in bank near floor chain conveyor. One man hand trucks 20 feet from bank and releases on chain	3/ 10.61	2.25	7.28	2.11	8.38	10.49	12.30
Two-man crew							
Two hand truckers place stacks on a floor chain 170 feet from storage. (Approximately an hour's supply.) Hand truckers then move to another job. Later fill up chain again	4/ 7.22	.0	3.89	2.02	4.47	6.49	7.47

1/ Costs do not include breaking out boxes above 6-high stacks in storage rooms.
2/ Computed from "current" wage rates
3/ Clamp-type 2-wheel hand truck 7.28 machine-hours, 50-foot floor chain conveyor 3.33 machine-hours, total 10.61 machine-hours.
4/ Clamp-type 2-wheel hand truck 3.89 machine-hours, 50-foot floor chain conveyor 3.33 machine-hours, total 7.22 machine-hours.

Clamp-Type 2-Wheel Hand Trucks, Floor Chain Conveyor and Stackbreaker

One Washington State apple plant uses a stackbreaker in combination with floor chain conveyors and hand trucks to supply a special mechanical dumper that dumps single boxes. Six-high stacks first must be broken down before boxes are fed into this dumper.

By use of this combination of equipment the same procedure for supplying the packing line is followed as when hand trucks and floor chain conveyors are used without the stackbreaker. Fruit is moved from storage either by a crew accumulating a bank of supply near the floor chain conveyor or by workers who place stacks on the conveyor. The work elements and labor requirements are identical to those shown in tables 83 and 84. Because of increased equipment costs, a cost analysis is presented in table 86.

Table 86.--Comparative labor and equipment costs of 2 specified methods of moving 1,000 unpacked boxes of apples from storage to the packing line by use of clamp-type 2-wheel hand trucks, floor chain conveyor, and stackbreaker 1/

Method	Labor and equipment required			Labor and equipment costs			
	Equipment time	Wait time	Total labor	Equipment	Labor 2/	Total costs: Current wages	Total costs: Assumed wages
	Machine-hours	Man-hours	Man-hours	Dollars	Dollars	Dollars	Dollars
Three-man crew							
Two hand truckers move stacks 170 feet from storage to build up a day's supply in bank near floor chain conveyor. They then move to another job; 1 man hand trucks 20 feet from bank to chain	3/ 13.94	2.25	7.28	4.47	8.38	12.85	14.66
Two-man crew							
Two hand truckers place stacks on a floor chain 170 feet from storage. (Approximately an hour's supply.) Hand truckers then move to another job. Later fill up chain again	4/ 10.55	.0	3.89	4.38	4.47	8.85	9.83

1/ Costs do not include breaking out boxes above 6-high stacks in storage rooms.
2/ Computed from "current" wage rates.
3/ Clamp-type 2-wheel hand truck 7.28 machine-hours, stackbreaker 3.33 machine-hours, 50-foot floor chain conveyor 3.33 machine-hours, total 13.94 machine-hours.
4/ Clamp-type 2-wheel hand truck 3.89 machine-hours, stackbreaker 3.33 machine-hours, 50-foot floor chain conveyor 3.33 machine-hours, total 10.55 machine-hours.

By use of the temporary bank method, stacks are hand trucked from storage to a bank near the floor chain where they are moved by another hand trucker to the floor chain conveyor. As the stacks move along the chain, they are fed into stackbreaking machine which breaks down the stacks and permits one box at a time to move into the dumper mechanism (fig. 91).

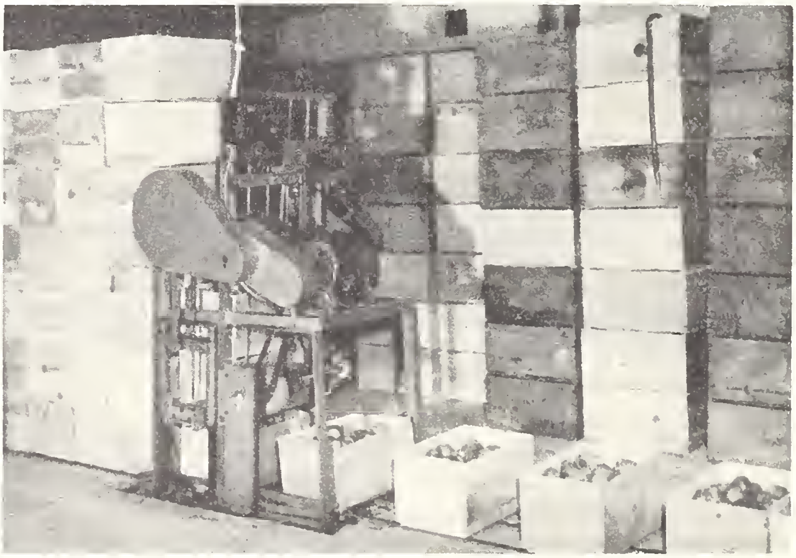

Figure 91.--Stacks moved from a temporary bank on the floor chain conveyor are fed into a stackbreaker.

A saving of about 30 percent may be realized by using the accumulator method. Equipment costs in both methods are considerably higher than they are when the stackbreaker is not used.

Clamp-Type 2-Wheel Hand Trucks, Belt Conveyor, Stackmaker, and Floor Chain Conveyor 34/

One Washington State plant uses a combination consisting of hand trucks, belt conveyors, stackmaker, and floor chain conveyor to move fruit to packing line. Stacks are hand trucked from the storage point 35 feet to a bank beside the belt conveyor. Another worker hand trucks the fruit 15 feet and places single boxes on the belt. The belt conveyor feeds the boxes into a stackmaker where they are built into 6-high stacks, are moved out of the stackmaker onto a floor chain conveyor, and are moved onto a stackdumper.

The methods used in this combination of equipment are the same as those described when hand trucks and belt conveyors are used without other types of equipment to supply the packing line. Work elements and labor requirements are identical to those shown in tables 80 and 81. For this reason, a cost analysis only is shown in table 87.

Table 87.—Comparative labor and equipment costs of 2 specified methods of moving 1,000 unpacked boxes of apples from storage to the packing line by use of clamp-type 2-wheel hand truck, belt conveyor, stackmaker, and floor chain conveyor 1/

Method	Labor and equipment required			Labor and equipment costs			
	Equipment time	Wait time	Total labor	Equipment	Labor 2/	Total costs	
						Current wages	Assumed wages
	Machine-hours	Man-hours	Man-hours	Dollars	Dollars	Dollars	Dollars
Three-man crew							
Two hand truckers move stacks 35 feet from storage to build up a day's supply in bank near the belt. They then move to another job; 1 man hand trucks stacks 15 feet to belt and places boxes on belt to dumper	3/ 14.84	1.36	4.85	7.27	5.58	12.85	14.06
One worker							
One hand trucker wheels stacks 50 feet from storage position to a position beside belt. He then places boxes on belt to dumper	4/ 13.32	.60	3.33	7.23	3.83	11.06	11.89

1/ Costs do not include breaking out boxes above 6-high stacks in storage rooms.
2/ Computed from "current" wage rates.
3/ Clamp-type 2-wheel hand truck 4.85 machine-hours, 140-foot belt conveyor 3.33 machine-hours, stackmaker 3.33 machine-hours, 10-foot floor chain conveyor 3.33 machine-hours, total 14.84 machine-hours.
4/ Clamp-type 2-wheel hand truck, 140-foot belt conveyor, stackmaker, and 10-foot floor chain conveyor 3.33 machine hours each, total 13.32 machine-hours.

34/ Stackmaker generally used in receiving. When used in storage to line it is estimated to operate 350 hours instead of 150 as shown on cost summary in Appendix. New cost of $0.87 per hour when stackmaker is used in storage to line based on 350 hours of use, $2,500 capital cost, and 15 years depreciation.

The costs of both methods are relatively high, for the equipment cost is increased with the inclusion of a stackmaker and floor chain conveyor. Equipment costs by either method are greater than labor costs.

Clamp-Type 2-Wheel Hand Trucks and Elevator

Washington State apple plants that use hand trucks and elevators for receiving fruit do not, as a rule, use these elevators for moving fruit from storage to the packing line. Usually a belt conveyor is used in place of elevators. However, one plant in which studies were made used the elevator to move fruit to the packing line part of the time.

When an elevator is used, fruit is hand trucked by two workers from storage into the elevator, the elevator moves the fruit to the off-loading floor, and it is again trucked to temporary storage in the dumping area. A third worker is used to keep the dumper supplied from the temporary supply bank.

Hand truckers move the 6-high stacks 70 feet from the storage point into a single elevator. The elevator moves the fruit to the off-loading floor where the same two hand truckers move the fruit from the elevator 100 feet to the temporary bank of supply in the dumping area. These two workers repeat this cycle of operations until a day's supply of fruit is accumulated at the dumping area and are then assigned to other jobs. One hand trucker moves the fruit 20 feet from a temporary bank to the dumper.

A total of 8.51 man-hours of labor per 1,000 boxes is required to move fruit from storage to the packing line by this method (table 88).

Table 88.--Labor required for a 3-man crew to move 1,000 unpacked boxes of apples from storage to the packing line by use of clamp-type 2-wheel hand truck and elevator 1/

Method	Workers	Productive labor	Fatigue allowance	Wait time	Total labor
	Number	Man-hours	Man-hours	Man-hours	Man-hours
Pick up 6-high stacks in storage by use of hand trucks	2	0.29	0.03	0.0	0.32
Transport 70 feet into the elevator	2	1.31	.13	2/ .06	1.50
Release stacks in elevator	2	.29	.03	.0	.32
Elevator cycle 3/	2	.20	.0	.20	.40
Pick up 6-high stacks in elevator by use of hand trucks	2	.29	.03	.0	.32
Transport 100 feet to a bank near the dumper	2	1.82	.18	.0	2.00
Release stacks in bank	2	.29	.03	.0	.32
Pick up 6-high stacks in bank by use of a hand truck	1	.29	.03	.0	.32
Transport 20 feet to the dumper	1	.45	.05	.0	.50
Release stacks at dumper	1	.24	.02	2.25	2.51
Total man-hours	-	5.47	.53	2.51	8.51

1/ Labor requirements do not include breaking out boxes above 6-high stacks in storage rooms.

2/ Wait time caused by crew interference.

3/ Vertical transportation distance is not included.

Almost one-half of this total labor was required for transporting fruit. Thirty percent of the total labor was wait time.

Total labor and equipment costs on the basis of current wage rates are $18.30 per 1,000 boxes (table 89). About one-half of these costs are equipment costs, which largely are elevator costs. It is possible with certain elevator installations that these costs could be reduced, but it is unlikely that this combination of equipment could compete costwise with other combinations of equipment in moving fruit from storage to the packing line.

Table 89.--Labor and equipment costs for a 3-man crew to move 1,000 unpacked boxes of apples to the packing line by use of clamp-type 2-wheel hand trucks and elevator 1/

Method	Labor and equipment required			Labor and equipment costs			
	Equipment time	Wait time	Total labor	Equipment	Labor 2/	Total costs: Current wages	Total costs: Assumed wages
	Machine-hours	Man-hours	Man-hours	Dollars	Dollars	Dollars	Dollars
Two hand truckers move stacks 70 feet from storage to elevator, then 100 feet from elevator to bank near dumper. After moving a day's supply they move to another job. One man hand trucks 20 feet to the dumper from the bank 3/	4/ 11.10	2.51	8.51	8.51	9.79	18.30	20.42

1/ Costs do not include breaking out boxes above 6-high stacks in storage rooms.
2/ Computed from "current" wage rates.
3/ Vertical transportation distance is not included.
4/ Clamp-type 2-wheel hand truck 8.51 machine-hours, 8,000-pound capacity elevator 2.59 machine-hours, total 11.10 machine-hours.

Breaking Out Unpacked Boxes of Apples from High Piles

Most Washington State apple plants store part of the fruit in stacks higher than the 6-high stacks handled by use of clamp-type hand trucks. High-piling, or stacking boxes of fruit more than 6 high in plants that do not use industrial-lift trucks, has previously been discussed. When the fruit is moved out of storage by use of equipment other than industrial-lift trucks, the high pile must be broken down to the 6-high stacks, and the boxes removed from above this height must be built into 6-high stacks.

Breaking down the high pile is an operation that may be performed simultaneously with moving fruit to the packing line, or it may be performed slightly in advance of these operations. In either case, the methods of breaking down high piles and the work involved are the same. As the fruit is moved from the high pile, it is placed in temporary storage near a conveyor belt or an elevator, depending on which type of equipment is used for subsequent operations.

The operation of breaking boxes out of high piles is the reverse of high-piling. Boxes are lowered rather than elevated. Stackbreaking is performed by a relatively small crew of workers who usually are more experienced than the high-piling crews, since stackbreaking is carried on during the entire packing season. Stackbreaking is performed more intermittently than high-piling, because the packing line sets the pace for the operation.

A 2-man crew is used to break down high-piled stacks to 6 high. One worker standing on a bench or on top of 6-high stacks lifts and hands boxes down to a worker on the floor. These stacks are hand trucked to a temporary storage bank. When the storage bank has been built, the crew is assigned to other work.

As with high-piling, manual breaking out of boxes from high piles is fatiguing work. Since one worker must stand either on a bench or on top of 6-high stacks and lower the boxes to a worker on the floor, there is considerable reaching and stooping involved. Moreover, this method of lowering boxes of fruit is conducive to rough handling. This manual method of stackbreaking has been improved by use of the mechanical high-piler developed through the research program.

Breaking out boxes from high-piled stacks is an important part of the job of moving apples to the packing line. When high-piled 12 boxes high, 40 percent of the total labor required to move apples to the packing line is accounted for in breaking down stacks (table 90). Thirty-three percent of the total labor is used in breaking down stacks when the boxes have been stacked 10 high.

Table 90.--Comparative labor requirements for breaking out of stacks of specified heights and moving 1,000 unpacked boxes of apples from storage to the packing line by use of manual break out method, 2-wheel hand trucks, and belt conveyor 1/

Operation	Workers	Labor requirements: 10-box high stacks 2/	Percent of total	12-box high stacks 2/	Percent of total
	Number	Man-hours	Percent	Man-hours	Percent
Breaking out high-piled boxes 3/	2	1.75	33	2.42	40
Transport 6-high stacks from storage point to temporary bank near belt conveyor 4/	2	1.52	28	1.52	25
Transport 6-high stacks from temporary bank to the belt and place boxes on the belt 5/	1	2.07	39	2.07	35
Total	-	5.34	100	6.01	100

1/ Moving boxes from storage to line includes: (1) Breaking out high-piled boxes and building 6-high stacks, (2) transporting to a bank near the belt conveyor, and (3) moving from the bank to the belt and placing boxes on the belt.

2/ Man-hours shown are the productive time required plus fatigue allowance and crew interference.

3/ Boxes are manually lifted from the high-piled stacks and built into 6-high stacks on the floor. From 10-high stacks 400 of the 1,000 boxes are broken out or removed from the high pile. From 12-high stacks 500 of the 1,000 boxes are broken out.

4/ Boxes are transported 35 feet from the storage point to the temporary bank. Includes pick up and release of stacks.

5/ One worker transports the 6-high stacks 15 feet from the temporary bank to the belt and places the boxes on the belt. Includes pick up and release of stacks.

Breaking Out Boxes Manually

Boxes are broken out manually from high piles by one worker standing on top of a bench or on top of 6-high stacks, and handing boxes down to another worker standing on the floor, who places them on the floor in stacks 6 high to be hand trucked away (fig. 92). Boxes from 9-high stacks are always broken out from a bench. 35/ Ten-high stacks may be broken out either by the worker standing on a bench or on top of the stacks. Stacks more than 10 boxes high usually are broken out by workers standing on top of the stack. The crew size and arrangement, whether the fruit is broken out from a bench or from the top of 6-high stacks, is the same.

Figure 92.--Manually breaking out high-piled boxes of apples.

The labor required to break out 1,000 high-piled boxes ranges from 4.20 to 4.83 man-hours, depending on the height of the stack. 36/ The labor required for breaking out high-piled boxes may be stated in two different ways; in terms of the total number of boxes broken out, or in terms of the total number of boxes moved to the packing line. Where boxes are stacked 12 high, 50 percent of the boxes moved to the packing line are broken out. Where stacked 10 high, 40 percent of the boxes are broken out of high piles.

For breaking out boxes from 12-high stacks, 4.83 man-hours of labor are required per 1,000 boxes broken out (table 91). The elapsed time required to break out boxes from high piles ranges from 0.70 to 1.21 hours per 1,000 boxes moved to the packing line, depending on the height of the stack (table 92).

35/ Nine-high stacks in storage were not widely used. Data on breaking out boxes from 9-high stacks were developed from elements of other operations.

36/ No studies were made of high-piling and breaking out 7 and 8 boxes high which can be done by one man from the floor.

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Table 91.--Comparative labor requirements for a 2-man crew to manually break out 1,000 unpacked boxes of apples from stacks of specified heights 1/

Height of stack	Productive labor	Fatigue allowance	Total labor
	Man-hours	Man-hours	Man-hours
9 boxes high 2/	3.65	0.55	4.20
10 boxes high 3/	3.65	.73	4.38
12 boxes high 4/	4.03	.80	4.83

1/ Labor requirements do not include moving fruit to the packing line.
2/ Three boxes from each 9-high stack are broken out.
3/ Four boxes from each 10-high stack are broken out.
4/ Six boxes from each 12-high stack are broken out.

Table 92.--Comparative labor and elapsed time required for a 2-man crew to manually break out a total of 1,000 unpacked boxes of apples and to break out the proportion of each 1,000 boxes moved to the packing line when stacked to specified heights

Height of stack	Labor required per 1,000 boxes broken out	Labor required per 1,000 boxes moved to line	Elapsed time per 1,000 boxes moved to line
	Man-hours	Man-hours	Hours
9 boxes high	4.20	1/ 1.40	0.70
10 boxes high	4.38	2/ 1.75	.88
12 boxes high	4.83	3/ 2.42	1.21

1/ Labor required for breaking out 333 boxes.
2/ Labor required for breaking out 400 boxes.
3/ Labor required for breaking out 500 boxes.

The cost of the manual method of breaking out boxes from high piles at current wage rates ranged from $1.61, when broken out of 9-high stacks, to $2.78, when broken out of 12-high stacks, per 1,000 boxes moved to the packing line (table 93). All of this cost is labor cost.

Table 93.--Comparative labor costs for a 2-man crew to break out boxes of apples manually from stacks of specified heights based on 1,000 unpacked boxes moved to the packing line

Height of stack	Elapsed time	Total labor required	Total cost: Current wages	Total cost: Assumed wages
	Hours	Man-hours	Dollars	Dollars
9 boxes high (333 boxes broken out)	0.70	1.40	1.61	1.96
10 boxes high (400 boxes broken out)	.88	1.75	2.01	2.45
12 boxes high (500 boxes broken out)	1.21	2.42	2.78	3.39

Breaking Out Boxes by Use of Mechanical Lift

The mechanical method of breaking out boxes from high piles resulted from the development of a mechanical high-piler. The mechanical high-piler breaks out boxes from the stacks by grasping and lifting the high-piled boxes which then can be pulled back with the high-piler and lowered to the floor. Breaking stacks by the high-piler is not as rough on the fruit and is not as fatiguing as the manual method. Moreover, use of the mechanical method reduces the number of workers required for moving fruit to the packing line.

2-stack lift.--To break out boxes from a 9-high stack, the 2-stack high-piler is pushed forward toward the high stacks and the top three boxes from the two stacks are elevated. The high-piler is pulled back, and the boxes are lowered to the floor. From adjoining stacks, three additional boxes are removed from each of two stacks and placed on top of the first boxes broken out, thus building two stacks of six each. Stacks are then 6 high and are ready for hand trucking to the temporary storage bank or the belt conveyor.

The 9-high stackbreaking operation might begin by lifting six boxes off the stacks, or the 9-high stacks might be broken into one 4-high and one 5-high stack and hand trucked to the belt conveyor in loads of these sizes. The latter procedure is unlikely.

Ten-high stacks are broken down by dividing the pile into two 5-high stacks (fig. 93). The high-piler is pushed forward, the top five boxes

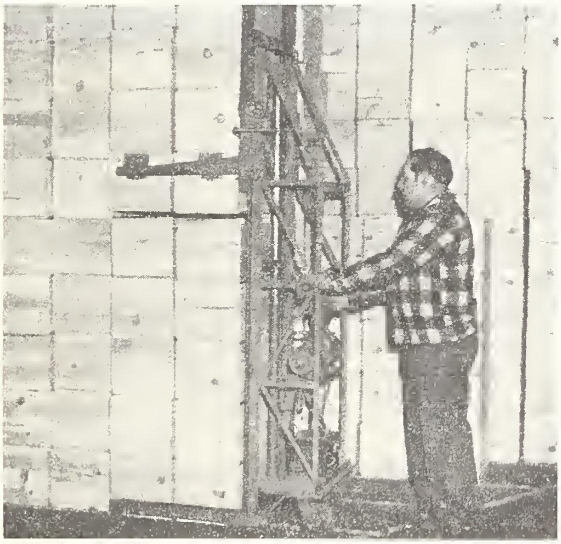

Figure 93.--The high-piler pushed into place and two stacks being lifted enough to clear the lower stacks.

Figure 94.--The load being pulled free from the two bottom stacks. After this the stacks are lowered to the floor.

in two stacks are gripped and elevated, and the high-piler is pulled back to deposit the boxes on the floor (fig. 94). In a 12-high operation, the high piles are divided into two stacks of six boxes each and the stacks are handled as in the 10-high operation.

As shown in table 94, a total of 0.93 man-hour of labor is required to break out 1,000 boxes from 12-high stacks by use of the 2-stack mechanical high-piler. A total of 4.83 man-hours of labor are required by use of the manual method. The mechanical method requires only 0.47 hour elapsed time--about one-third the 1.21 hours required for the manual method.

The mechanical high-piler is relatively more efficient for breaking down high piles than for high-piling. Also, the fruit-moving crew is reduced by one man.

Table 94.--Comparative labor and elapsed time required for 1 worker to break out 1,000 unpacked boxes of apples from stacks of specified heights by use of a 2-stack portable mechanical lift

Height of stack	Labor required per 1,000 boxes broken out	Labor required per 1,000 boxes moved to line	Elapsed time per 1,000 boxes moved to line
	Man-hours	Man-hours	Hours
9 boxes high	2.47	1/ 0.82	0.82
10 boxes high	1.31	2/ .52	.52
12 boxes high	.93	3/ .47	.47

1/ Labor required for breaking out 333 boxes.
2/ Labor required for breaking out 400 boxes.
3/ Labor required for breaking out 500 boxes.

Single-stack lift.--Late during the 1951-52 season, a 6-box high-piler was developed which operates similarly to the 12-box machine (figs. 95 and 96). When boxes are broken out of 12-high stacks, use of the single-stack high-piler requires additional elapsed time of approximately 0.30 of an hour per 1,000 boxes moved to the packing line. Labor requirements are 1.54 man-hours to break out 1,000 boxes compared with 0.93 man-hour for the 2-stack high-piler (tables 94 and 95). The extra capacity of the 2-stack machine may be a means of achieving a better balanced handling operation. However, the larger machine is slightly heavier and is not as maneuverable as the smaller machine. The single-stack high-piler has an advantage over the larger machine when moved from location to location, particularly if moved up and down stairways. Actually, the comparative advantages of the two high-pilers cannot be determined until more commercial experience has been obtained.

Figure 95.--The single-stack mechanical high-piler.

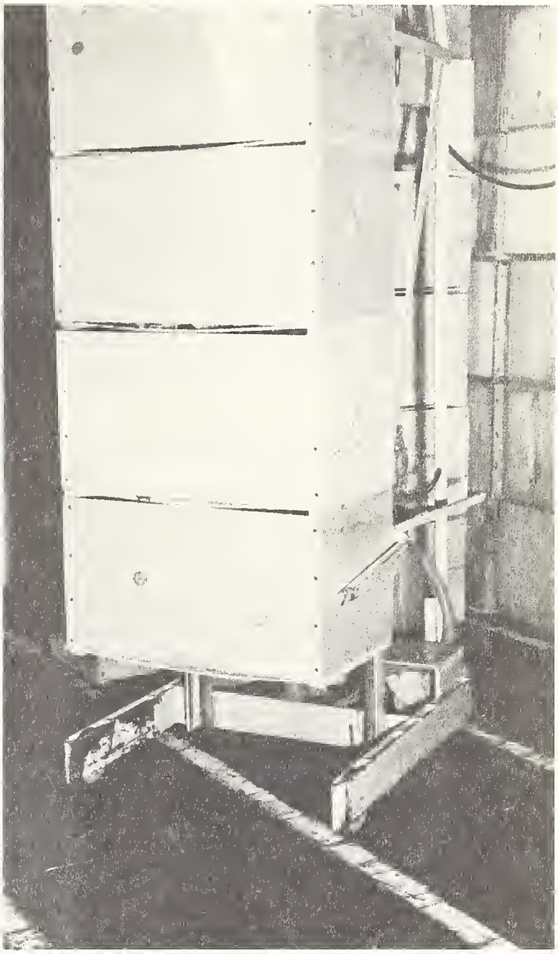

Figure 96.--The single-stack machine lowering a stack of boxes.

Table 95.--Comparative labor and elapsed time required for 1 worker to break 1,000 unpacked boxes of apples from stacks of specified heights by use of a single-stack portable mechanical lift

Height of stack	Labor required per 1,000 boxes broken out	Labor required per 1,000 boxes moved to line	Elapsed time per 1,000 boxes moved to line
	Man-hours	Man-hours	Hours
9 boxes high	3.37	1/ 1.12	1.12
10 boxes high	2.12	2/ .85	.85
12 boxes high	1.54	3/ .77	.77

1/ Labor required for breaking out 333 boxes.
2/ Labor required for breaking out 400 boxes.
3/ Labor required for breaking out 500 boxes.

Comparison of 2-stack and single-stack lifts.--The comparative efficiency, based on labor and equipment costs, of the 2-stack and single-stack mechanical high-pilers is shown in table 96.

Table 96.--Comparative labor and equipment costs for breaking out the required volumes from each 1,000 unpacked boxes of apples moved to the line from stacks of specified heights by use of specified types of mechanical lifts

Height of stack and type of equipment	Elapsed time	Labor and equipment required		Labor and equipment costs			
		Equipment time	Total labor	Equipment	Labor 1/	Total--current wage rates	Total--assumed wage rates
	Hours	Machine-hours	Man-hours	Dollars	Dollars	Dollars	Dollars
9 boxes high (333 boxes broken out)							
2-stack lift	0.82	0.82	0.82	0.48	0.94	1.42	1.63
Single-stack lift	1.12	1.12	1.12	.66	1.29	1.95	2.23
10 boxes high (400 boxes broken out)							
2-stack lift	.52	.52	.52	.31	.60	.91	1.04
Single-stack lift	.85	.85	.85	.50	.98	1.48	1.69
12 boxes high (500 boxes broken out)							
2-stack lift	.47	.47	.47	.28	.54	.82	.94
Single-stack lift	.77	.77	.77	.45	.89	1.34	1.53

1/ Computed from "current" wage rates.

Breaking Out Boxes by Use of Gravity Conveyors

This method of breaking down stacks involves the use of gravity-type roller conveyors to move the high-piled fruit from the stacks to a belt conveyor. By this method, the first row of stacks is broken down to approximately 4 boxes high, and a roller conveyor is piled on top of this row with the end of the conveyor near the high-piled boxes slightly elevated while the other end of the conveyor is attached to the belt conveyor. When breaking down from 10 high, the rows of stacked boxes next to the conveyor are placed on the conveyor by a worker standing on the 4-high stacks (fig. 97). Boxes are given a slight push and they are then conveyed by gravity to a worker at the intersection of the roller and belt conveyors (fig. 98). The worker at the belt conveyor turns the boxes of fruit from the gravity conveyor onto the powered belt conveyor, thus eliminating hand trucking and placing the boxes on the belt. Three or four rows of high-piled boxes can be broken down to 4 high before it is necessary to move the gravity conveyor.

When boxes are broken out from 12 high, the gravity conveyor is inclined from the belt conveyor to 6-high stacks. The worker on top of the 6-high stacks follows the same procedure as previously described.

A gravity conveyor can be used to break high-piled boxes only when the distance from the high-piled stacks to the belt conveyor is relatively short. If the distance is too great, the angle of incline of the gravity conveyor does not permit boxes to roll to the belt conveyor and considerably

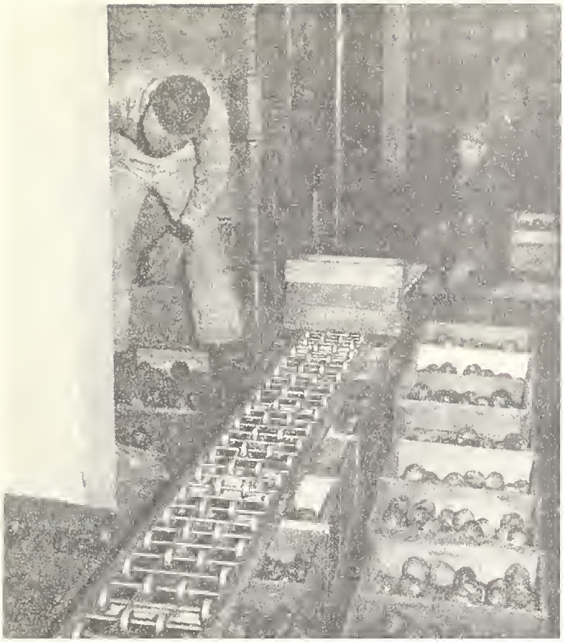

Figure 97.--Top man places high-piled boxes on roller conveyor. Bottom man turns boxes from roller to belt conveyor.

Figure 98.--Roller inclined from high-piles to belt. Boxes go on belt to the dumping area.

more time is required to move and set up the conveyor. In addition, use of the method assumes that boxes are stacked off the belt conveyor near the dumping area. The boxes are hand trucked to a temporary bank and then to the dumper. Table 97 presents a comparison of labor requirements for breaking out the required volumes from each 1,000 boxes and moving the 1,000 boxes to the packing line by use of roller conveyor and manual methods for breaking out.

Table 97.--Comparative labor requirements for 2-man crew to break out the required volumes from high piles and move 1,000 boxes of unpacked apples from storage to packing line by use of 2 specified methods

Type of equipment and description of operation	When broken out from 10-high stacks		When broken out from 12-high stacks	
	Boxes handled	Labor required	Boxes handled	Labor required
	Number	Man-hours	Number	Man-hours
Breaking out by use of roller conveyor				
Breaking out upper 6 boxes of stacks and placing boxes on belt conveyor	600	1.33	500	1.33
Hand truck lower part stacks 12.5 feet to belt	1/ 400	.57	2/ 500	.47
Place hand trucked boxes on belt conveyor	400	.43	500	.54
Total	-	2.33	-	2.12
Breaking out manually using bench				
Breaking out upper part of stack and placing boxes in 6-high stacks	400	1.75	500	2.42
Hand truck 6-high stacks 12.5 feet	1,000	.95	1,000	.95
Place hand trucked boxes on belt conveyor	1,000	1.03	1,000	1.03
Total	-	3.73	-	4.40

1/ Hand trucked in unit loads of 4 boxes each.
2/ Hand trucked in unit loads of 6 boxes each.

Comparison of Methods and Equipment for Breaking Out Boxes from High Piles

As shown in table 98, plant operators should save $1.96 per 1,000 boxes moved to the packing line by substituting the 2-stack mechanical high-piler for manual methods. When the fruit is stored 9 high, the mechanical high-piler saves only $0.19 per 1,000 boxes. While the savings with a 9-high stack are not great, it must be recognized that the fruit is not handled as roughly and a smaller crew is needed. Thus, it probably would be desirable for a firm to use the mechanical high-piler in 9-high storage, provided the job is of sufficient volume.

Table 98.--Comparative labor and equipment costs for breaking out, by use of specified methods, the required volumes from each 1,000 unpacked boxes of apples moved to the line when stacked to specified heights 1/

Method	Total labor and equipment costs based on current wage rates when stacked		
	9 boxes high	10 boxes high	12 boxes high
	Dollars	Dollars	Dollars
Breaking out boxes manually by use of 2-man crew	1.61	2.01	2.78
Breaking out boxes mechanically by use of 2-stack lift and 1 operator	1.42	.91	.82
Breaking out boxes mechanically by use of single-stack lift and 1 operator	1.95	1.48	1.34
Breaking out boxes by use of gravity roller conveyors and 2-man crew	-	2/ 1.42	1.19

1/ Costs shown include labor and equipment costs.
2/ Because of the method, 600 boxes are broken out of 10-box-high stacks for each 1,000 boxes moved to the packing line rather than the 400 boxes broken out by use of other methods.

Comparative Labor Requirements, and Labor and Equipment Costs, of Various Methods of Moving Apples from Storage to the Packing Line When High-Piled Boxes Are Broken Out by Use of Manual and Mechanical Methods

In previous discussions of various types and combinations of types of equipment used for moving unpacked boxes of apples from storage to the packing line, the labor and equipment requirements and cost data shown have not included breaking out boxes from high piles, or boxes from above the 6-high stacks handled as unit loads by use of hand trucks. Table 99 shows for each of these methods the total labor requirements for moving 1,000 unpacked boxes of apples to the packing line when 500 of the 1,000 boxes are manually broken out of 12-box-high stacks. In the break-out operation, the upper six boxes in each stack are removed by use of a 2-man crew and are placed into 6-high stacks on the floor for pickup by hand trucks. As shown in table 99, use of a 2-man crew for manual break-out operations adds 2.42 man-hours of labor, per 1,000 boxes moved to the packing line, to the labor required when boxes are not broken out of high piles. In addition, inability to coordinate these operations fully

Table 99.--Comparative labor requirements for manually breaking out required volume of boxes from 12-box-high stacks and moving 1,000 unpacked boxes of apples to the packing line by use of specified methods and types of equipment 1/

Type of equipment and method	Labor required: When boxes not broken out of high piles 2/	For manually breaking out boxes from high-piles 3/	Additional wait time when manually breaking boxes from high piles	Total	Increased labor requirements for manually breaking out
	Man-hours	Man-hours	Man-hours	Man-hours	Percent
Clamp-type 2-wheel hand truck					
1. 2 workers break out high-piled boxes, 2 workers hand-truck 6-high stacks 170 feet to temporary bank, 1 worker hand-trucks 20 feet from bank to dumper	7.28	2.42	0.29	9.99	37.2
Clamp-type 2-wheel hand truck and belt conveyor					
1. 2 workers break out high-piled boxes, 2 workers hand-truck 6-high stacks 35 feet to temporary bank, 1 worker hand-trucks 15 feet from bank to conveyor and places boxes on belt	4.85	2.42	-	7.27	49.9
2. 2 workers break out high-piled boxes, 1 worker hand-trucks 6-high stacks 50 feet to belt conveyor and places box on belt (conveyor has accumulator device)	3.33	2.42	-	5.75	72.7
Clamp-type 2-wheel hand truck and floor chain conveyor					
1. 2 workers break out high-piled boxes, 2 workers hand-truck 6-high stacks 170 feet to temporary bank, 1 worker hand-trucks 20 feet from bank to conveyor	7.28	2.42	.29	9.99	37.2
2. 2 workers break out high-piled boxes, 2 workers hand-truck 6-high stacks 170 feet to end release on 50-foot floor chain conveyor which serves as accumulator	3.89	2.42	.35	6.66	71.2
Clamp-type 2-wheel hand truck, floor chain conveyor, end stackbreaker					
1. 2 workers break out high-piled boxes, 2 workers hand-truck 6-high stacks 170 feet to temporary bank, 1 worker hand-trucks 20 feet from bank and releases on conveyor--conveyor feeds into stackbreaker--breaks down 6-high stacks	7.28	2.42	.29	9.99	37.2
2. 2 workers break out high-piled boxes, 2 workers hand-truck 6-high stacks 170 feet to end release on 50-foot floor chain conveyor which serves as accumulator, stackbreaker breaks down 6-high stacks	3.89	2.42	.35	6.66	71.2
Clamp-type 2-wheel hand truck, belt conveyor, stackmaker, end floor chain conveyor					
1. 2 workers break out high-piled boxes, 2 workers hand-truck 6-high stacks 35 feet to temporary bank, 1 worker hand-trucks 15 feet to and places boxes on belt conveyor. Belt conveyor feeds boxes into stackmaker which builds 6-high stacks and releases on floor chain conveyor	4.85	2.42	-	7.27	49.9
2. 2 workers break out high-piled boxes, 1 worker hand-trucks 6-high stacks 50 feet to and places boxes on belt conveyor. Belt conveyor feeds boxes into stackmaker which builds 6-high stacks and releases on floor chain	3.33	2.42	-	5.75	72.7
Clamp-type 2-wheel hand truck and elevator					
1. 2 workers break out high-piled boxes, 2 workers hand-truck 6-high stacks 70 feet into single elevator, ride elevator and hand-truck 100 feet from elevator to temporary bank, 1 worker hand-trucks 20 feet from bank to dumper 4/	8.51	2.42	-	10.93	28.4

1/ Transportation distance from storage stacks to dumper standardized at 190 feet.
2/ Labor required for picking up 6-high stacks of boxes in storage, transportation, and releasing stacks. In belt conveyor methods, includes placing boxes singly on conveyor. Also includes wait time involved in performing these operations.
3/ Labor required to break out 500 boxes from 12-box high stacks.
4/ Vertical transportation distance not included.

increases the wait time when the manual break-out method is used in connection with five of the methods for moving the fruit from the storage point to the line.

Manual break-out operations increase labor requirements by 28.4 to 72.7 percent over requirements of the other methods--the lesser increase when using the elevator-and-hand-truck method, and the greater percent when using the belt-conveyor and hand-truck methods. The former general method has particularly high labor requirements aside from the break-out operation.

However, the methods showing the greatest percentages of increase in labor requirements still maintain their relative positions as the methods requiring the least labor. The belt-conveyor-hand-truck method, with an accumulator device added to the conveyor, requires 5.75 man-hours of labor per 1,000 boxes. The addition of a stackmaker and floor chain conveyor in this basic method does not change labor requirements and, considered only from the viewpoint of labor inputs, the methods using the stackmaker and floor chain conveyor are more efficient than others discussed. The elevator-hand-truck method is least efficient with labor requirements of 10.93 man-hours per 1,000 boxes.

Total labor and equipment requirements for moving 1,000 unpacked boxes from storage to the packing line by various methods, when half of the boxes are mechanically broken out of 12-box-high stacks, are shown in table 100. In all methods, breaking out the upper six boxes in 12-box-high stacks by use of the 2-stack mechanical high-piler adds 0.47 of a man-hour and 0.47 of a machine-hour to previous requirements. Moreover, the idle time of the high-piler and other equipment must be added. This idle equipment time results from the use of one of the hand truckers, already employed, for breaking out high-piled boxes. However, when boxes are mechanically broken out as they are moved to the line, wait time previously involved in two methods actually is reduced 0.47 of a man-hour. However, this reduction in wait time does not reduce the machine-hours required.

The two methods in which wait time is reduced are those using hand trucks and belt conveyor, and this equipment in combination with a stackmaker and floor chain conveyor. No increase in labor requirements is involved when mechanical stackbreaking is added to the use of these methods. Labor requirements remain at 3.33 man-hours per 1,000 boxes. The method employing hand trucks and an elevator has the highest labor requirement, 8.98 man-hours per 1,000 boxes.

Table 101 shows the labor and equipment costs for moving 1,000 unpacked boxes of apples to the packing line by the various methods, when half the boxes are broken out manually, and also when they are broken out mechanically. When one hand trucker stops at the storage stacks to break out boxes with the mechanical lift, equipment costs for some methods are sharply increased because of idle equipment time that must be charged to the operation. However, total labor and equipment costs are lower by all methods when breaking out boxes from high piles with the mechanical lift rather than manually. On the basis of current wage rates, the lowest cost, \$8.33 per 1,000 boxes, is obtained by use of clamp-type 2-wheel hand trucks, floor chain conveyor, and mechanical high-piler. This method requires only two workers. The floor chain conveyor serves as an accumulator. The highest cost, \$21.08 per 1,000 boxes, is obtained when using hand trucks, elevator, and manual break-out. Use of the mechanical lift reduces costs of this method only \$0.08 per 1,000 boxes.

Table 100.--Comparative labor and equipment requirements for mechanically breaking out required volume of boxes from 12-box high stacks and moving 1,000 unpacked boxes of apples to the packing line by use of specified methods and types of equipment 1/

Type of equipment and method	Equipment time required: When boxes are not broken out of high piles	Equipment time required: Productive time mechanical high-piler	Equipment time required: Reduction in wait time when boxes are mechanically broken out	Equipment time required: Additional idle time--all equipment	Equipment time required: Total all equipment	Labor required: When boxes are not broken out of high piles 2/	Labor required: For mechanically breaking out boxes from high piles 3/	Labor required: Reduction in wait time when boxes are mechanically broken out	Labor required: Total	Increased labor requirements for mechanically breaking out
	Machine-hrs.	Machine-hrs.	Machine-hrs.	Machine-hrs.	Machine-hrs.	Man-hours	Man-hours	Man-hours	Man-hours	Percent
Clamp-type 2-wheel hand truck and mechanical high-piler										
1. 2 workers break out high-piled boxes and hand-truck 6-high stacks 170 feet to temporary bank, 1 worker hand-trucks 20 feet from bank to dumper	7.28	0.47	-	2.21	4/ 9.96	7.28	0.47	-	7.75	6.5
Clamp-type 2-wheel hand truck, belt conveyor, and mechanical high-piler										
1. 2 workers break out high-piled boxes and hand-truck 6-high stacks 35 feet to temporary bank, 1 worker hand-trucks 15 feet from bank to conveyor and places boxes on conveyor	8.18	.47	-	1.00	5/ 9.65	4.85	.47	-	5.32	9.7
2. 1 worker breaks out high-piled boxes and hand-trucks 6-high stacks 50 feet to belt conveyor and places boxes on belt conveyor (conveyor has accumulator device)	6.66	.47	.47	3.33	6/ 9.99	3.33	.47	.47	3.33	-
Clamp-type 2-wheel hand truck, floor chain conveyor, and mechanical high-piler										
1. 2 workers break out high-piled boxes and hand-truck 6-high stacks 170 feet to temporary bank, 1 worker hand-trucks 20 feet from bank to conveyor	10.61	.47	-	2.21	7/ 13.29	7.28	.47	-	7.75	6.5
2. 2 workers break out high-piled boxes and hand-truck 6-high stacks 170 feet and release on 50-foot floor chain conveyor which serves as accumulator	7.22	.47	-	2.18	8/ 9.87	3.89	.47	-	4.36	12.1
Clamp-type 2-wheel hand truck, floor chain conveyor, stackbreaker, and mechanical high-piler										
1. 2 workers break out high-piled boxes and hand-truck 6-high stacks 170 feet to temporary bank, 1 worker hand-trucks 20 feet from bank and releases on conveyor, conveyor feeds into stack-breaker which breaks down 6-high stacks	13.94	.47	-	2.21	9/ 16.62	7.28	.47	-	7.75	6.5
2. 2 workers break out high-piled boxes and hand-truck 6-high stacks 170 feet and release on 50-foot floor chain conveyor which serves as accumulator, stackbreaker breaks stack	10.55	.47	-	2.18	10/ 13.20	3.89	.47	-	4.36	12.1
Clamp-type 2-wheel hand truck, belt conveyor, stackmaker, floor chain conveyor, and mechanical high-piler										
1. 2 workers break out high-piled boxes and hand-truck 6-high stacks 35 feet to temporary bank, 1 worker hand-trucks 15 feet to and places boxes on belt conveyor which feeds into stack-maker. Stacks rebuilt 6-high and released on floor chain	14.84	.47	-	1.00	11/ 16.31	4.85	.47	-	5.32	9.7
2. 1 worker breaks out high-piled boxes and hand-trucks 6-high stacks 50 feet to and places boxes on belt conveyor, which feeds into stackmaker. Stacks rebuilt 6-high and released on floor chain	13.32	.47	.47	3.33	12/ 16.65	3.33	.47	.47	3.33	-
Clamp-type 2-wheel hand truck, elevator, and mechanical high-piler										
1. 2 workers break out high-piled boxes and hand-truck 6-high stacks 70 feet into single elevator, ride elevator and hand-truck 100 feet from elevator to temporary bank, 1 worker hand-trucks 20 feet from bank to dumper 13/	11.10	.47	-	3.05	14/ 14.62	8.51	.47	-	8.98	5.5

1/ Transportation distance from storage stacks to dumper standardized at 190 feet.
2/ Labor required for picking up 6-high stacks of boxes in storage, transportation, and releasing stacks. In belt conveyor method includes placing boxes singly on conveyor. Also includes wait time involved in these operations.
3/ Labor required to break out 500 boxes from 12-box high stacks.
4/ Clamp-type 2-wheel hand truck 7.75 machine-hours, mechanical lift 2.21 machine-hours, total 9.96 machine-hours.
5/ Clamp-type 2-wheel hand truck 5.32 machine-hours, mechanical lift 1.00 machine-hours, 140 foot belt conveyor 3.33 machine hours, total 9.65 machine-hours.
6/ Clamp-type 2-wheel hand truck mechanical lift and 140 foot belt conveyor 3.33 machine-hours each, total 9.99 machine-hours.
7/ Clamp-type 2-wheel hand truck 7.75 machine-hours, mechanical lift 2.21 machine-hours, 50 foot floor chain conveyor 3.33 machine-hours, total 13.29 machine-hours.
8/ Clamp-type 2-wheel hand truck 4.36 machine-hours, mechanical lift 2.18 machine-hours, 50 foot floor chain conveyor 3.33 machine-hours, total 9.87 machine-hours.
9/ Clamp-type 2-wheel hand truck 7.75 machine-hours, mechanical lift 2.21 machine-hours, 50 foot floor chain conveyor 3.33 machine-hours, stackbreaker 3.33 machine-hours, total 16.62 machine-hours.
10/ Clamp-type 2-wheel hand truck 4.36 machine-hours, mechanical lift 2.18 machine-hours, 50 foot floor chain conveyor 3.33 machine-hours, stackbreaker 3.33 machine-hours, total 13.20 machine-hours.
11/ Clamp-type 2-wheel hand truck 5.32 machine-hours, mechanical lift 1.00 machine hours, 140 foot belt conveyor 3.33 machine-hours, 10 foot floor chain conveyor 3.33 machine-hours, stackmaker 3.33 machine-hours, total 16.31 machine-hours.
12/ Clamp-type 2-wheel hand truck, mechanical lift, 140 foot belt conveyor, 10 foot floor chain conveyor, and stackmaker 3.33 machine-hours each, total 16.65 machine-hours.
13/ Vertical transportation distance is not included.
14/ Clamp-type 2-wheel hand truck 8.98 machine-hours, mechanical lift 2.82 machine-hours, 8,000-pound capacity elevator 2.82 machine-hours, total 14.62 machine-hours.

Table 101.--Comparative labor and equipment costs for breaking out the required number of boxes from 12-high stacks and moving to the packing line 1,000 unpacked boxes of apples by use of specified methods and types of equipment 1/

Type of equipment and method	Equipment cost	Labor cost current wage rates	Total cost current wage rates	Total cost assumed wage rates
	Dollars	Dollars	Dollars	Dollars
Clamp-type 2-wheel hand truck				
1. 2 workers hand-truck 6-high stacks 170 feet to temporary bank, 1 worker hand-trucks 20 feet from bank to dumper, and				
No boxes broken out from high pile	0.18	8.37	8.55	10.37
2 of the hand truckers manually break out boxes	2/ .24	11.49	11.73	14.23
2 of the hand truckers and mechanical lift break out boxes	1.49	8.91	10.40	12.34
Clamp-type 2-wheel hand truck and belt conveyor				
1. 2 workers hand-truck 6-high stacks 35 feet to temporary bank, 1 worker hand-trucks 15 feet from bank to conveyor and places boxes on conveyor, and				
No boxes broken out from high pile	3.98	5.58	9.56	10.77
2 of the hand truckers manually break out boxes	2/ 4.04	8.36	12.40	14.21
2 of the hand truckers and mechanical lift break out boxes	4.58	6.12	10.70	12.03
2. 1 worker hand-trucks 6-high stacks 50 feet to belt conveyor and places boxes on belt (conveyor has accumulator device), and				
No boxes broken out from high pile	3.94	3.83	7.77	8.60
2 workers manually break out boxes	3.94	6.61	10.55	11.99
2 hand truckers and mechanical lift break out boxes	5.90	3.83	9.73	10.56
Clamp-type 2-wheel hand truck and floor chain conveyor				
1. 2 workers hand-truck 6-high stacks 170 feet to temporary bank, 1 worker hand-trucks 20 feet from bank to conveyor, and				
No boxes broken out from high pile	2.11	8.38	10.49	12.30
The 2 hand truckers manually break out boxes	2/ 2.17	11.49	13.66	16.16
The 2 hand truckers and mechanical lift break out boxes	3.42	8.91	12.33	14.27
2. 2 workers hand-truck 6-high stacks 170 feet and release on 50-foot floor chain conveyor which serves as accumulator, and				
No boxes broken out from high pile	2.02	4.47	6.49	7.47
The 2 hand truckers manually break out boxes	2/ 2.09	7.66	9.75	11.41
The 2 hand truckers and mechanical lift break out boxes	3.32	5.01	8.33	9.42
Clamp-type 2-wheel hand truck, floor chain conveyor, and stackbreaker				
1. 2 workers hand-truck 6-high stacks 170 feet to temporary bank, 1 worker hand-trucks 20 feet from bank and releases on conveyor, conveyor feeds into stackbreaker which breaks down 6-high stacks, and				
No boxes broken out from high pile	4.47	8.38	12.85	14.66
2 of the hand truckers manually break out boxes	2/ 4.53	11.49	16.02	18.52
2 hand truckers and mechanical lift break out boxes	5.78	8.91	14.69	16.63
2. 2 workers hand-truck 6-high stacks 170 feet and release on 50-foot floor chain conveyor which serves as accumulator, stackbreaker breaks stacks, and				
No boxes broken out from high pile	4.38	4.47	8.85	9.83
The 2 hand truckers manually break out boxes	2/ 4.45	7.66	12.11	13.77
The 2 hand truckers and mechanical lift break out boxes	5.68	5.01	10.69	11.78
Clamp-type 2-wheel hand truck, belt conveyor, stackmaker, and floor chain conveyor				
1. 2 workers hand-truck 6-high stacks 35 feet to temporary bank, 1 worker hand-trucks 15 feet to and places boxes on belt conveyor, which feeds into stackmaker. Stacks rebuilt 6-high and released on floor chain, and				
No boxes broken out from high pile	7.27	5.58	12.85	14.06
2 of the hand truckers manually break out boxes	7.27	8.36	15.63	17.44
2 of the hand truckers and mechanical lift break out boxes	7.33	6.12	13.45	14.78
2. 1 worker hand-trucks 6-high stacks 50 feet to and places boxes on belt conveyor, which feeds into stackmaker. Stacks rebuilt 6-high and released on floor chain, and				
No boxes broken out from high pile	7.23	3.83	11.06	11.89
2 workers manually break out boxes	7.23	6.61	13.84	15.28
The hand trucker and mechanical lift break out boxes	8.65	3.83	12.48	13.31
Clamp-type 2-wheel hand truck and elevator				
1. 2 workers hand-truck 6-high stacks 70 feet into single elevator, ride elevator and hand-truck 100 feet from elevator to temporary bank, 1 worker hand-trucks 20 feet from bank to dumper, and				
No boxes broken out from high pile	8.51	9.79	18.30	20.42
2 of the hand truckers manually break out boxes	8.51	12.57	21.08	23.81
2 of the hand truckers and mechanical lift break out boxes	10.67	10.33	21.00	23.24

1/ Cost data for mechanical break out of boxes from high pile covers use of 2-stack portable lift. Cost data for both manual and mechanical break out of boxes from 12-high stacks include breaking out 500 boxes of each 1,000 moved to packing line, pick up of 6-high stacks, transportation, and release at temporary bank or at dumper. Transportation distances standardized at 190 feet.

2/ Increased because of 2.42 machine-hours of clamp-type 2-wheel hand truck time.

Industrial Clamp-Type Truck

As previously pointed out, with respect to handling unpacked boxes of apples, industrial-clamp trucks are of two sizes, handling 36 and 24 boxes, respectively. When these trucks handle packed fruit, the sizes of the unit loads are reduced respectively to 30 and 20 boxes, because packed fruit weighs approximately 30 percent more than loose fruit.

The relatively light weight of the smaller truck permits its use on floors in many storage plants that cannot support heavier equipment. This size truck also is quite maneuverable and can be operated where posts or other obstructions normally interfere with the operation of larger equipment.

The industrial-clamp truck is used either to transport fruit directly to the dumper from storage or to build a bank of supply in the dumping area from which a hand trucker supplies the dumper.

Industrial Clamp-Type Truck and Clamp-Type 2-Wheel Hand Truck

By this method, the industrial truck operator picks up fruit in storage, transports it 170 feet, and releases it in a temporary storage bank. A hand truck operator moves the fruit the remaining 20 feet as it is needed by the dumper. The labor required for performing this operation with a truck handling 24 boxes at a time is analyzed in table 102.

Table 102.--Labor required for a 2-man crew to move 1,000 unpacked boxes of apples from storage to the packing line by use of clamp-type industrial truck and clamp-type 2-wheel hand truck

Operation	Workers	Productive labor	Fatigue allowance	Wait time	Total labor
	Number	Man-hours	Man-hours	Man-hours	Man-hours
Pick up a 24-box unit load in storage by use of industrial clamp truck	1	0.22	0.01	0.0	0.23
Transport load 170 feet to a bank near the dumper	1	.77	.04	.0	.81
Release load in bank	1	.19	.01	.0	.20
Pick up a 6-high stack in the bank by use of a hand truck	1	.39	.04	.0	.43
Transport 20 feet to the dumper	1	.45	.04	.0	.49
Release load at the dumper	1	.24	.02	2.15	2.41
Total man-hours	-	2.26	.16	2.15	4.57

This method requires 4.57 man-hours of labor to move 1,000 boxes to the packing line, most of this being wait time by the hand trucker. It is assumed that the industrial truck operator moves to other assigned work after he has completed the bank of supply, avoiding wait time. If odd jobs were available to the hand truck operator, a 30- to 40-percent reduction in total labor requirements could be achieved.

Industrial Clamp-Type Truck Alone

By use of a second method, the industrial truck moves the fruit directly to the dumper, transporting the full distance of 190 feet from storage. The industrial truck operator transports a unit load from storage and places it in position by the dumper. He then moves a second load from storage to the dumping area and delays positioning it until the first load is dumped. This cycle is repeated for subsequent loads. The work of the industrial truck operator is determined by the rate of dumping. The method requires 3.33 man-hours of labor and an equivalent number of machine-hours per 1,000 boxes (table 103), 63 percent of this being wait time. Some savings could have been made if the truck operator could intermittently perform other tasks or supply two packing lines.

Table 103.--Labor required for 1 worker to move 1,000 unpacked boxes of apples from storage to the packing line by use of clamp-type industrial truck

Operation	Workers	Productive labor	Fatigue allowance	Wait time	Total labor
	Number	Man-hours	Man-hours	Man-hours	Man-hours
Pick up 24-box unit load in storage by use of industrial truck	1	0.22	0.01	0.0	0.23
Transport load 190 feet to the dumper	1	.83	.04	.0	.87
Release the load behind the dumper	1	.13	.01	2.09	2.23
Total man-hours	-	1.18	.06	2.09	3.33

Industrial Clamp-Type Truck and Floor Chain Conveyor

Each load of 24 boxes is released onto a section of dual floor chain conveyor in front of the dumper and the boxes are brought up to position for the dumper without additional labor by the truck operator. A 15-foot floor chain conveyor keeps the dumper supplied for approximately one-half hour, during which the industrial truck operator is free to do other work.

The labor required to supply the dumper by this improved method requires 1.24 man-hours. This is less than the 3.33 or 4.57 man-hours that are required, respectively, by the other two methods of supplying the dumper (table 104). Furthermore, wait time is eliminated, and the allowance for fatigue is small because of mechanization.

Table 104.--Labor required for 1 worker to move 1,000 unpacked boxes of apples from storage to the packing line by use of clamp-type industrial truck and floor chain accumulator

Operation	Workers	Productive labor	Fatigue allowance	Wait time	Total labor
	Number	Man-hours	Man-hours	Man-hours	Man-hours
Pick up a 24-box unit load in storage by use of industrial truck	1	0.22	0.01	0.0	0.23
Transport load 190 feet to the dumper	1	.83	.04	.0	.87
Release the load on floor chain accumulator back of the dumper	1	.13	.01	.0	.14
Total man-hours	-	1.18	.06	.0	1.24

Comparison of Industrial Clamp-Type Truck Methods

The method of supplying boxes to the packing line by an industrial-clamp truck with a floor chain conveyor serving as an accumulator reduces labor requirements 63 percent from the most efficient of the other two methods. The improved method reduces the amount of truck time more than enough to offset the added cost of a floor chain conveyor. Under some circumstances, installation of a floor chain conveyor might make the purchase of an additional clamp truck unnecessary. Comparative labor and equipment costs are shown in table 105.

Table 105.--Comparative labor and equipment costs of moving 1,000 unpacked boxes of apples from storage to the packing line by use of 3 specified methods involving clamp-type industrial truck

Method	Labor and equipment required			Labor and equipment costs			
	Equipment time	Wait time	Total labor	Equipment	Labor 1/	Total costs: Current wages	Total costs: Assumed wages
	Machine-hours	Man-hours	Man-hours	Dollars	Dollars	Dollars	Dollars
Industrial truck moves 24-box unit loads 170 feet from storage to a bank near the dumper. Industrial truck goes to other jobs. Hand trucker moves 6-high stacks 20 feet to the dumper	2/ 4.57	2.15	4.57	1.84	5.44	7.28	8.42
Industrial truck moves 24-box unit loads 190 feet from storage to dumper (truck keeps pace with the dumper)	3/ 3.33	2.09	3.33	4.73	4.33	9.06	9.89
Industrial truck moves 24-box unit loads 190 feet from storage to a floor chain accumulator behind the dumper	4/ 4.57	.0	1.24	2.92	1.61	4.53	4.84

1/ Computed from "current" wage rates.
2/ Clamp-type 2-wheel hand truck 3.33 machine-hours, 1,000-pound capacity electric industrial clamp-type lift truck 1.24 machine-hours, total 4.57 machine-hours.
3/ 1,000-pound capacity electric industrial clamp-type lift truck 3.33 machine-hours.
4/ 30-foot floor chain conveyor 3.33 machine-hours, 1,000-pound capacity electric industrial clamp-type lift truck 1.24 machine-hours, total 4.57 machine-hours

Industrial Fork-Lift Truck and Pallets

Industrial fork-lift trucks are used only in specially designed plants. Most of these plants are of new construction, but some are remodeled plants. In most cases, transportation areas are level and hard surfaced. However, differences occur in the transportation distances because of plant layouts.

In most plants fork-lift truck operators can do additional work when supplying the packing line if the periods of inactivity are great enough to make it worthwhile to shift to other jobs. This stresses the need of laying out a fork-lift truck plant so that this time can be utilized. A number of plants use fork-lift trucks to bring pallet loads from storage and accumulate a supply of boxes on gravity roller conveyors or roller dollies at the dumper. After the loaded pallets are positioned, the fork-lift truck operator moves to other work. Management is generally aware of the possibilities in such plants for maximum use of the truck operator's time.

Industrial Fork-Lift Truck Alone

By use of the fork-lift truck alone, pallet loads of 48 boxes are transported 190 feet from storage as they are used by the dumper. If the transportation distance is not too great, the lift-truck operator can do small odd jobs such as removing empty boxes from the dumper between cycles. However, the frequency with which unit loads must be brought to the dumper greatly limits this possibility. Therefore, it is assumed that for 190 feet the lift-truck operator's time is fully spent supplying the dumper.

By this method (table 106) of supplying the packing line directly with a fork-lift truck, 3.33 man-hours of labor are required to handle 1,000 boxes. Eighty percent, or 2.66 man-hours of this labor is wait time.

Table 106.--Labor required for 1 worker to move 1,000 unpacked boxes of apples from storage to the packing line by use of pallets and fork-lift truck alone

Operation	Workers	Productive labor	Fatigue allowance	Wait time	Total labor
	Number	Man-hours	Man-hours	Man-hours	Man-hours
Pick up pallet load of 48 boxes in storage by use of fork-lift truck	1	0.09	0.01	0.0	0.10
Transport 190 feet to the dumper	1	.44	.02	.0	.46
Release the load at the dumper	1	.10	.01	2.66	2.77
Total man-hours	-	.63	.04	2.66	3.33

Industrial Truck and Gravity Conveyor Section

The most widely used method by which fork-lift trucks move apples to the packing line involves the use of gravity conveyor sections in front of the dumper. These sections permit several unit loads of fruit to be accumulated at a time and there is sufficient fruit to keep the packing line supplied for about one-half hour.

By this method, fruit is picked up in storage, transported 190 feet, and released on the gravity roller conveyor at the rate of 1,000 boxes per 0.67 of a man-hour (table 107). Most of this time is required for transportation.

Table 107.--Labor required for 1 worker to move 1,000 unpacked boxes of apples from storage to the packing line by use of pallets, fork-lift truck, and gravity conveyor sections

Operation	Workers	Productive labor	Fatigue allowance	Wait time	Total labor
	Number	Man-hours	Man-hours	Man-hours	Man-hours
Pick up unit load (48 boxes) in storage by use of fork-lift truck	1	0.09	0.01	0.0	0.10
Transport 190 feet to the dumper	1	.44	.02	.0	.46
Release the load on the roller conveyors at the dumper	1	.10	.01	.0	.11
Total man-hours	-	.63	.04	.0	.67

Comparison of Methods

The method of moving apples to gravity conveyor sections at the packing line is the lowest cost method (table 108). Labor and equipment costs are approximately three times as much when the roller accumulator is not used. This saving is so important and obvious that most Washington State plants use the accumulator method.

Table 108.--Comparative labor and equipment costs of moving 1,000 unpacked boxes of apples from storage to the packing line by use of 2 specified methods involving pallets and fork-lift trucks

Method	Labor and equipment required			Labor and equipment costs			
	Equipment time	Wait time	Total labor	Equipment	Labor 1/	Total costs: Current wages	Total costs: Assumed wages
	Machine-hours	Man-hours	Man-hours	Dollars	Dollars	Dollars	Dollars
Move 48-box unit loads 190 feet from storage to the dumper. Pallet loads released on floor behind dumper	2/ 4.00	2.66	3.33	8.94	4.33	13.27	14.10
Move 48-box unit loads 190 feet from storage to the dumper. Pallets released on two 15-foot gravity roller conveyor sections which accumulate 4 pallet loads	3/ 4.67	.0	.67	3.19	.87	4.06	4.22

1/ Computed from "current" wage rates.
2/ 4,000-pound capacity electric fork-lift truck 3.33 machine-hours, 20.8 pallets (48-box) 0.67 machine-hours, total 4.00 machine-hours.
3/ 4,000-pound capacity electric fork-lift truck 0.67 machine-hours, 20.8 pallets (48-box) 0.67 machine-hours, 30 feet of gravity roller conveyor 3.33 machine-hours, total 4.67 machine-hours.

Industrial Fork-Lift Truck, Low-Lift Pallet Transporter, Belt Conveyor, and Pallets

One apple plant in Washington State uses a low-lift pallet transporter in combination with the fork-lift truck and belt conveyor. To move apples to the packing line, the fork-lift truck is used in a new section of the building to remove pallet loads of 48 boxes from storage, transport and release them on the platform of the old section of the building in which the packing line is located (fig. 99). The low-lift pallet transporter picks up the pallet load and transports it to a point near the packing line where one worker breaks out boxes from unit loads and places them on the belt conveyor (fig. 100).

The fork-lift truck moves the fruit approximately 60 feet into the old part of the building where the low-lift pallet transporter picks up the load and moves it an additional 60 feet. After the fruit is placed on the belt conveyor it is transported the remaining 70 feet of the 190-foot standard distance. The fork-lift truck driver and the operator of a low-lift pallet transporter are occupied only part time in this operation. The man placing fruit on the belt is occupied full time. A total of 4.28 man-hours of labor is required to move 1,000 boxes to the line by this method. More than three-fourths of this labor was used by the man placing fruit on the belt conveyor, who spent more than one-half of his time waiting (table 109).

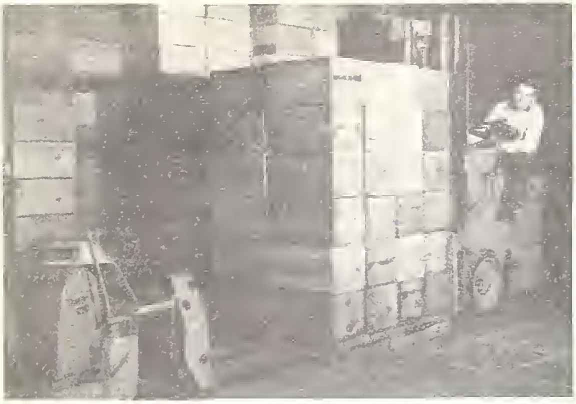

Figure 99.--Fork-lift truck releasing a pallet load for a low-lift pallet transporter to pick up and move to line.

Figure 100.--The low-lift pallet transporter moving a 48-box pallet load of apples.

Table 109.--Labor required for a 2-man crew to move 1,000 unpacked boxes of apples from storage to the packing line by use of pallets, fork-lift truck, low-lift pallet transporter, and belt conveyor

Operation	Workers	Productive labor	Fatigue allowance	Wait time	Total labor
	Number	Man-hours	Man-hours	Man-hours	Man-hours
Pick up 48-box pallet load in storage by use of fork-lift truck	1	0.09	0.01	0.0	0.10
Transport 60 feet to section of old building	1	.23	.01	.0	.24
Release unit load on platform	1	.04	.0	.0	.04
Pick up 48-box pallet load by use of low-lift pallet transporter	1	.11	.01	.0	.12
Transport 60 feet to the dumper	1	.30	.02	.0	.32
Release unit load at the belt conveyor to the dumper	1	.12	.01	.0	.13
Place boxes on belt to the dumper	1	1.30	.26	1.77	3.33
Total man-hours	-	2.19	.32	1.77	4.28

In this operation, the low-lift pallet transporter was utilized to move packed boxes of fruit back to storage at the time it was bringing unpacked fruit to the packing line. Thus, the time of the machine was fully utilized. Even though the transporter did not travel empty, machine costs are more than twice as great as labor costs. The total cost to move 1,000 boxes to the packing line by this method was $10.65 (table 110).

Table 110.--Labor and equipment costs of moving 1,000 unpacked boxes of apples from storage to the packing line by use of pallets, fork-lift truck, low-lift pallet transporter, and belt conveyor

Method	Labor and equipment required			Labor and equipment costs			
	Equipment time	Wait time	Total labor	Equipment	Labor 1/	Total cost: Current wages	Total cost: Assumed wages
	Machine-hours	Man-hours	Man-hours	Dollars	Dollars	Dollars	Dollars
Fork-lift truck moves pallet load of 48 boxes 60 feet to a point in an old building, low-lift transporter transports 60 feet to a belt conveyor. Another worker lifts boxes from pallets to belt going to dumper	2/ 5.23	1.77	4.28	5.58	5.07	10.65	12.21

1/ Computed from "current" wage rates.
2/ 4,000-pound capacity electric fork-lift truck 0.38 machine-hours, 4,000-pound capacity low-lift pallet transporter 0.57 machine-hours, 20.8 pallets (48-box) 0.95 machine-hours, 70-foot belt conveyor 3.33 machine-hours, total 5.23 machine-hours.

Comparison of Selected Methods and Types of Equipment for Moving Apples from Storage to the Packing Line

Table 111 presents the comparative labor and equipment costs incurred in moving 1,000 unpacked boxes of apples from storage to the packing line, over a distance of 190 feet, by selected methods previously discussed. For all methods involving hand trucks, the costs, per 1,000 boxes, cover breaking out half of the boxes from 12 box high stacks.

At current wage rates, the lowest cost, of $4.06 per 1,000 boxes, is obtained by use of industrial fork-lift trucks transporting 48 boxes per pallet load and releasing the loads on two 15-foot sections of gravity roller conveyors at the dumper. The conveyor sections serve as accumulators. If the fork-lift truck must bring up pallet loads at the rate boxes are dumped at the beginning of the packing line, costs are increased to $13.27 per 1,000 boxes.

Of the various methods utilizing hand trucks, the combination of floor chain conveyor, hand truck, and mechanical high-piler incurs the lowest labor and equipment costs, or $8.33 per 1,000 boxes.

Moving apples to the packing line by hand trucks and elevator is the highest cost method, at $21.08 per 1,000 boxes.

Table 111.--Comparative labor and equipment costs for moving 1,000 unpacked boxes of apples from storage to the packing line by use of specified methods and types of materials-handling equipment 1/

Type of equipment and method	Workers	Equipment cost 2/	Labor cost--current wage rates 3/	Total cost--current wage rates	Total cost--assumed wage rates 4/
	Number	Dollars	Dollars	Dollars	Dollars
Clamp-type 2-wheel hand trucks					
1. 2 workers break down stacks from 12-high and hand-truck 170 feet to a temporary bank, 1 worker hand-trucks 20 feet from bank to dumper	3	0.24	11.49	11.73	14.23
2. 2 workers break down stacks from 12-high with mechanical high-piler and hand-truck 170 feet to a temporary bank, 1 worker hand-trucks 20 feet from bank to dumper	3	1.49	8.91	10.40	12.34
Belt conveyor and hand truck					
1. 2 workers break down stacks from 12-high and hand-truck 35 feet to a temporary bank, 1 worker hand-trucks 15 feet from bank to belt and places boxes on the belt	3	4.04	8.36	12.40	14.21
2. 2 workers break down stacks from 12-high with mechanical high-piler and hand-truck 35 feet to a temporary bank, 1 worker hand-trucks 15 feet from bank to belt and places boxes on a belt	3	4.58	6.12	10.70	12.03
Floor chain conveyor and hand truck					
1. 2 workers break down stacks from 12-high and hand-truck 170 feet to a temporary bank, 1 worker hand-trucks 20 feet from a bank to a floor chain	3	2.17	11.49	13.66	16.16
2. 2 workers break down stacks from 12-high with mechanical high-piler and hand-truck stacks 170 feet to a floor chain conveyor	2	3.32	5.01	8.33	9.42
Floor chain conveyor, stackbreaker, and hand truck					
1. 2 workers break down stacks from 12-high and hand-truck 170 feet to a temporary bank, 1 worker hand-trucks 20 feet from a bank to a floor chain	3	4.53	11.49	16.02	18.52
2. 2 workers break down stacks from 12-high with mechanical high-piler and hand-truck stacks 170 feet to a floor chain conveyor	2	5.68	5.01	10.69	11.78
Belt conveyor, stackmaker, floor chain conveyor, and hand truck					
1. 2 workers break down stacks from 12-high and hand-truck 35 feet to a temporary bank, 1 worker hand-trucks 15 feet from bank to belt and places boxes on a belt	3	7.27	8.36	15.63	17.44
2. 2 workers break down stacks from 12-high with mechanical high-piler and hand-truck 35 feet to a temporary bank, 1 worker hand-trucks 15 feet from bank to belt and places boxes on a belt	3	7.33	6.12	13.45	14.78
Elevator and hand truck 5/					
1. 2 workers break down stacks from 12-high, 2 workers hand-truck 20 feet to elevator, and 100 feet from elevator to temporary bank, 1 worker hand-trucks 20 feet from bank to dumper	5	8.51	12.57	21.08	23.81
2. 2 workers break down stacks from 12-high with mechanical high-piler, hand-truck the stacks 70 feet to an elevator, and 100 feet to a temporary bank, 1 worker hand-trucks 20 feet from bank to dumper	3	10.67	10.33	21.00	23.24
Clamp-type industrial lift truck					
1. Industrial truck moves 24-box loads 170 feet from storage to a temporary bank, 1 worker hand-trucks 20 feet from bank to dumper	2	1.84	5.44	7.28	8.42
2. Industrial lift truck moves 24-box loads 190 feet from storage to floor chain accumulator behind dumper	1	2.92	1.61	4.53	4.84
Pallets and fork-lift truck					
1. Fork truck moves 48-box loads 190 feet to the dumper, pallets released on floor behind dumper	1	8.94	4.33	13.27	14.10
2. Fork truck moves 48-box unit loads 190 feet from storage to the dumper, pallets released on two 15-foot roller conveyors	1	3.19	.87	4.06	4.22
Pallets and fork-lift trucks, low-lift pallet transporter, and belt conveyor					
1. Fork truck moves 48-box loads 60 feet to old building, low-lift transporter moves fruit 60 feet to a belt conveyor, 1 worker places boxes from pallet to belt	3	5.58	5.07	10.65	12.21

1/ Transportation distances are standardized at 190 feet.
2/ Equipment costs computed from data on ownership and operating costs shown in table 2.
3/ "Current" labor costs computed from wage rates of $1.15 per hour for unskilled labor and $1.30 per hour for semiskilled workers (key workers such as industrial truck operators).
4/ Assumed labor costs computed from wage rates of $1.40 per hour for unskilled labor and $1.55 per hour for semiskilled workers.
5/ Vertical transportation distance not included.

METHODS AND EQUIPMENT FOR MOVING APPLES FROM THE PACKING LINE TO STORAGE

Nearly all Washington State apple packing houses are equipped with weight-type sizing equipment having two rows of tubs into which different sizes of apples are automatically tripped. Apples from these tubs are packed in containers by packers stationed alongside the tubs in a narrow aisle. Directly opposite, and not more than five or six feet from the tubs, is a drag chain conveyor line on which each packer places the packed boxes of apples. The conveyor moves the packed boxes of apples to the end of the packing line where workers stamp and mark the boxes according to variety, grade, and size of fruit. From the stamping and marking station, boxes are conveyed a few feet to a lidding machine.

The operator of the lidding machine usually permits a number of boxes to accumulate before commencing the lidding operation. 37/ Thus, the boxes usually move intermittently from the lidder in groups unless one lidding machine is being used to lid boxes for more than one packing line. Not only is the flow of fruit from the lidding machine intermittent in the single-line plant, it also is slow. When 300 unpacked boxes per hour are dumped into the cleaner, only 210 to 220 boxes an hour are packed. 38/ Even when one machine lids boxes for more than one packing line, a relatively small number of boxes arrive at a given storage room, since the fruit from each line usually is a different grower's lot and may be stored in different rooms.

However, in some plants having multiple packing lines, fruit from two or more lines may arrive in the same cold storage room and, depending upon the storage practices of the organization, usually must be segregated on the basis of growers' lots. In some cooperatively-owned plants, fruit is pooled after it is packed. That is, grower's identity is lost. This practice has possibilities for increased efficiency in moving fruit back to storage, but even when the fruit is pooled, growers' lots frequently are kept separate to determine the keeping quality of the fruit and determine whether the sales return would be averaged in an early or late pool.

Although unpacked apples are handled in only one type of container, insofar as inside dimensions are concerned, packed fruit may be handled either in standard wood boxes or corrugated paper cartons. 39/ The handling

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37/ The operator of the lidding machine is referred to in this industry as a lidder.

38/ Two-hundred and ten packed boxes per hour assumed for the calculations in this section of the report. The amount could be greater, depending on the number of sorters, size of fruit, and quality.

39/ A few apple packing houses pack miniature or half boxes which are one-half the size of standard box.

of packed boxes of apples does not differ materially from handling unpacked boxes except that packed standard boxes always are handled and transported on their sides, which increases the height of a stack of boxes. (The standard box is one inch wider than it is deep.) The packed box also weighs more than a box of loose fruit. However, the fact that the apples in packed boxes are lidded and do not spill out in handling permits them to be moved more freely and seems to compensate for these factors.

There are no significant differences in the length of time, labor requirements, and equipment requirements, for handling packed standard boxes and cartons of apples. For further details see the Appendix.

A relatively large percentage of the apples packed in cartons are tray packed. 40/ Instead of going through the lidding machine, tray pack cartons either are glued by hand, or in plants turning out large quantities, sealed with automatic case-sealers. In either instance, the handling proceeds the same as with the standard pack except that tray pack cartons usually are not high-piled. When used for handling tray pack cartons, 2-wheel hand trucks have larger lips or blades on the clamping arms so that they will slip underneath and distribute the weight of the carton over a greater surface. Studies of handling operations by use of hand trucks and fork-lift trucks show that there is no significant difference in the time required to handle and transport cartons as compared with standard packed boxes.

Some packed boxes of fruit are high-piled when returned to storage. However, high-piling is not as common with packed fruit as with loose fruit. Packed fruit most often is high-piled during the receiving season or during a period of light shipping. After all fruit is under cover and shipping has been carried on for a time, there usually is storage space enough so that high-piling is unnecessary. In years when the apple crop is relatively small, very little packed fruit is high-piled.

Packed boxes of apples usually are not high-piled to the same height as unpacked fruit because of the increased height of the stack when the boxes are turned on their sides. Also, the need for storage space, at least during the latter part of the packing season, is not as great as during the receiving season. 41/ In plants using industrial fork-lift trucks, packed boxes of fruit are stacked only 15 boxes high instead of 18. Industrial-clamp trucks stack 10 high instead of 12 high.

40/ Cartons are also used for consumer packaged apples and loose fruit but neither of these packs is common and both are almost universally fresh packed, that is, the fruit is shipped out as it is packed. Consumer packages are packed in either tray pack or a bonding-type carton.

41/ Use of the mechanical high-piler makes it relatively more desirable to high-pile to greater heights.

In moving packed boxes of fruit to storage from the packing line, it is necessary that the segregating operation be performed prior to other operations comprising this cycle of operations, which are: (1) Pick up unit loads by use of clamp-type 2-wheel hand trucks or industrial-clamp or fork-lift trucks, (2) transport loaded which consists of moving unit loads to temporary banks or points of permanent storage, (3) set down unit loads, and (4) return empty with the hand truck or industrial truck.

The pickup operation is performed at the segregating area where the unit loads of 5, 6, 20, 30, or 40 boxes have been made up by the segregator. This operation begins when the truck operator starts to maneuver his truck to pick up a load, and ends when he is in position to begin the next operation; or in the case of industrial equipment, when the unit load clears its original position.

Transport loaded begins when the truck operator starts to move toward the temporary bank or point of permanent storage with the loaded hand truck, or when the unit load clears its original position, and ends when the operator stops the forward motion or begins his maneuvering to set down, position, or release the load being transported.

The stacking, positioning, release, or set-down operation begins when the truck operator stops the forward motion, begins maneuvering for release, or when the unit load on the transportation equipment arrives at the storage point. The operation includes lowering or positioning the load, releasing the clamping arms, or withdrawing the forks. The operation ends when the hand-truck operator starts his travel to return empty to pick up the next load or when the forks or clamps of the industrial truck clear the load.

The return-empty operation consists of returning with the empty equipment to pick up the next load. The operation begins when the hand-truck operator starts this travel to pick up the next load or when the forks or clamps of the industrial truck clear the load, and ends when he starts to maneuver to pick it up. For purposes of analysis, return-empty and transport-loaded operations are combined and shown under transportation in the tables that follow.

When conveyors are employed, two operations usually are involved: (1) Placing single boxes on the conveyor and (2) removing boxes from the conveyor. Both of these operations begin when the first box is picked up and end when the last box is set down. Between the pickup and set down, it may be necessary for the worker to turn and move the box into an appropriate position in a stack, unit load, or on the conveyor.

The transportation distance in moving fruit back to storage varies from 100 to 190 feet. For the purposes of analysis, it has been assumed that the distance is 175 feet, 15 feet of which is accounted for by transportation on gravity roller conveyor sections from which the segregation operation is performed. In the belt conveyor method, it is assumed that the fruit is moved 100 feet by belt conveyor and 60 feet by hand trucks. 42/ In actual practice, belt conveyors are usually longer than 60 feet.

Costs of most of the methods of moving packed boxes of fruit back to storage other than by industrial trucks may be reduced by use of the mechanical high-piler. The full extent of the savings cannot be accurately determined until commercial use of the machine has been studied. However, estimates are possible by use of the time study data.

The six combinations of types of equipment used for moving packed boxes of apples to storage are: (1) Clamp-type 2-wheel trucks and gravity roller conveyors, (2) clamp-type 2-wheel hand trucks, belt conveyor, and gravity roller conveyors, (3) clamp-type 2-wheel hand trucks, elevator, and gravity roller conveyor, (4) industrial fork-lift truck, pallets, and gravity roller conveyor, (5) low-lift pallet transporter, industrial fork-lift truck, pallets, and gravity roller conveyors, and (6) industrial clamp-type lift truck and gravity roller conveyors.

Segregation of Packed Boxes of Apples

An important part of the work of moving packed boxes of apples to storage is the segregation on the basis of grade, size, and variety. As a physical handling operation, segregation is the separation of boxes in a lot and the building of unit loads. Unit loads contain 5 or 6 boxes when the fruit is handled by 2-wheel hand trucks, and 20, 30, or 40 boxes when handled by use of industrial trucks.

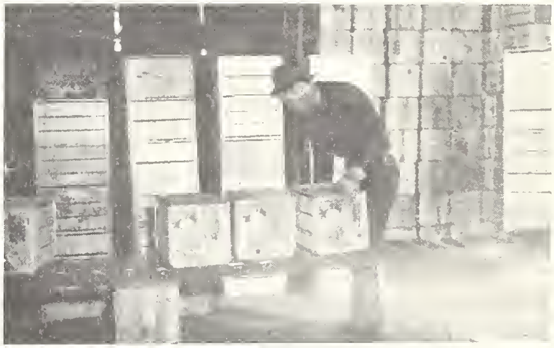

Figure 101.--One man segregating packed boxes of apples from gravity-type conveyor section.

If storage rooms are crowded, packed boxes usually are not segregated into exact sizes or in lots of only one size to the lot. In such cases, two, three, or more sizes are mixed in each unit load of one grade. On a sellers' market more sizes can be mixed into the segregated unit, since buyers are less critical of obtaining a mixture of sizes. On a buyers' market, it frequently is necessary to sort the segregated boxes again to eliminate certain sizes. The second sorting can be avoided by not mixing sizes in the same stack when performing the initial segregation.

42/ The belt conveyor method is by far the most common method of moving fruit back to storage. Even in plants where hand trucks or industrial-clamp trucks do all other handling, belt conveyors are used to return the fruit to storage.

Segregation is frequently from sections of gravity roller conveyors (figs. 101 and 102). A power unit forces the boxes onto the conveyor. The use of these sections permits several boxes to accumulate and give the segregator time to exercise choice as to the order in which he will handle the boxes. In a single-line plant, one worker usually is employed to segregate and one or more workers to truck the fruit away from the segregation area, the actual number depending on the transportation distance (fig. 103).

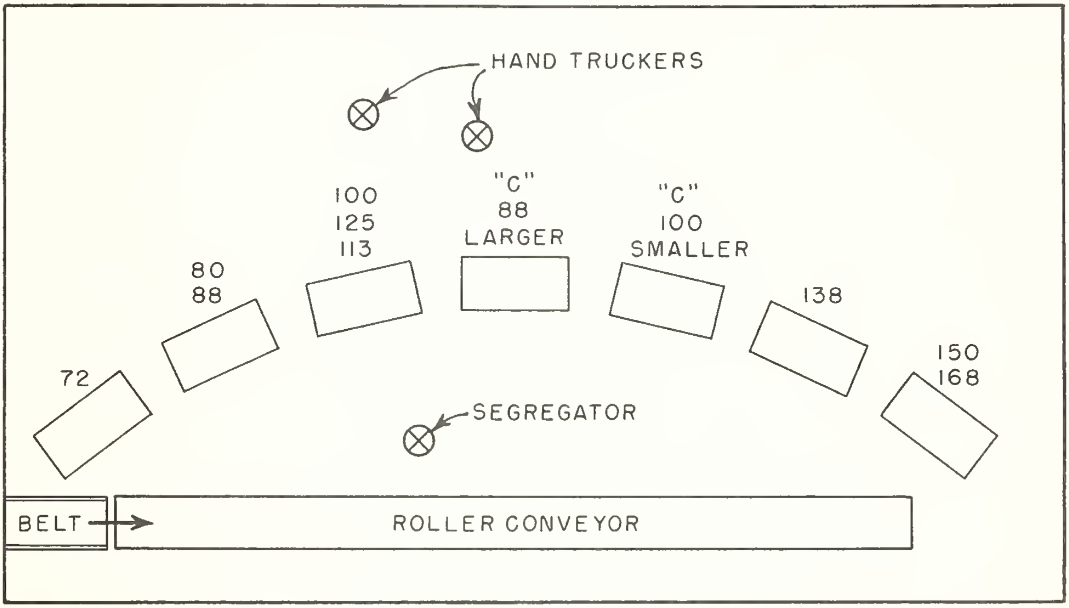

Figure 102.--One to three groups of sizes are placed in each segregated unit at the plant shown in figure 101.

Figure 103.--In this plant part of the fruit is segregated to either side of a conveyor, depending on the size of the fruit. One hand trucker and one segregator work as a team on each side.

Segregation in belt conveyor plants usually is performed in the room in which the fruit is to be stored, which is convenient for hand trucking boxes to the final storage position. In some cases, certain sizes or grades may be removed from the conveyor in one storage room and other grades in other rooms. In plants using industrial fork-lift trucks, fruit usually is segregated in a special room or area, which in most of these plants adjoins the packing room (figs. 104 and 105). The industrial truck transports segregated unit loads into the storage rooms.

Figure 104.--Large segregation area with one or two sizes on a pallet.

Figure 105.--Segregating three or more sizes to a pallet.

Clamp-Type 2-Wheel Hand Trucks and Gravity Roller Conveyors

Many of the smaller plants in Washington State use clamp-type 2-wheel hand trucks to move fruit from the packing line back to storage. Usually packed boxes of fruit are segregated at or near the packing line from which point the fruit is hand trucked to storage. The transportation distance in some plants is not as great as the 160 feet used for comparative analyses.

Hand Trucks and Manual High-Piling

In the most widely used method of moving packed boxes of apples from the packing line to storage by hand trucks, one worker segregates fruit into unit-load stacks of boxes 6 high and transports these 30 feet to a temporary storage bank, keeping the segregation area clear, and two workers transport the fruit from the temporary bank the remaining 130 feet and pile it 10 boxes high. The top four boxes, made up in the segregating area, are manually high-piled.

As shown in table 112, the hand-truck method of moving fruit to storage from the packing line and manually high-piling it requires 19.04 man-hours

Table 112.--Labor required for a 3-man crew to move 1,000 packed boxes of apples from the packing line to storage and pile 10 boxes high by use of clamp-type 2-wheel hand trucks, gravity roller conveyor, and manual high piling

Operation	Workers	Productive labor	Fatigue allowance	Wait time	Total labor
	Number	Man-hours	Man-hours	Man-hours	Man-hours
One worker segregates boxes at roller conveyor and builds 6-high stacks	1	2.19	0.44	2.13	4.76
Pick up 6-high stacks of boxes in segregation area by use of 2-wheel hand truck	1	.23	.02	3.51	3.76
Transport 30 feet by use of 2-wheel hand truck	1	.62	.06	.0	.68
Release stacks in bank by use of 2-wheel hand truck	1	.29	.03	.0	.32
Pick up 6-high stacks of boxes in bank by use of 2-wheel hand truck	2	.29	.03	4.20	4.52
Transport 130 feet by use of 2-wheel hand truck	2	2.33	.23	.0	2.56
Release 6-high stacks in storage	2	.35	.04	.0	.39
Manually high-pile boxes in 10-high stacks 1/	2	1.64	.41	.0	2.05
Total man-hours	-	7.94	1.26	9.84	19.04

1/ The 4 boxes above the original 6-high stacks, or 400 of each 1,000 packed boxes moved to storage, are high-piled.

of labor per 1,000 boxes. Of the total labor required, 52 percent is lost in wait time. The segregator waits 2.13 man-hours because the packing line does not turn out fruit fast enough to keep him occupied. The worker trucking to the temporary supply bank loses 3.51 man-hours, almost three times as much time as he spends in productive work. The two workers hand trucking from the temporary bank of supply to storage and high-piling lose 4.20 man-hours. Consolidation or rearrangement of the workers should permit the release of one worker.

Hand Trucks and Mechanical High-Piling

By use of a mechanical high-piler, the 3-man crew can be rearranged as follows: One worker segregating boxes, moving fruit 80 feet to a bank of supply; one worker moving fruit 80 feet to storage; and one worker mechanically high-piling. By use of this method, packed boxes would be handled in 5 box high stacks as unit loads, to facilitate mechanical high-piling.

By use of the mechanical high-piler, the labor required to move 1,000 packed boxes to storage is reduced by nearly 5 man-hours from the labor required by the previously described method. As shown in table 113, labor requirements are 14.28 man-hours per 1,000 boxes. Wait time is reduced almost one-half. The man trucking fruit to the temporary bank of supply loses 2.10 man-hours in wait time, which would permit him to transport a greater distance.

Table 113.--Labor required for a 3-man crew to move 1,000 packed boxes of apples from the packing line to storage and pile 10 boxes high by use of gravity roller conveyor, clamp-type 2-wheel hand trucks, and mechanical high-piler 1/

Operation	Workers	Productive labor	Fatigue allowance	Wait time	Total labor
	Number	Man-hours	Man-hours	Man-hours	Man-hours
One worker segregates boxes at roller conveyor and builds 5-high stacks	1	2.19	0.44	2.13	4.76
Pick up 5-high stacks of boxes in segregating area by use of 2-wheel hand truck	1	.28	.03	2.10	2.41
Transport 80 feet by 2-wheel hand truck	1	1.78	.18	.0	1.96
Release stacks in bank by use of 2-wheel hand truck	1	.35	.04	.0	.39
Pick up 5-high stacks of boxes in bank by use of 2-wheel hand truck	1	.35	.04	.97	1.36
Transport 80 feet by use of 2-wheel hand truck	1	1.78	.18	.0	1.96
Release stacks in storage	1	.42	.04	.0	.46
High-pile mechanically to 10 boxes high 1/	1	.89	.09	.0	.98
Total man-hours	-	8.04	1.04	5.20	14.28

1/ Lower 5 boxes in 10-high stacks are released as a unit load in storage position by clamp-type 2-wheel hand truck. Upper 5 boxes are high-piled by mechanical high-piler.

Comparison of Methods

Total labor and equipment costs for moving 1,000 packed boxes to storage by the method involving manual high-piling is $22.43 (table 114)

Table 114.--Comparative labor and equipment costs for moving 1,000 packed boxes of apples from the packing line to storage and pile 10 boxes high by use of 2 specified hand-truck methods

Type of equipment and method	Labor and equipment required			Labor and equipment costs			
	Equipment time	Wait time	Total labor	Equipment	Labor 1/	Total costs: Current wages	Total costs: Assumed wages
	Machine-hours	Man-hours	Man-hours	Dollars	Dollars	Dollars	Dollars
Clamp-type 2-wheel hand truck and gravity roller conveyor							
One worker segregates and hand trucks 30 feet to bank, 2 workers hand truck 130 feet to storage and high-pile 10 boxes high	2/ 19.04	9.84	19.04	0.53	21.90	22.43	27.19
Clamp-type two-wheel hand truck, gravity roller conveyor, and mechanical high-piler							
One worker segregates and hand trucks 80 feet to temporary bank, 1 worker hand trucks 80 feet to storage and 1 worker mechanically high-piles	3/ 19.04	5.20	14.28	3.23	16.42	19.65	23.22

1/ Computed from "current" wage rates.
2/ Clamp-type 2-wheel hand truck 14.28 machine-hours, 15-foot gravity roller conveyor 4.76 machine-hours, total 19.04 machine-hours.
3/ Clamp-type 2-wheel hand truck 9.52 machine-hours, 15-foot gravity roller conveyor 4.76 machine-hours, mechanical lift 4.76 machine-hours, total 19.04 machine-hours.

Equipment costs account for only 2.4 percent of the total cost. The improved method reduces these costs to $19.65. Labor costs are reduced $5.48, but the machine costs are increased. Machine costs are high because the mechanical high-piler stands idle most of the time. It is possible that the high-piler might be used intermittently for operations, thus reducing some machine costs. A further improvement in the method might involve stacking the fruit higher, which permits the machine to work more efficiently.

Clamp-Type 2-Wheel Hand Trucks, Belt Conveyor, and Gravity Roller Conveyor

The belt-conveyor-hand-truck method is the one most widely used for moving fruit from storage back to the packing line. Segregation of packed boxes is by a gravity roller conveyor. All plants that use belt conveyors for receiving and other operations, and many plants that use floor chain conveyors, industrial-clamp trucks, or 2-wheel hand trucks alone for other operations, use the belt-conveyor-hand-truck combination for moving packed boxes to storage. The use of belt conveyors for moving fruit to storage ties directly in with packing-line operations, because as the fruit leaves the packing line on a conveyor no additional labor is required for moving it to the storage room.

When belt conveyors are used to move fruit to storage, packed boxes usually are segregated in the cold room, usually from a section of gravity roller conveyor, but occasionally from a live belt, the latter requiring more effort (fig. 106). After the fruit is loaded off of the belt into the segregated units, it is hand trucked to storage position or to the high-piler. As shown in figure 107, sections of gravity-type roller conveyors are sometimes used in manually high-piling packed boxes.

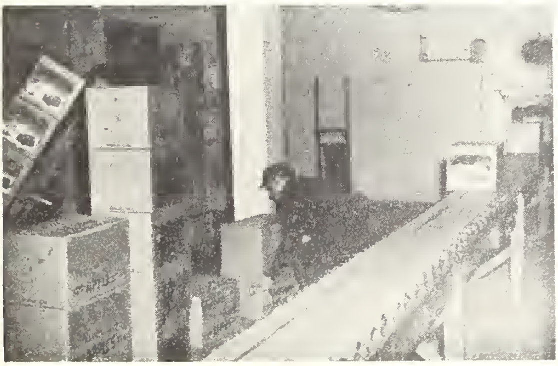

Figure 106.--Segregating and hand trucking cartons into storage using a belt conveyor and hand trucks.

Figure 107.--High-piling packed boxes with the aid of a roller conveyor.

It is assumed that the transportation distance on the belt conveyor is 100 feet, that 15 feet of gravity roller conveyor is used, and that the fruit is hand trucked 60 feet.

Usually the total transportation distance, when belt conveyors are used to move fruit to storage, is much greater than 175 feet since belt conveyors extend into all storage rooms. Although labor requirements are not altered by the transportation distance, machine costs are affected.

Method Employing 3-Man Crew

In the most widely used method of moving apples from the packing line to storage, one worker in the cold room segregates and builds stacks 6 high, and two workers hand truck the stacks 60 feet to the storage position and high-pile the fruit in stacks 10 boxes high.

For a 3-man crew to move apples to storage by hand truck and belt conveyors required 14.28 man-hours of labor (table 115). Over one-half of this labor was accounted for by wait time. About 72 percent of this idle time occurred through the delays of the two workers hand trucking and high-piling fruit largely because fruit does not move from the packing line rapidly enough to keep the workers occupied. The delay time of the two hand truckers, who also high-pile, is of such magnitude that one of the workers could be released if the mechanical high-piler were used. However, if manual methods are used, two workers are necessary for high-piling.

Table 115.--Labor required for a 3-man crew to move 1,000 packed boxes of apples from the packing line to storage and pile 10 boxes high by use of clamp-type 2-wheel hand trucks, belt conveyor, and gravity roller conveyor

Operation	Workers	Productive labor	Fatigue allowance	Wait time	Total labor
	Number	Man-hours	Man-hours	Man-hours	Man-hours
One worker segregates boxes at roller conveyor and builds 6-high stacks	1	2.19	0.44	2.13	4.76
Pick up 6-high stacks of boxes in segregation area by use of 2-wheel hand truck	2	.23	.02	5.51	5.76
Transport 60 feet by use of 2-wheel hand truck	2	1.14	.11	.07	1.32
Release stacks in storage by use of 2-wheel hand truck	2	.35	.04	.0	.39
Manually high-pile boxes in 10-high stacks	2	1.64	.41	.0	2.05
Total man-hours	-	5.55	1.02	7.71	14.28

Method Employing 2-Man Crew

An improved method of moving apples to storage eliminates the worker assigned solely to segregating. By use of the improved method, boxes are segregated by the two workers who hand truck and high-pile the fruit. The change in crew size and arrangement is accomplished by an accumulator section of dead roller conveyor sufficient in size to hold enough boxes to permit the two workers to leave the segregation area intermittently while high-piling. Since 40 percent of the boxes are high-piled, approximately 22 percent of the time must be spent high-piling. The accumulator space must be large enough to hold about 50 boxes. If the transportation distance is more than 60 feet, it would not be possible to use this method unless an additional hand trucker were added or the two workers performed at above normal rates.

The improved method of moving fruit to storage by belt conveyor, hand trucks, and gravity roller conveyor requires 9.52 man-hours per 1,000 boxes handled, a saving of 33 percent compared with the method employing a 3-man crew (table 116). Wait time is reduced 4.76 man-hours.

Table 116.--Labor required for a 2-man crew to move 1,000 packed boxes of apples from the packing line to storage and pile 10-boxes high by use of clamp-type 2-wheel hand trucks, belt conveyor, and gravity conveyor accumulator

Operation	Workers	Productive labor	Fatigue allowance	Wait time	Total labor
	Number	Man-hours	Man-hours	Man-hours	Man-hours
Two workers segregate boxes at roller conveyor and build 6-high stacks	2	2.19	0.44	1.44	4.07
Pick up 6-high stacks of boxes in segregation areas by use of 2-wheel hand truck	2	.23	.02	1.44	1.69
Transport 60 feet by use of 2-wheel hand truck	2	1.14	.11	.07	1.32
Release stacks in storage by use of 2-wheel hand truck	2	.35	.04	.0	.39
Manually high-pile boxes in 10-high stacks	2	1.64	.41	.0	2.05
Total man-hours	-	5.55	1.02	2.95	9.52

Comparison of Methods

The improved method of moving fruit to storage by belt conveyors, hand trucks, and a gravity conveyor accumulator costs $15.32 per 1,000 boxes compared with $20.79 by the method employing a 3-man crew (table 117). All of this saving is made possible by the reduction in labor. The accumulator roller, which is added behind the lidding machine, would replace the power conveyor at no additional cost. Some extra work is involved in pushing the boxes from the accumulator roller. However, the lidder, whose work is intermittent, can do it.

Table 117.—Comparative labor and equipment costs for moving 1,000 packed boxes of apples from the packing line to storage by use of 2 specified methods employing belt conveyor, clamp-type 2-wheel hand trucks, and gravity conveyor sections 1/

Method	Labor and equipment required: Equipment time	Labor and equipment required: Wait time	Labor and equipment required: Total labor	Labor and equipment costs: Equipment	Labor and equipment costs: Labor 1/	Total costs: Current wages	Total costs: Assumed wages
	Machine-hours	Man-hours	Man-hours	Dollars	Dollars	Dollars	Dollars
Three-man crew							
One worker segregates, 2 workers hand truck 60 feet and manually high-pile 10 boxes high	2/ 19.04	7.71	14.28	4.37	16.42	20.79	24.36
Two-man crew							
Two workers segregate, hand truck 60 feet and manually high-pile 10 boxes high	2/ 19.04	2.95	9.52	4.37	10.95	15.32	17.70

1/ Computed from "current" wage rates.
2/ Clamp-type 2-wheel hand trucks 9.52 machine-hours, 100-foot belt conveyor 4.76 machine-hours, 15-foot gravity roller conveyor 4.76 machine-hours, total 19.04 machine-hours.

Clamp-Type 2-Wheel Hand Trucks, Elevator, and Gravity Roller Conveyor

Elevators are not commonly used in Washington State plants to move packed boxes to storage, but are used occasionally in one or two plants. Fruit usually is hand trucked from the segregating area to a temporary storage bank and then to the elevator. At the off-loading floor, a crew unloads the elevator and moves the fruit to storage. Because elevator cycles are relatively slow, it is necessary to use a temporary bank of supply to keep the segregation area clear. That is, the completed unit loads that have been segregated must be moved away from the segregating conveyor in order to leave room for additional unit loads of packed boxes.

When elevators and hand trucks are used to move boxes of apples from the packing line to storage, one worker is used to segregate and one worker to move fruit approximately 30 feet from the segregating area to the temporary storage bank. This worker and two others move the fruit approximately 50 feet from temporary storage into the elevator. Two of these workers ride the loaded elevator to the off-loading floor and hand truck the apples the remaining 80 feet to storage. These two workers also do the high-piling.

The labor required by a 4-man crew using elevators and hand trucks to move 1,000 packed boxes of fruit from the packing line to storage is 19.04 man-hours (table 118). Forty-seven percent of this labor is wait time. The wait time was divided, 24 percent by the segregator, 32 percent by the worker moving fruit to temporary storage, 38 percent by the other two crew members, and 6 percent was due to crew interference.

Total labor and equipment costs for moving 1,000 packed boxes of apples from the packing line to storage and piling in stacks 10 boxes high by an elevator and hand trucks is \$32.25 (table 119). Both labor and equipment costs are high. Machine costs account for 32 percent of the total.

Table 118.--Labor required for a 4-man crew to move 1,000 packed boxes of apples from the packing line to storage and pile 10 boxes high by use of elevator, clamp-type 2-wheel hand trucks, and gravity roller conveyor

Operation	Workers	Productive labor	Fatigue allowance	Wait time	Total labor
	Number	Man-hours	Man-hours	Man-hours	Man-hours
One worker segregates boxes at roller conveyor and builds 6-high stacks	1	2.19	0.44	2.13	4.76
Pick up 6-high stacks in segregation area by use of 2-wheel hand truck	1	.23	.02	2.86	3.11
Transport 30 feet by use of 2-wheel hand truck	1	.62	.06	.0	.68
Release from 2-wheel hand truck in bank	1	.29	.03	.0	.32
Pick up 6-high stacks in bank by use of 2-wheel hand truck	3	.29	.03	3.40	3.72
Transport 50 feet to elevator by use of 2-wheel hand truck	3	.97	.10	1/ .23	1.30
Release stacks in elevator from 2-wheel hand truck	3	.29	.03	.0	.32
Elevator cycle	2	.20	.0	1/ .20	.40
Pick up 6-high stacks in elevator by use of 2-wheel hand truck	2	.29	.03	.0	.32
Transport 80 feet to storage by use of 2-wheel hand truck	2	1.48	.15	1/ .04	1.67
Release stacks in storage from 2-wheel hand truck	2	.35	.04	.0	.39
Manually high-pile boxes to 10 high	2	1.64	.41	.0	2.05
Total man-hours	-	8.84	1.34	8.86	19.04

1/ Wait time caused by crew interference.

Table 119.--Labor and equipment costs for moving 1,000 packed boxes of apples from the packing line to storage and piling 10 high by use of elevator, 2-wheel hand trucks, gravity roller conveyor and 4-man crew

Method	Workers	Labor and equipment required			Labor and equipment costs			
		Equipment time	Wait time	Total labor	Equipment	Labor 1/	Total costs: Current wages	Total costs: Assumed wages
	Number	Machine-hours	Man-hours	Man-hours	Dollars	Dollars	Dollars	Dollars
Elevator, 2-wheel hand truck, and gravity roller conveyor								
One worker segregates, 1 worker hand trucks to bank, 3 workers hand truck from bank to elevator, 2 workers ride elevator, hand truck 80 feet to storage, and high-pile boxes 10 high	4	2/ 22.10	8.86	19.04	10.35	21.90	32.25	37.01

1/ Computed from "current" wage rates.
2/ Clamp-type 2-wheel hand trucks 14.28 machine-hours, 15-foot roller conveyor 4.76 machine-hours, 8,000-pound capacity elevator 3.06 machine-hours, total 22.10 machine-hours.

Gravity Roller Conveyor, Industrial Fork-Lift Truck and Pallets

When industrial fork-lift trucks are used to move packed boxes of apples to storage, boxes are segregated in a special area. Gravity roller conveyors, from which boxes are segregated, bring the fruit to the segregation area and a worker builds the unit loads of 40 boxes each. The lift-truck operator picks up the fruit and moves it to storage and stores it in tiers three unit loads (15 boxes) high. The lift-truck operator who moves packed fruit to storage usually brings loose fruit back to the packing line. For this reason, it has been assumed in this analysis that there is no wait or delay time on the part of the lift-truck operator.

By the fork-lift-truck method, one worker segregates the packed boxes, and a second man, working part time, operates the fork-lift truck. The segregation operation is paced by the supply of fruit from the packing line, but the work of moving fruit to storage is not affected directly by this pace because the lift-truck operator transports loose fruit to the packing line after placing a load of packed fruit in storage.

The labor required to move 1,000 boxes to storage, in pallet loads of 40 boxes, is 5.43 man-hours (table 120). A little less than one-half of this time is lost in waiting because the rate of segregating is paced by the packing line.

Table 120.--Labor required by a 2-man crew to move 1,000 packed boxes of apples from the packing line to storage by use of gravity roller conveyor, pallets and industrial fork-lift truck

Operation	Workers	Productive labor	Fatigue allowance	Wait time	Total labor
	Number	Man-hours	Man-hours	Man-hours	Man-hours
One worker segregates boxes at roller conveyor and builds 40-box pallet loads	1	2.27	0.45	2.04	4.76
Pick up 40-box pallet load in segregation areas by use of fork-lift truck	1	.06	.0	.0	.06
Transport 160 feet by use of fork-lift truck	1	.47	.03	.0	.50
Release pallet in storage with fork-lift truck (average 1st, 2nd, and 3rd tiers)	1	.11	.0	.0	.11
Total man-hours	-	2.91	.48	2.04	5.43

Labor and equipment costs of $9.41 per 1,000 boxes are incurred for the segregator and a fork-lift truck to move fruit to storage (table 121). Thirty-three percent of this is machine cost.

Table 121.--Labor and equipment costs for moving 1,000 packed boxes of apples from the packing line to storage by use of gravity roller conveyor, pallets, and fork-lift truck 1/

Method	Labor and equipment required			Labor and equipment costs			
	Equipment time	Wait time	Total labor	Equipment	Labor 1/	Total costs: Current wages	Total costs: Assumed wages
	Machine-hours	Man-hours	Man-hours	Dollars	Dollars	Dollars	Dollars
Fork-lift truck and pallet							
One worker segregates onto pallets, 1 fork-lift truck transports 160 feet to storage	2/ 6.10	2.04	5.43	3.07	6.34	9.41	10.77

1/ Computed from "current" wage rates.
2/ 15-foot gravity roller conveyor 4.76 machine-hours, 4,000-pound capacity electric fork-lift truck 0.67 machine-hours, 20.8 pallets (48-box) 0.67 machine-hours, total 6.10 machine-hours.

Gravity Roller Conveyor, Low-Lift Pallet Transporter, Industrial Fork-Lift Truck, and Pallets

In one method studied a low-lift pallet transporter was used in combination with a gravity roller conveyor for segregating and a fork-lift truck was used to move fruit from the packing line to storage. The pallet transporter and fork-lift truck also moved unpacked boxes of fruit to the packing line in connection with this operation. If it were not possible for the equipment to be used in a dual capacity, both cycles of operation would be inefficient. In the plant in which this method was used, the segregation operation was performed in an older part of the plant where the fork-lift truck could not maneuver because of low ceiling heights and inadequate structural strength of the floors.

By this method one worker segregates packed boxes and builds 40-box pallet loads, one worker, part-time, operates the low-lift pallet transporter and another worker, part-time, operates the fork-lift truck. The pallet transporter moves the unit loads approximately 80 feet from the segregating area to a point where they are transferred to the fork-lift truck, which transports the unit loads another 80 feet to storage (fig. 108).

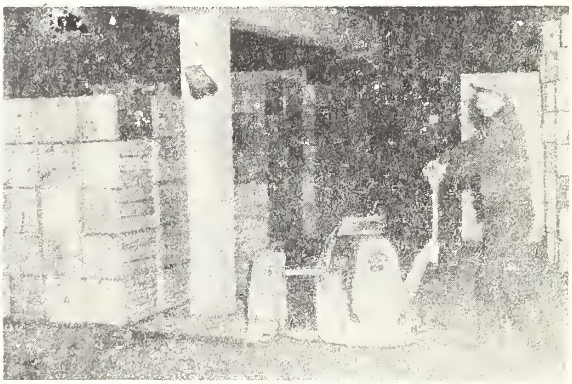

Figure 108.--The low-lift pallet transporter picking up a pallet load of packed apples.

A total of 6.22 man-hours of labor are required to move 1,000 boxes to storage by this method (table 122). Of the total labor, 2.26 man-hours are wait time, most of which results from the segregator waiting for the fruit. Nineteen percent of the productive time

Table 122.--Labor required for a 3-man crew to move 1,000 packed boxes of apples from the packing line to storage by use of gravity roller conveyors, fork-lift truck, low-lift pallet transporter, and pallets

Operation	Workers	Productive labor	Fatigue allowance	Wait time	Total labor
	Number	Man-hours	Man-hours	Man-hours	Man-hours
One worker segregates boxes at conveyors and builds 40-box pallet loads	1	2.27	0.45	2.04	4.76
Pick up 40-box pallet load in segregation area by use of low-lift pallet transporter	1	.12	.01	.0	.13
Transport 80 feet to storage by use of low-lift pallet transporter	1	.40	.04	.0	.44
Release pallet on floor in cold storage room by use of low-lift pallet transporter	1	.14	.02	.0	.16
Pick up 40-box pallet load in storage by use of fork-lift truck	1	.06	.0	.22	.28
Transport 80 feet to storage point by use of fork-lift truck	1	.32	.02	.0	.34
Release in storage with fork-lift truck (average 1st, 2nd, and 3rd tiers--15 boxes high)	1	.11	.0	.0	.11
Total man-hours	-	3.42	.54	2.26	6.22

was accounted for by the pallet transporter operator and 14 percent by the fork-lift-truck operator. It is assumed that the lift-truck operators are utilized for bringing unpacked fruit to the line and that the time they normally would wait between pallet loads of packed fruit is fully utilized.

As shown in table 123, when the low-lift pallet transporter is used in combination with the fork-lift truck and conveyor for moving fruit to

Table 123.--Labor and equipment costs for moving 1,000 packed boxes of apples from the packing line to storage by use of gravity roller conveyor, low-lift pallet transporter, fork-lift truck, pallets, and a 3-man crew

Method	Labor and equipment required			Labor and equipment costs			
	Equipment time	Wait time	Total labor	Equipment	Labor 1/	Total costs: Current wages	Total costs: Assumed wages
	Machine-hours	Man-hours	Man-hours	Dollars	Dollars	Dollars	Dollars
Gravity roller conveyor--low-lift pallet transporter, fork-lift truck, and pallets							
One worker segregates onto pallets, one low-lift pallet transporter, and one fork-lift truck	2/ 7.46	2.26	6.22	5.45	7.26	12.71	14.27

1/ Computed from "current" wage rates.
2/ 4,000-pound capacity electric fork-lift trucks 0.73 machine-hours, 4,000-pound capacity electric low-lift pallet transporter 0.73 machine-hours, 15-foot gravity roller conveyor 4.76 machine-hours, 20.8 pallets (48-box) 1.24 machine-hours, total 7.46 machine-hours.

storage, 1,000 boxes could be handled for $12.71, 43 percent being equipment costs. These costs might be reduced by keeping the boxes on the belt conveyor from the packing line for a distance sufficient to do the segregating where the fork-lift truck could pick up the pallets. However, plant renovation and extension of part of the conveyor system would be necessary in most of the older plants. Another possibility is for one worker to operate both the pallet transporter and fork-lift truck.

Gravity Roller Conveyor and Industrial Clamp-Type Lift Truck

When moving fruit from the packing line to storage the industrial-clamp truck picks up unit loads in the segregating area which either may be a special area near the packing line, as with fork-lift truck handling, or in a cold storage room from the belt conveyor, as in the belt conveyor handling method. The latter method of segregating the fruit in the cold storage room and moving it to cold storage position by use of an industrial-clamp truck is convenient in plants that have converted from belt conveyor handling. The industrial-clamp truck handles unit loads of 20 boxes of packed fruit (30 boxes by use of the larger size truck). A comparable unit load of loose fruit is 24 boxes.

A problem in handling packed boxes of apples is that labels are usually pasted on the end of the apple box shortly after the fruit leaves the lidding machine. For a short time care must be exercised in handling the box or the label will be pushed out of place or torn. When the industrial-clamp truck lifts a box with a fresh label, the label may tear and the box slip out of place. This difficulty can be avoided by turning the label end of the box inward, providing an unlabeled gripping surface outside.

The industrial-clamp truck can be used to handle packed cartons by using broad, rubber-padded clamping arms which spread their pressure over a wider surface and thus acquire enough friction surface.

In stacking packed boxes of apples by industrial-clamp trucks, dunnage strips are unnecessary. Packed boxes are turned on their sides and are flatter and more stable than boxes of loose fruit. 43/

As with other methods, when fruit is moved from the packing line by industrial-clamp trucks the work is paced by the rate of the packing line, or 210 packed boxes an hour. Therefore, unless the plant layout and work arrangements permit the truck and operator to do additional work between trips of moving fruit to storage, considerable idle time will result.

One worker is required for the segregating operation, and one to operate the industrial-clamp truck. It is assumed that the truck operator's extra time is used in other materials-handling operations.

By this method, with a 2-man crew, it required 6.31 man-hours of labor to move 1,000 boxes to storage (table 124). Approximately one-third of

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43/ The bottom of the standard apple box is made of thin shook held together with cleats. Cleats make it necessary to have the top row of the unit load in almost exact alignment with the bottom load or the cleats of the top stack do not nest on the edges of the boxes on the bottom stack.

Table 124.--Labor required for a 2-man crew to move 1,000 packed boxes of apples from the packing line to storage by use of gravity roller conveyor and industrial clamp-type truck

Operation	Workers	Productive labor	Fatigue allowance	Wait time	Total labor
	Number	Man-hours	Man-hours	Man-hours	Man-hours
One worker segregates boxes at conveyor and builds 20-box unit loads	1	2.27	0.45	2.04	4.76
Pick up 20-box unit load in segregation area by use of clamp-type lift truck	1	.13	.0	.0	.13
Transport unit load 160 feet by use of clamp-type lift truck	1	.88	.07	.0	.95
Release unit load in storage with clamp-type lift truck (average 1st and 2nd tiers--10 boxes high)	1	.47	.0	.0	.47
Total man-hours	-	3.75	.52	2.04	6.31

this time is lost by waiting, since the flow of fruit from the packing line is insufficient to keep the segregator occupied. Only 1.55 man-hours, or 25 percent of the total labor, is required to transport the fruit to storage position. The lift truck and operator could be used for other work over two-thirds of the time.

Industrial-clamp trucks could move apples to storage at a cost of $9.88 per 1,000 boxes. Machine costs were nearly one-fourth of the labor costs (table 125).

Table 125.--Labor and equipment costs for 2-man crew to move 1,000 packed boxes of apples from the packing line to storage by use of gravity roller conveyor and industrial clamp-type truck

Method	Labor and equipment required			Labor and equipment costs			
	Equipment time	Wait time	Total labor	Equipment	Labor 1/	Total costs: Current wages	Total costs: Assumed wages
	Machine-hours	Man-hours	Man-hours	Dollars	Dollars	Dollars	Dollars
Industrial clamp-type lift truck							
One worker segregates, 1 industrial clamp-type lift truck transports 160 feet	1/ 6.31	2.04	6.31	2.39	7.49	9.88	11.46

1/ Computed from "current" wage rates.
2/ 15-foot gravity roller conveyor 4.76 machine-hours, 1,000-pound electric clamp-type lift truck 1.55 machine-hours, total 6.31 machine-hours.

This method of moving fruit to the packing line could be modified by segregating the fruit in the cold storage room from a belt conveyor (fig. 109). The industrial-lift truck usually would have a shorter transportation distance than the 160 feet assumed in the method previously discussed. However, this method is not used unless loose fruit is being moved to the packing line from the room in which the "to-storage operation" is being carried on, or an adjacent room.

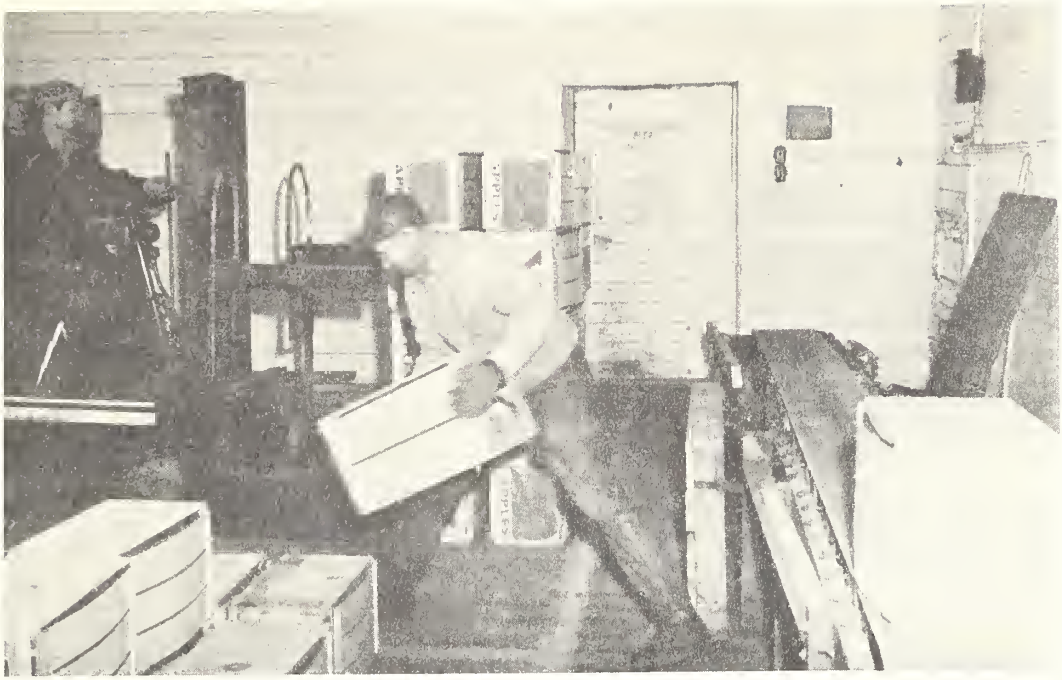

Figure 109.--Segregating packed boxes from belt conveyor. Boxes are moved away by the industrial clamp truck.

Comparative Labor and Equipment Costs of Selected Methods and Types of Equipment for Moving Packed Boxes of Apples to Storage

The costs of moving apples back to storage from the packing line by various methods and types of equipment ranged from $9.41 to $32.25 per 1,000 boxes (table 126). Lowest costs were obtained by use of industrial-clamp trucks; highest costs, by use of elevators and hand trucks. The low-lift pallet transporter method cost 135 percent as much as the fork-lift truck method. The costs with the fork-lift truck were slightly lower than with the industrial-clamp truck.

Equipment costs are lowest when hand trucks are used to move fruit to storage. However, labor costs are greatest when hand trucks are used alone or in combination with elevators. Highest equipment costs are associated with the use of elevators.

Determining the most efficient method for moving fruit from the packing line to storage must be on an individual plant basis. The most efficient method, using fork-lift trucks, cannot ordinarily be used in older plants. However, many of the older plants now using "conventional" equipment could use industrial clamp-type trucks and reduce labor costs by more than half--somewhat more than this, in fact, in plants adapted to the use of a 36-box industrial-clamp truck.

Table 126.--Comparative labor and equipment costs for moving 1,000 packed boxes of apples from the packing line to storage by use of specified methods and types of equipment 1/

Type of equipment and method	Workers	Labor and equipment required: Equipment time	Labor and equipment required: Wait time	Labor and equipment required: Total labor	Labor and equipment costs: Equipment 2/	Labor and equipment costs: Labor 3/	Total costs: Current wages	Total costs: Assumed wages 4/
	Number	Machine-hours	Man-hours	Man-hours	Dollars	Dollars	Dollars	Dollars
Gravity-type roller conveyor and clamp-type 2-wheel hand truck								
One worker segregates and hand-trucks 30 feet to bank, 2 workers hand-truck 130 feet to storage and high-pile boxes 10-high (table 117)	3	19.04	9.84	19.04	0.53	21.90	22.43	27.19
Gravity-type roller conveyor, belt conveyor and hand truck								
One worker segregates. 2 workers hand-truck 60 feet to storage and high-pile boxes 10-high (table 117)	3	19.04	7.71	14.28	4.37	16.42	20.79	24.36
Gravity-type roller conveyor, elevator, and hand truck								
One worker segregates. 1 worker hand-trucks 30 feet to bank. 3 workers hand-truck 50 feet from bank to elevator. 2 workers off-load elevator. hand-truck 80 feet to storage and high-pile (table 119) 5/	4	22.10	8.86	19.04	10.35	21.90	32.25	37.01
Gravity-type roller conveyor, fork-lift truck and pallets								
One worker segregates onto pallets, 1 fork-lift truck transports 160 feet to storage (table 121) 6/	2	6.10	2.04	5.43	3.07	6.34	9.41	10.77
Gravity-type roller conveyor, low-lift pallet transporter, fork-lift truck and pallets								
One worker segregates onto pallets, 1 low-lift pallet transporter transports 80 feet, and 1 fork-lift truck transports 80 feet (table 123) 6/	3	7.46	2.26	6.22	5.45	7.26	12.71	14.27
Gravity-type roller conveyor and industrial clamp-type lift truck								
One worker segregates. 1 clamp-type lift truck transports 160 feet (table 125) 6/	2	6.31	2.04	6.31	2.39	7.49	9.88	11.46

1/ Transportation distances are standardized at 175 feet of which 15 feet is by gravity-type roller conveyor in segregating operation.
2/ Equipment costs computed from data on ownership and operating costs shown in table 2.
3/ "Current" labor costs computed from wage rates of $1.15 per hour for unskilled labor and $1.30 per hour for semiskilled workers (key workers such as industrial truck operators).
4/ Assumed labor costs computed from wage rates of $1.40 per hour for unskilled labor and $1.55 per hour for semiskilled workers.
5/ Vertical transportation distance is not included.
6/ Labor requirements shown for these methods are based on the assumption that lift trucks and their operators will work part-time only in moving packed boxes of fruit to storage and that the remainder of the time of the worker and equipment will be used for other productive work.

METHODS AND EQUIPMENT FOR MOVING APPLES OUT OF STORAGE AND LOADING REFRIGERATOR CARS AND HIGHWAY TRUCKS

Most Washington State apples are loaded out for shipment from storage. Packed fruit may remain in storage several months before it is shipped. Occasionally, especially during the fall months, some cars are loaded as the fruit comes off the packing line. However, loading cars with boxes moving directly from the packing line is slow because carloading operations are paced by the rate at which the packed boxes move away from the lidding machine. This cycle of operations is discussed in the section that follows. This section covers moving boxes of apples out of storage and loading refrigerated highway trucks or railroad cars.

Most Washington State apples are shipped out in refrigerated railroad cars. Although some cars are shipped with loads varying in size from 756 to 840 boxes, the usual load consists of 798 boxes. Because of the size of loads, analyses of labor and equipment requirements and costs, on the basis of 1,000 boxes, do not give the costs per carload or truckload. However, costs for a carload of 800 boxes are 80 percent of the costs per 1,000 boxes.

Shipping is a cycle of operations performed in the following sequence: (1) Blocking out the load, (2) manifesting the shipment, (3) transporting fruit from storage points to the carrier, and (4) loading the car or truck. Loading a refrigerator car in a divided load consists of a number of operations: (1) Stacking the boxes, (2) stripping the boxes for stability in transit, (3) bracing the boxes on either side of the doorway of the car, and, at times, (4) labeling the boxes. When loading cars or trucks solid, some of these operations are not performed.

There are a number of variations in the manner of loading refrigerator cars and trucks. To simplify the analysis of loading operations and to facilitate the discussion, all of the methods have been grouped into the most common types and comparative data are presented for these types. The different types and combinations of types of equipment used for moving apples out of storage and loading cars or trucks are: (1) Clamp-type 2-wheel hand trucks, (2) clamp-type 2-wheel hand trucks and belt conveyor, (3) clamp-type 2-wheel hand trucks and floor chain stack conveyors, (4) clamp-type 2-wheel hand trucks and elevators, (5) industrial fork-lift trucks and pallets, (6) industrial fork-lift trucks, pallets, and belt conveyors, (7) industrial fork-lift trucks, pallets, and pallet dolly, (8) industrial fork-lift trucks, low-lift pallet transporters, and belt conveyors, and (9) clamp-type industrial truck and belt conveyor.

In the sections that follow, loading operations are divided into two groups of operations for analytical purposes: (1) Blocking out the load and manifesting the shipment, and (2) transporting packed boxes from temporary blocks or other storage points into the carrier and loading the carrier. Labor and equipment requirements under the various methods and types of equipment are first shown for the latter group of operations only. In the section covering comparisons of methods, the labor and equipment requirements for blocking out and manifesting have been added to determine total requirements per 1,000 boxes.

All methods of loading refrigerator cars apply only to divided and braced loads, except that 2-wheel hand truck methods cover both solid and divided loads. All methods of loading refrigerated highway trucks apply to solid loads.

In discussing the various methods and types of equipment, it has been assumed that boxes of fruit have been blocked out and are ready to be moved to the car so that the fruit-handling crew will not delay the car-loading crew. The number of workers in the carloading crews and their duties are based on usual industry practice. However, in actual practice, carloading can be done by one worker if necessary and under some circumstances one or two additional men may be added to the crew if there is a need to get the car loaded out by deadline or if there are workers in the warehouse who otherwise are not occupied.

Blocking Out the Load

Blocking out a load consists of searching through stacks of boxes in storage to locate and break out the number of boxes of each grower's lot by variety, grade, and size required to make up the load. Because of the variability between loads shipped, it is difficult to determine a standard time for the operation. 44/ The load may be blocked out either during a carloading, or at any time varying from a few minutes to many days before the carloading actually begins. When blocked out during carloading, the boxes to be loaded are selected and transported directly to the car or truck for loading. When blocked out before carloading, the boxes to be loaded are selected and transported to a central location where the fruit is accumulated in a block or bank. Because blocking out before loading frequently is done by the crew during its spare time, the entire load usually is not blocked out in a continuous operation.

The labor required for blocking out is materially affected by the method of segregating grades and sizes of fruit in the storage house and

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44/ The operations in blocking out which vary with each load are looking for the lot, size, and variety needed and digging into the stacks for different sizes when the boxes have been segregated into stacks containing two or three sizes of fruit. The other operations of blocking out--breaking out stacks, picking up, transporting and releasing by the transporting unit--are standardized.

by the type of sale. An order may include two or more varieties of apples, a number of sizes of each variety, and even two or three different grades of apples. Another factor affecting blocking-out time is plant layout. Average labor requirements for blocking out 1,000 boxes of apples are shown in table 127.

Table 127.--Labor required to block out 1,000 packed boxes of apples by use of specified types of equipment

Type of equipment	Average labor requirements
	Man-hours
Clamp-type 2-wheel hand truck	3.58
Industrial fork-lift truck	.95
Industrial clamp-lift truck	1.79

When fruit is moved directly from the end of the packing line to the car for loading, the loads are blocked out while the packed boxes are being segregated, provided the plant is packing the variety of apples being shipped on advance sales orders, and the management prefers to ship the fruit being packed instead of fruit packed earlier in the season. Instead of moving the fruit to storage from the segregating area, hand truckers build the carload lots in storage near a belt conveyor or shipping platform. Usually this method of blocking out takes place late in the packing season, since earlier in the season the warehouse usually does not have enough space in the cold storage rooms.

Manifesting the Shipment

Manifesting a shipment is the preparation of a check or tally sheet showing the number of boxes going into a shipment by variety, size, and grade. Frequently, the manifest is made up of certain sizes and grades and considerable time is spent in locating the necessary number of boxes of each grade and size to go into the blocked-out load. Usually the manifest is made up of the normal run of sizes of a certain grade in a certain lot, excluding only very large or very small sizes.

The manifest can be made up while the load is being blocked out before loading or during loading. In either case, one or two workers usually prepare the manifest. When this operation is performed during carloading it is performed in connection with blocking out the fruit. One worker counts and records the stacks as they are moved out of the cold storage area. Occasionally, manifesting is done after boxes are placed in the car. A worker obtains a tally of each tier as it is placed in the car by having one of the carloaders call out the sizes and grades to him.

An analysis of manifesting operations shows that labor requirements are lowest for "check manifesting," in which the worker only counts the number of stacks of different sizes rather than individual boxes. When individual boxes were counted by one worker and called off to another worker, the labor required is 0.45 man-hour per 1,000 boxes (table 128).

Table 128.--Labor required to manifest 1,000 packed boxes of apples when check manifested and when completely manifested

Type of manifest	Plants	Studies	Labor requirements		
			High	Low	Average
	Number	Number	Man-hrs.	Man-hrs.	Man-hrs.
Check manifesting	3	3	0.12	0.09	0.10
Complete manifesting	5	5	.50	.35	.45

Transporting Fruit from the Storage Point to the Carrier

For the purposes of analysis, transportation begins when packed boxes of fruit are picked up in the blocked-out bank or from its storage position for movement into the car and ends when the fruit arrives in the car, or at a stacking point in the car. For the transporting vehicles this includes the operation of picking up in the cold storage room, transporting to the railroad car and releasing in the railroad car. By use of the belt conveyor method, boxes are transferred to the belt after the stacks of boxes have been moved to the conveyor. Transportation distances from the storage point to the release point inside the car or truck are standardized at 110 feet.

Loading Refrigerator Cars

Loading refrigerator cars consists of the following operations: (1) Stacking or stowing the boxes, (2) stripping boxes for stability, (3) bracing boxes on either side of the doorway or filling the doorway solid, and (4) labeling the boxes.

Two different loading patterns are used commonly for stacking packed boxes of apples in refrigerator cars. The first of these is shown in figure 110. Boxes are stacked 6 high in rows across the cars that are 7 stacks wide, with 19 rows making up the carload. When the boxes are stacked in this pattern, the load is stabilized by nailing lath across the top of the second, fourth, and sixth tiers of boxes, or on the third and sixth tiers in the car.

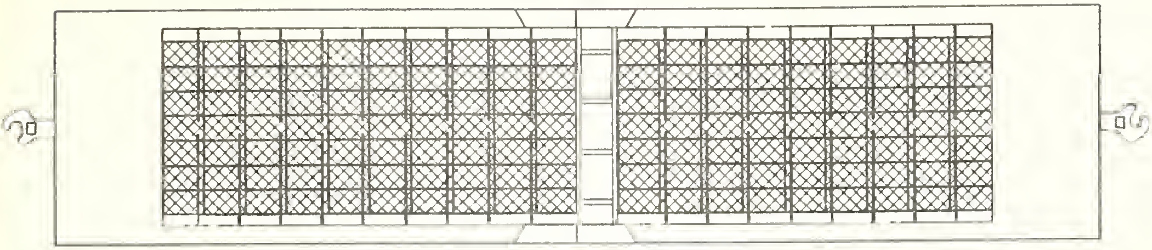

Figure 110.--A divided refrigerator carload of apples stripped with lath and braced in the doorway. Each of the 19 rows across the car contains 42 boxes--6 boxes high and 7 boxes wide.

In the second loading pattern, which is shown in figure 111, boxes are stacked 5 high and 8 wide across the car for a total of 20 rows. When this pattern is used no lathing is needed. Boxes are loaded against the sides of the car, thereby preventing the side shift that is a problem in the other pattern.

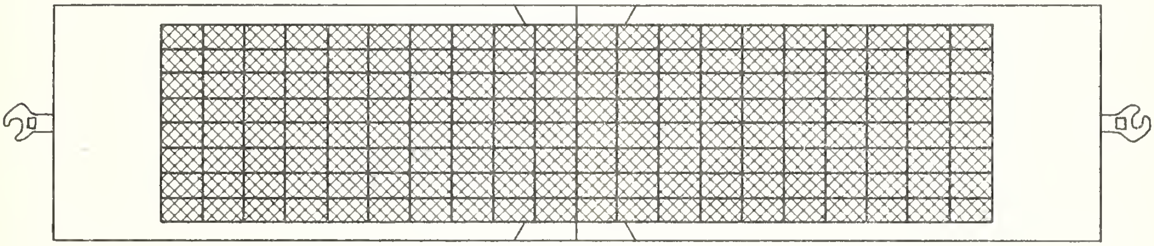

Figure 111.--A solid loaded refrigerator carload of apples loaded sideways and lengthwise. Each of the 20 rows contains 40 boxes.

When cars are not loaded solid, stripping the load by lathing or slatting the boxes is necessary to give stability to the load in transit. Specifically, stripping is the nailing of strips of lath across the ends of boxes in the rows of boxes. These strips extend to each side of the car to give sideway stability. Stripping every third tier of boxes in a stack requires less time than stripping every second tier.

Stripping the rows of boxes in the car must be closely integrated with stacking fruit or delays will be caused by one worker waiting on the other. The first laths are nailed in place after the first eight boxes in a 2-high, 4-wide row,or 12 boxes in a 3-high, 4-wide row, have been stacked. Four pieces of lath are nailed on top of the first section of stacked boxes (two on the front end of the box and two on the back of the box.) This operation is repeated on the second and fourth tiers, but on the sixth tier only two laths are nailed in place across the front of the box because of the limited working space between the top of the boxes and the car ceiling.

Refrigerator cars are loaded either in solid loads or in divided loads. Divided loads are braced by use of a wood framework to take up slack space in the car. In a solid load slack space is eliminated by arranging the boxes in such a way that they completely or almost completely fill the car. Bracing the doorway of the car, or filling in the doorway of the car solid with boxes of fruit, is the final carloading operation.

The first step in bracing a load is the construction of two gates which are placed against the stacked boxes in the doorway of the railway car. As shown in figures 112 and 113, these center gates usually are made of 2- by 4-inch and 1- by 4-inch lumber. (Some plants build the gates inside the car. Other plants have a jig on which the gates are built.)

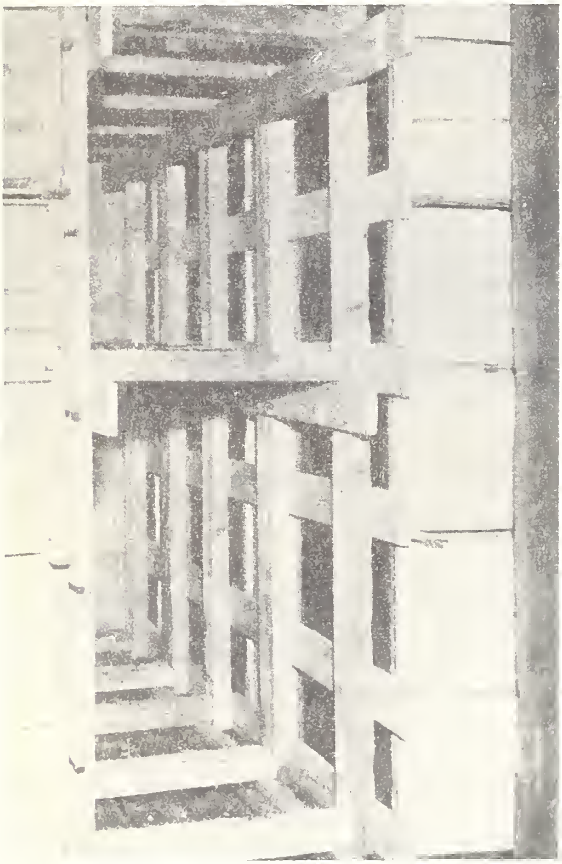

Figure 112.--An approved type of car brace (Type A) with the main support horizontal.

Figure 113.--An approved type of car brace (Type B) with the main support vertical.

After the gates are placed against the stacks of boxes in the car, the carloader jacks or wedges the gates back and places 2- by 4-inch spreaders to maintain the position of the boxes. These spreaders usually are placed individually after each row of boxes has been moved back as far as possible and they occupy most of the space that was left between rows while the car was being loaded. This type of bracing is shown in figure 112.

Another type of center gate bracing is similar to the type previously described except that the main supports are across the boxes or horizontal rather than vertical to the stacks (fig. 113). The two types of gates require the same time to build and install. 45/

When cars are loaded solid, the necessity for bracing is eliminated. If the carload of boxes has been stripped, additional work must be done in order to load the car solid lengthwise. With the load stacked 6 high, 7 stacks wide across the car, the load would be in excess of 798 boxes if this stacking arrangement continued into the doorway. Therefore, the 6-high stacks are reduced to five boxes high near the doorway.

Since a drop from a 6-high to a 5-high stack would leave the top row of boxes on the 6-high stacks free to shift during transit, a rack, constructed of 2- by 4-inch lumber, 8 feet long and about 18 inches wide, is usually placed under the first lower row; sometimes the rack is placed between the fourth and fifth tiers of boxes. Thus, the lower stacks overlap the top boxes of the higher stacks by about 3 inches (fig. 114). The next row is stacked 5 high, on the regular floor rack, overlapping the racked-up stack. This ties the entire load together, and with the desired number of boxes in the load. With a two-way solid load (8 wide and 5 high throughout the car, including the doorway) it is unnecessary for the stacks to be broken out near the door.

When either of the lengthwise solid loading methods is used the boxes must be pushed back from the doorway to insure a compact load. After the stacks have been pressed back into the car as far as possible the remaining space in the doorway is filled with boxes. Because the dimensions of refrigerator cars vary, the pattern of stacking in the center cannot be completely standardized. From 35 to 84 boxes can be placed in the center, depending on the size of the car. If extra space is left in the doorway, this space is taken up by a single gate or dunnage filler.

45/ Specification of standard containers and loading rules for fresh fruit and fresh or green vegetables (not cold packed or frozen), freight container tariff No. 1-C, Pacific Coast and Transcontinental Territories--J. J. Quinn, Agent, Chicago, Ill., November 1950.

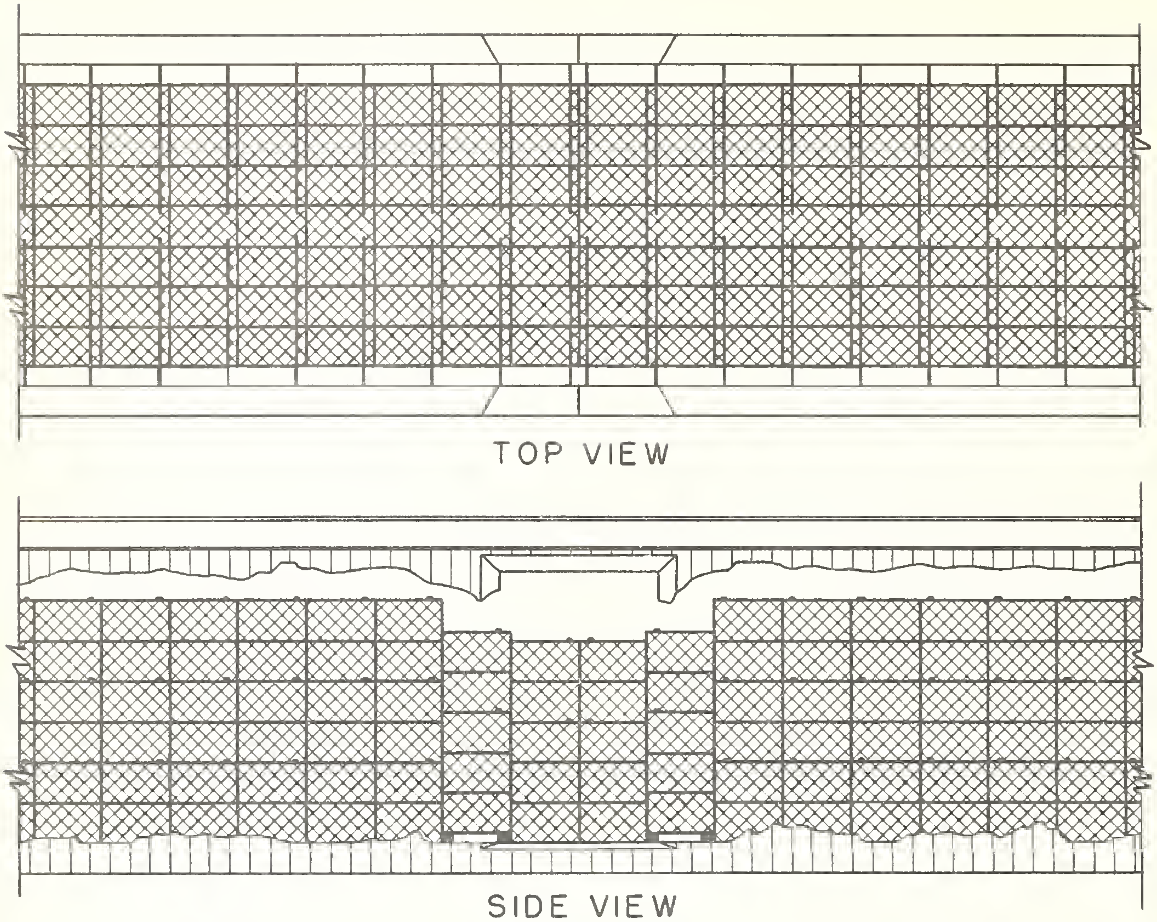

Figure 114.--A railroad carload of fruit stripped with lath and loaded solid in the doorway. This car has 14 rows, 7 wide and 6 high, 3 or 4 rows 7 wide and 5 high and 20 boxes in the doorway.

Less labor is required when cars are loaded solid than when they are loaded in divided loads and braced (table 129). By use of belt conveyors 3.33 man-hours of labor are required inside the cars per 1,000 boxes when the load must be braced. The solid load requires only 1.91 man-hours. However, additional time may be required by workers outside of the car when loading solid because the rate of carloading is slowed down while the center area in the doorway of the car is solidly filled. Sometimes a man inside the plant, putting fruit on the belt or bringing up to the car, is delayed during this period. In building the braced load, the pace of carloading continues until the braces are ready to put in place, at which time the workers moving fruit to the car are assigned to other work and one or two workers build the braces.

Table 129.--Comparative labor requirements for operations performed inside the car in loading 1,000 packed boxes of apples in refrigerator cars when loads are divided and braced and when loaded solid, by use of belt conveyor to supply the carloading crew

Operation	Solid loads: Productive labor	Solid loads: Fatigue allowance	Solid loads: Total labor	Divided and braced loads: Productive labor	Divided and braced loads: Fatigue allowance	Divided and braced loads: Total labor
	Man-hours	Man-hours	Man-hours	Man-hours	Man-hours	Man-hours
Stack boxes in proper loading position	1.09	0.22	1.31	1.19	0.24	1.43
Strip each 2nd tier of boxes	-	-	-	.90	.09	.99
Brace load or fill in doorway solid	.55	.05	.60	.83	.08	.91
Total man-hours	1.64	.27	1.91	2.92	.41	3.33

The solid load requires slightly less labor for stacking boxes in place because the last few boxes are stacked solid in the center of the car. The labor required for stripping is eliminated by use of the solid load, saving almost one man-hour, and filling in the center of the car requires less labor than putting in braces.

The choice of either of these two types of loads may depend upon factors other than the amount of labor required. Loading regulations designate the divided and braced load as the approved method of carloading. However, freight claim statistics show that recoopering and bad order damage are not great enough to offset the extra cost of the braces. 46/ Furthermore, some shippers who regularly ship in solid loads indicate that the arrival condition of these cars is very good provided all slack is removed from the load.

Although boxes usually are not labeled in the car, in some cases fruit is held unlabeled and sold subject to the buyer's label or a specified label being placed on the box. In such cases, boxes are labeled as they are loaded (fig. 115). However, this operation cannot be considered a part of carloading since labeling is regularly performed at the packing line.

Figure 115.--Labeling boxes of apples in refrigerator car.

Except for those boxes loaded in the doorway, boxes are labeled after they are placed in the car. Otherwise, the worker's hand would

46/ "Car Bracing," Apple Research Digest No. 24, September, 1948, Yakima, Wash.

tend to push the wet labels out of place or tear them. Labeling usually begins after the first row of boxes has been placed in the car and lathed. While the labeler is placing the labels on the boxes, the stacker and lather proceed to the other end of the car and begin stacking and stripping. In this manner the stacker and lather change positions in the car after each row and the labeler follows them.

Because boxes are only rarely labeled inside the car, a standard time value for this operation is not included in the analysis.

Loading Refrigerated Highway Trucks

Refrigerated highway trucks are loaded in a greater variety of ways than refrigerated cars, with loads varying from 600 to 800 boxes. Methods used, including crew arrangements, and labor requirements for blocking out and the transporting of fruit from the storage point into a highway truck are the same as when loading refrigerator cars. However, no bracing or stripping is used in loading motortrucks. Therefore, the differences between loading highway trucks and refrigerator cars are not great and only a limited amount of adjusting of refrigerator car data is necessary to present an adequate analysis for the trucks. These adjustments are based on differences in operation of the loading crew.

In loading highway trucks, the carrier is entered from one end of the truck body rather than from a center door as in the refrigerator cars. Highway trucks always are loaded solid and usually the rows across the truck bed are broken down to distribute an extra amount of weight over the rear wheels of the truck. The stacking pattern varies, with the front parts of the load being only 2 boxes high and gradually increasing in weight to the rear of the truck bed where the rows are 7 boxes high.

Clamp-Type 2-Wheel Hand Trucks

Refrigerator Cars in Solid Loads

Restacking boxes in car.--The common method of loading cars by use of 2-wheel hand trucks is for 6-high stacks of boxes to be transported from the temporary block or storage point into the car and released in that end of the car in which the carloading crew is working. Boxes are lifted from the stacks one at a time and stowed into final storage position. (This method is used for loading either a solid or a divided load.)

Five men are employed in the crew. Three men transport 6-high stacks 110 feet to the car and into it releasing the fruit in front of the men stacking boxes. Two workers inside the car manually lift the boxes, just delivered, one at a time, and build 5-high stacks in the proper loading

Figure 116.--Loading boxes of apples solid across the car.

positions (fig. 116). This cycle is repeated until 91 percent of the boxes have been placed. The remaining boxes are then used to fill in the doorway solid.

By this method, 8.04 man-hours of labor are required per 1,000 boxes loaded--33 percent of it in waiting, 57 percent (or 4.61 man-hours) in transporting (table 130). The elapsed time required is 1.61 hours.

Jacking stacks of boxes into position.--An improved method of loading cars by hand trucks requires a 4-man crew. Three workers hand truck 5-high stacks into the car and one worker, by use of a jack, jacks the stacks into tight position. Two of the men in this crew fill in the doorway solid when that point in carloading is reached.

Table 130.--Labor required for a 5-man crew to move 1,000 packed boxes of apples out of storage and solid load refrigerator cars by use of clamp-type 2-wheel hand trucks when boxes are restacked 1/

Operation	Workers	Productive labor	Fatigue allowance	Wait time	Total labor
	Number	Man-hours	Man-hours	Man-hours	Man-hours
Set up and clean up	5	0.26	0.0	0.09	0.35
Pick up 6-high stacks by use of hand trucks	3	.29	.03	.0	.32
Transport 110 feet to stacking point in car	3	1.88	.19	.14	2.21
Release 6-high stacks in car in front of carman	3	.50	.05	1.53	2.08
Stack boxes in railroad car	2	1.30	.26	.32	1.88
Fill in doorway solid with boxes	2	.50	.10	.60	1.20
Total man-hours	-	4.73	.63	2.68	8.04
Elapsed time--hours					1.61

1/ Labor requirements shown do not cover bl[illegible]king out and manifesting loads.

The box jack is a small pry bar with a hinged metal brace used as a heel to give leverage in prying the stack into place. One worker positions the 5-high stacks by placing his foot against the heel of the jack and pulling back on the pry bar (fig. 117). Usually the hand truck releases the load as closely as possible to the loading position, so a minimum of jacking is required.

This method requires 7.40 man-hours of labor to load 1,000 boxes (table 131). Of the total labor required, 23 percent was lost in wait time. Sixty-four percent of the labor required was used in transporting fruit to the car.

Figure 117.--Hand jacking stacks of boxes into position.

Table 131.--Labor required for a 4-man crew to move 1,000 packed boxes of apples out of storage and solid load a refrigerator car by use of clamp-type 2-wheel hand trucks and box jack when stacks are jacked into position 1/

Operation	Workers	Productive labor	Fatigue allowance	Wait time	Total labor
	Number	Man-hours	Man-hours	Man-hours	Man-hours
Set up and clean up	4	0.22	0.0	0.06	0.28
Pick up 5-high stacks by use of 2-wheel hand trucks	3	.35	.04	.0	.39
Transport 110 feet to the stacking point in car	3	2.26	.23	.14	2.63
Release 5-high stacks in car for positioning by use of box jack	3	.78	.08	.86	1.72
Position stacks in place by use of box jack	1	1.06	.11	.01	1.18
Fill in doorway solid with boxes	2	.50	.10	.60	1.20
Total man-hours	-	5.17	.56	1.67	7.40
Elapsed time--hours					1.85

1/ Labor requirements shown do not cover blocking out and manifesting loads.

Comparison of hand-truck methods for solid loading of refrigerator cars.--The improved method of loading cars by hand trucks and a box jack incurs labor and equipment costs of $8.63 per 1,000 boxes, which is $0.73 less than by use of the common method (table 132).

The improved method of loading cars by use of the box jack saves 0.64 man-hours. Offsetting this saving, the improved method requires 15 percent more elapsed time to complete the loading operation. However, it should not be assumed that all of the advantages and disadvantages of these two methods are shown by these figures. The improved method is more desirable from the standpoint of preserving fruit quality. The unit loads of five boxes each are not broken out and each box is not roughly handled which is in contrast to the common method by use of which each box is lifted individually and put into place.

Table 132.--Comparative labor and equipment costs for moving 1,000 packed boxes of apples out of storage and solid loading refrigerator cars by use of 2 specified clamp-type 2-wheel hand truck methods 1/

Method	Workers	Elapsed time	Labor and equipment required: Equipment time	Labor and equipment required: Wait time	Labor and equipment required: Total labor	Labor and equipment costs: Equipment	Labor and equipment costs: Labor 2/	Total costs: Current wages	Total costs: Assumed wages
	Number	Hours	Machine-hours	Man-hours	Man-hours	Dollars	Dollars	Dollars	Dollars
Boxes restacked in car									
Three workers hand truck 110 feet into the railroad car; 2 workers stack boxes and fill in doorway solid with boxes	5	1.61	4.82	2.68	8.04	0.11	9.25	9.36	11.37
Boxes positioned with hand jack									
Three workers hand truck 110 feet to the railroad car; 1 worker jacks stacks into place, and fills in doorway solid with boxes	4	1.85	4.95	1.67	7.40	.12	8.51	8.63	10.48

1/ Costs shown do not cover blocking out and manifesting loads.
2/ Computed from "current" wage rates.

Refrigerator Cars in Divided Loads

The practice of loading refrigerator cars with divided and braced loads is more widespread than with solid loads. The usual method of loading a car by hand trucks, when the load is divided and braced, is to wheel 6-high stacks into the car and release them in the end where the loading crew is working. The carloading crew manually lifts each box from the 6-high stacks and rebuilds stacks of the same height at the proper position in the row. The rows are built across the car so that each row can be stripped at each second tier of boxes. 47/ Boxes are stacked into position until they reach the doorway where space is left to insert or construct two braces which are wedged apart holding the load

47/ In practice, some firms strip only two tiers rather than three.

solid in both ends of the car. A 6-man crew is used--3 hand truckers, 2 carloaders, and 1 worker to strip each row and construct the braces to fill in the doorway.

A hand truck can be used for loading cars only when the height of the shipping platform permits fruit to be hand trucked across a bridgeplate into the railroad car.

As shown in table 133, 7.50 man-hours of labor are required per 1,000 boxes to load refrigerator cars when the load is braced and hand trucks are used for transporting. Only 9 percent of this labor was wait time. Of the total labor required, 3.08 man-hours, or 41 percent, was required for hand trucking. The elapsed time required to load by this method, using a 6-man crew in part of the work, was 2.01 hours.

Table 133.--Labor required for a 6-man crew to move 1,000 packed boxes of apples out of storage and load a refrigerator car by use of clamp-type 2-wheel hand trucks when the load is divided, braced, and stripped 1/

Operation	Workers	Productive labor	Fatigue allowance	Wait time	Total labor
	Number	Man-hours	Man-hours	Man-hours	Man-hours
Set up and clean up	6	0.26	0.0	0.16	0.42
Pick up 6-high stacks by use of 2-wheel hand trucks	3	.29	.03	.0	.32
Transport 110 feet to the stacking point inside car	3	1.88	.19	.14	2.21
Release stacks in car in front of carloaders	3	.50	.05	.0	.55
Stack boxes in the railroad car	2	1.43	.29	.34	2.06
Strip every 2nd tier of boxes in railroad car	1	.90	.09	.04	1.03
Brace doorway	1	.83	.08	.0	.91
Total man-hours	-	6.09	.73	.68	7.50
Elapsed time--hours					2.01

1/ Labor requirements shown do not cover blocking out and manifesting load.

Loading Refrigerated Highway Trucks

The size and arrangement of the crew outside the truck, when boxes are loaded into highway trucks by hand trucks, is the same as when loading refrigerator cars. However, in practice the number of hand truckers used depends on the transportation distance involved. In this case, a distance of 130 feet is assumed, since 20 feet additional transportation distance are necessary, above the 110 feet, when refrigerator cars are loaded, because the hand trucker must travel the length of the highway truck bed. Even though the distance is increased, three hand truckers can supply the two workers inside the highway truck who stack the boxes in a solid load.

The use of hand trucks and a 5-man crew to load a highway truck requires 5.80 man-hours of labor per 1,000 boxes and an elapsed time of 1.16 hours (table 134). Less labor is required than in loading a similar number of boxes into refrigerator cars because no gate is placed in the center of the highway truck. The operation is fairly efficient with only slightly less than 10 percent delay time.

Table 134.--Labor required for a 5-man crew to move 1,000 packed boxes of apples from storage and solid load refrigerated highway trucks by use of clamp-type 2-wheel hand trucks 1/

Operation	Workers	Productive labor	Fatigue allowance	Wait time	Total labor
	Number	Man-hours	Man-hours	Man-hours	Man-hours
Set up and clean up	5	0.26	0.0	0.09	0.35
Pick up 6-high stacks in storage by use of 2-wheel hand trucks	3	.29	.03	.0	.32
Transport 130 feet to stacking point inside motortruck	3	2.33	.23	.0	2.56
Release stacks at stacking point inside truck	3	.35	.04	.0	.39
Stack boxes in highway truck	2	1.43	.29	.46	2.18
Total man-hours	-	4.66	.59	.55	5.80
Elapsed time--hours					1.16

1/ Labor requirements shown do not cover blocking out and manifesting loads

Clamp-Type 2-Wheel Hand Trucks, Belt Conveyors, and Gravity-Type Roller Conveyors

The most widely used combination of equipment for loading refrigerator cars and motortrucks consists of gravity-type roller conveyors, belt conveyors, and clamp-type 2-wheel hand trucks. Even in industrial-truck operations conveyors are used in combination with industrial trucks which replace hand trucks. When hand trucks are used to bring fruit to the conveyor, the method is the same as that used for performing other cycles of operations in which fruit is placed on a belt conveyor. The use of the belt conveyor permits fruit to be moved from any floor or storage room to the carrier.

Sections of gravity-type conveyor are used inside the car or motortruck as a means of moving boxes of fruit from the belt conveyor to the end of the car. As one end of a car is loaded, the conveyor is gradually withdrawn to the other end and finally removed, a small section at a time, as the second end is loaded.

Loading Refrigerator Cars in Divided Loads

6-man crew using "turn man."--The more common method using hand truck, belt conveyor and gravity roller conveyor in loading a refrigerator car

Figure 118.--Placing packed boxes of apples on a belt conveyor in a cold storage room.

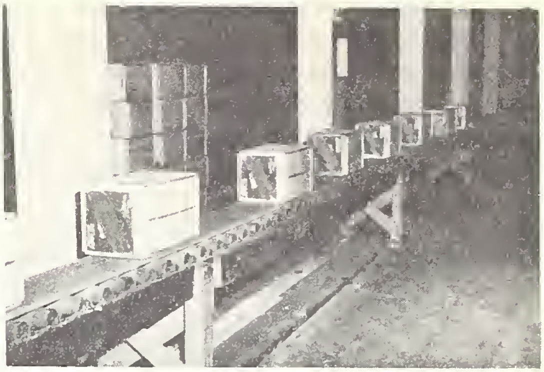

Figure 119.--Packed boxes of apples being transported by a belt conveyor.

employs a 6-man crew, one member of which is stationed at the car door as a turn man. Two men hand truck 6-high stacks of boxes 50 feet and release the stacks beside a belt conveyor. One worker places fruit on the belt which conveys boxes to the car door (figs. 118 and 119). The turn man standing in the doorway of the car transfers the boxes from the belt conveyor to a portable roller conveyor and gives each box a slight shove so that it rolls to the carloader in one end of the car (fig. 120). The carloader removes boxes of fruit from the roller conveyor and stacks them in loading position, while another worker strips each required row of boxes to keep them from shifting crosswise of the car.

Figure 120.--The turn man and stacker in a refrigerator car.

This method of loading cars in divided and braced loads requires 9.00 man-hours per 1,000 boxes, and an elapsed time of 2.44 hours (table 135). Sixteen percent of the labor is required for transferring boxes from the belt conveyor to the roller conveyor and 3.22 man-hours for moving boxes to the car, which is 36 percent of the total labor.

<u>5-man crew using curved section of gravity conveyor</u>.--An improved method of loading cars by hand truck, belt conveyor, and gravity roller conveyor, makes use of inclined, curved sections of gravity roller conveyor or box accelerators (figs. 121 and 122). Use of either of these

Table 135.--Labor required for a 6-man crew to move 1,000 packed boxes of apples out of storage and load refrigerator cars by use of clamp-type 2-wheel hand truck, belt conveyor, and gravity roller conveyor when loads are divided, braced, and stripped 1/

Operation	Workers	Productive labor	Fatigue allowance	Wait time	Total labor
	Number	Man-hours	Man-hours	Man-hours	Man-hours
Set up and clean up	6	0.21	0.0	0.37	0.58
Pick up 6-high stacks by use of 2-wheel hand truck	2	.29	.03	.0	.32
Transport 50 feet to belt conveyor	2	.97	.10	.08	1.15
Release stacks beside belt conveyor in double rows	2	.29	.03	.0	.32
Place boxes on belt conveyor	1	1.05	.21	.17	1.43
Transfer boxes from belt conveyor to gravity roller conveyor	1	1.04	.10	.29	1.43
Stack boxes in the railroad car	1	1.19	.24	.0	1.43
Strip every 2nd tier of boxes stacked in railroad car	1	.90	.09	.44	1.43
Brace doorway of railroad car	1	.83	.08	.0	.91
Total man-hours	-	6.77	.88	1.35	9.00
Elapsed time--hours					2.44

1/ Labor requirements shown do not cover blocking out and manifesting loads.

two devices under proper conditions eliminates the need for a turn man. Except for this difference the procedure and arrangement of workers is the same for this method and the method previously described.

Figure 121.--Curved roller conveyor slanted to carry boxes to stacker.

The inclined, curved sections of roller conveyor can be used only where the height of the loading dock and the car are such that an incline will allow the boxes to roll around the curve and onto dead conveyor sections by gravity. Where the

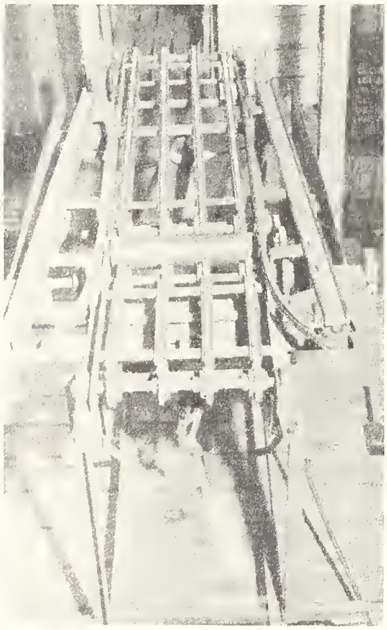

Figure 122.--Box accelerator used in carloading.

loading dock is too low in relation to the top of the floor rack in the car to provide the proper inclination, a box accelerator is used. The box kicker or accelerator is a short section of powered chain conveyor which adds momentum to the boxes as they move from the belt conveyor, so they will roll over the dead section of roller conveyor to the stowing point in the car. The box kicker also spaces the boxes so that they do not arrive too fast or irregularly for handling by the carloader (fig. 123).

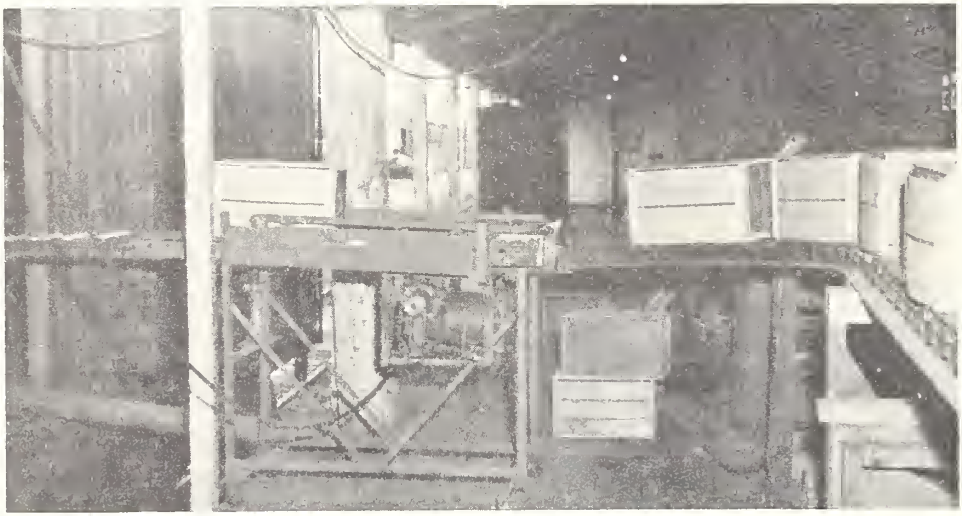

Figure 123.--Box accelerator sending boxes through car door to stacker.

Table 136.--Labor required for a 5-man crew to move 1,000 unpacked boxes of apples out of storage and load refrigerator cars by use of clamp-type 2-wheel hand truck, belt conveyor, and gravity-type roller conveyor (including straight and curved sections) when loads are divided, braced, and stripped 1/

Operation	Workers	Productive labor	Fatigue allowance	Wait time	Total labor
	Number	Man-hours	Man-hours	Man-hours	Man-hours
Set up and clean up	5	0.21	-	0.27	0.48
Pick up 6-high stacks by use of 2-wheel hand trucks	2	.29	0.03	.0	.32
Transport 50 feet to belt conveyor	2	.97	.10	.08	1.15
Release stacks beside belt conveyor in double rows	2	.29	.03	.0	.32
Place boxes on belt conveyor	1	1.05	.21	.17	1.43
Stack boxes in railroad car	1	1.19	.24	.0	1.43
Strip every 2nd tier of boxes stacked in the railroad car	1	.90	.09	.44	1.43
Brace doorway of railroad car	1	.83	.08	.0	.91
Total man-hours	-	5.73	.78	.96	7.47
Elapsed time--hours					2.44

1/ Labor requirements shown do not cover blocking out and manifesting loads.

As shown in table 136, 7.47 man-hours of labor are required to load 1,000 boxes. The elapsed time is the same as by use of the common method.

Comparison of Hand-Truck-Conveyor Methods for Divided Loading of Refrigerator Cars

When a 6-man crew, which includes a turn man, is loading refrigerator cars, labor and equipment costs are $1.76 more per 1,000 boxes than when a 5-man crew using a curved down section attached to the roller conveyor is employed (table 137). This saving is due to a reduction in labor. The use of the box kicker, when the height of the loading platform is insufficient for use of the curved conveyor section, would be of advantage. However, too great a speed and rhythm in bringing boxes to the worker stacking them in the car induces rough handling. There is no assurance that a turn man would not be inclined to set a rhythmic pace also.

Table 137.--Comparative labor and equipment costs for moving 1,000 packed boxes of apples out of storage and loading refrigerator cars by use of 2 specified clamp-type 2-wheel hand trucks, belt conveyors, and gravity-type roller conveyor methods when loads are divided, braced, and stripped 1/

Method	Workers	Elapsed time	Labor and equipment required: Equipment time	Labor and equipment required: Wait time	Labor and equipment required: Total labor	Labor and equipment costs: Equipment	Labor and equipment costs: Labor 2/	Total costs: Current wages	Total costs: Assumed wages
	Number	Hours	Machine-hours	Man-hours	Man-hours	Dollars	Dollars	Dollars	Dollars
Turn man									
Two workers hand truck 50 feet to belt conveyor, 1 worker places on, 1 worker stacks boxes off the belt conveyor, 1 worker strips load and braces doorway	6	2.44	3/ 4.65	1.35	9.00	1.29	10.35	11.64	13.89
No turn man									
Two workers hand truck 50 feet to belt conveyor, 1 worker places on, 1 worker stacks boxes off belt conveyor, 1 worker strips load and braces doorway	5	2.44	3/ 4.65	.96	7.47	1.29	8.59	9.88	11.75

1/ Costs shown do not include blocking out and manifesting loads.
2/ Computed from "current" wage rates.
3/ Clamp-type 2-wheel hand truck 1.79 machine-hours, 100-foot belt conveyor 1.43 machine-hours, 15-foot gravity roller conveyor 1.43 machine-hours, total 4.65 machine-hours.

Loading Refrigerated Highway Trucks

When highway trucks are loaded by conveyors, slightly longer sections of roller conveyor are used in the truck than are used in refrigerator cars, since the conveyor must reach from one end of the truck to the other. In refrigerator cars the conveyor extends only one-half the length of the car. A small increase in setup time is necessary because of the extra length of roller conveyor used and the method of setting up the conveyor in the truck. Belt conveyors are as widely used for loading highway trucks as for refrigerator cars because belt conveyors used in receiving are available later for out-loading. However, in some belt-conveyor and hand-truck plants it may be necessary to move the fruit to ground floor on belt conveyors and then hand truck it into the highway truck, when loading is done in an area not serviced by belt conveyor.

6-man crew using box spacer.--When belt conveyors are used to load highway trucks, one worker, usually the truck driver, spaces the boxes as they roll into the truck, thus making it more convenient for the worker stacking fruit into position to perform this operation. The truck driver usually is not employed by the apple house and is not obligated to assist with loading operations but wishes to see that the truck is satisfactorily loaded.

When belt conveyors are used to load highway trucks, two workers hand truck fruit 60 feet from the storage position to the belt and one worker loads boxes on the conveyor. At the highway truck, one worker (the truck driver) pushes boxes onto the roller conveyor as they move by, thus serving as a "turn man and box spacer," two workers stack the boxes. By use of this method 1,000 boxes can be loaded into highway trucks with 7.70 man-hours of labor and in an elapsed time of 1.44 hours (table 138). Delays that occur in the operation account for 20 percent of the total labor. Most of it is by the workers stacking boxes inside the truck. About 3.22 man-hours or 42 percent of the labor are required for moving fruit to the truck.

Table 138.--Labor required for a 6-man crew to move 1,000 packed boxes of apples from storage and solid load highway trucks by use of belt conveyor, clamp-type 2-wheel hand truck, and gravity-type roller conveyor 1/

Operation	Workers	Productive labor	Fatigue allowance	Wait time	Total labor
	Number	Man-hours	Man-hours	Man-hours	Man-hours
Set up and clean up	4	0.35	0.0	0.35	0.70
Pick up 6-high stacks by use of 2-wheel hand trucks	2	.29	.03	.0	.32
Transport stacks 60 feet to belt conveyor	2	1.14	.11	.07	1.32
Release stacks beside belt conveyor	2	.29	.03	.0	.32
Place boxes on belt conveyor	1	1.05	.21	.0	1.26
Push boxes along roller conveyor leading into truck	1	1.04	.10	.12	1.26
Stack boxes inside highway truck	2	1.25	.25	1.02	2.52
Total man-hours	-	5.41	.73	1.56	7.70
Elapsed time--hours					1.44

1/ Labor requirements shown do not cover blocking out and manifesting loads.

4-man crew without box spacer.--An improved method of loading a highway truck eliminates the worker spacing boxes as they enter the truck and one of the loaders inside the truck. This reduction in crew size is accomplished by having the worker who places boxes on the belt conveyor space them at regular intervals and by setting up the belt conveyor so it will force the boxes on the roller conveyor to the loading area (fig.

By this method two workers hand truck 6-high stacks 60 feet from the storage point to the belt conveyor, one worker inside the plant places boxes on the belt, and one worker stacks boxes as they arrive inside the truck. The improved method of loading highway trucks using only one loader and no box spacer reduces the labor required to load 1,000 boxes to 5.51 man-hours, or 28 percent below that required by use of a 6-man crew (table 139). Wait time is reduced to 9 percent of the total labor requirements. Although the labor requirement for moving fruit to the carrier by this method is the same, proportionately more labor is required because of the smaller total labor requirements. Although the total man-hours of labor are reduced by the improved method, the elapsed time required to load the carrier is increased 24 percent.

Figure 124.--Boxes moved into a highway truck by belt conveyor. The belt forces the boxes on the roller conveyor to the end of the truck.

Table 139.--Labor required for a 4-man crew to move 1,000 packed boxes of apples from storage and solid load highway trucks by use of belt conveyor, clamp-type 2-wheel hand truck, and gravity-type roller conveyor 1/

Operation	Workers	Productive labor	Fatigue allowance	Wait time	Total labor
	Number	Man-hours	Man-hours	Man-hours	Man-hours
Set up and clean up	2	0.35	0.0	0.20	0.55
Pick up 6-high stacks by use of 2-wheel hand trucks	2	.29	.03	.0	.32
Transport stacks 60 feet to belt conveyor	2	1.14	.11	.07	1.32
Release stacks beside belt conveyor	2	.29	.03	.0	.32
Place boxes on belt conveyor	1	1.05	.21	.24	1.50
Stack boxes inside highway truck	1	1.25	.25	.0	1.50
Total man-hours	-	4.37	.63	.51	5.51
Elapsed time--hours					1.78

1/ Labor requirements shown do not cover blocking out and manifesting loads.

Comparison of Hand-Truck-Conveyor Methods for Loading Highway Trucks

The improved method reduces labor costs substantially but increases the elapsed time of loading the truck about 20 minutes and, therefore, increases machine cost slightly. The net saving in combined costs of labor and machines is $2.31 per 1,000 boxes (table 140).

Table 140.--Comparative labor and equipment costs for moving 1,000 packed boxes of apples from storage and solid loading highway trucks by use of specified belt conveyor, clamp-type 2-wheel hand truck, and gravity roller conveyor methods 1/

Method	Workers	Elapsed time	Labor and equipment required: Equipment time	Labor and equipment required: Wait time	Labor and equipment required: Total labor	Labor and equipment costs: Equipment	Labor and equipment costs: Labor 2/	Total costs: Current wages	Total costs: Assumed wages
	Number	Hours	Machine-hours	Man-hours	Man-hours	Dollars	Dollars	Dollars	Dollars
Using box spacer									
Two workers hand truck 60 feet to conveyor, 1 worker places on conveyor, 1 worker pushes boxes on roller, 2 workers stack boxes inside truck	6	1.44	3/ 4.48	1.56	7.70	1.21	8.86	10.07	11.99
Without box spacer									
Two workers hand truck 60 feet to conveyor, 1 worker places on conveyor, 1 worker stacks boxes inside highway truck	4	1.78	4/ 4.96	.51	5.51	1.42	6.34	7.76	9.13

1/ Costs shown do not cover blocking out and manifesting loads.
2/ Computed from "current" wage rates.
3/ Clamp-type 2-wheel hand truck 1.96 machine-hours, 100-foot belt conveyor 1.26 machine-hours, 30-foot gravity roller conveyor 1.26 machine-hours, total 4.48 machine-hours.
4/ Clamp-type 2-wheel hand truck 1.96 machine-hours, 100-foot belt conveyor 1.50 machine-hours, 30-foot gravity roller conveyor 1.50 machine-hours, total 4.96 machine-hours.

Clamp-Type 2-Wheel Hand Trucks and Floor Chain Conveyors

Floor chain conveyors in combination with hand trucks were not used to load refrigerated cars and motortrucks at the time field studies were conducted. However, this equipment could be used for loading carriers and its comparative efficiency determined by constructing a method by use of elemental data. Because a large volume of fruit must be handled over a floor chain conveyor to keep ownership costs within reasonable limits, it is doubtful whether many plants have a large enough volume of fruit moving from one floor, and from one part of that floor, so that the floor chain conveyor could be utilized efficiently.

A possible floor chain conveyor and 2-wheel hand truck method for loading would employ one man for hand trucking boxes 30 feet to a conveyor, and one worker removing stacks of boxes from the conveyor and hand trucking them 20 feet into the car. Two workers would be used for stacking and stripping boxes inside the car and installing the braces.

As constructed from elemental data from other operations, use of this method of loading cars would require a total of 6.62 man-hours per 1,000 boxes (table 141). The elapsed time would be 2.33 hours. The amount of delay would not be great, for only 4 percent of the total labor is wait time. While the total man-hours to load are less than when using the hand truck alone, this saving in labor will tend to be offset by increased cost of equipment.

Table 141.--Labor that would be required for a 4-man crew to move 1,000 packed boxes of apples out of storage and load refrigerator cars by use of floor chain conveyor and clamp-type 2-wheel hand trucks when loads are divided, braced, and stripped 1/

Operation	Workers	Productive labor	Fatigue allowance	Wait time	Total labor
	Number	Man-hours	Man-hours	Man-hours	Man-hours
Set up and clean up	4	0.22	0.0	0.06	0.28
Pick up 6-high stacks by use of 2-wheel hand trucks	1	.29	.03	.0	.32
Transport 30 feet to floor chain conveyor	1	.62	.06	.0	.68
Release stacks on floor chain conveyor	1	.24	.02	.10	.36
Pick up 6-high stacks by use of 2-wheel hand trucks	1	.23	.02	.0	.25
Transport 20 feet from floor chain conveyor to stacking point inside car	1	.45	.05	.0	.50
Release stacks in car in front of carloader	1	.50	.05	.06	.61
Stack boxes in refrigerator car	2	1.43	.29	.0	1.72
Strip every 2nd tier of boxes in railroad car	2	.90	.09	.0	.99
Brace doorway	1	.83	.08	.0	.91
Total man-hours	-	5.71	.69	.22	6.62
Elapsed time--hours					2.33

1/ Labor requirements shown were determined through use of elemental data from other operations. These requirements do not cover blocking out and manifesting loads.

Clamp-Type 2-Wheel Hand Trucks and Elevators

Elevators are seldom used by Washington State apple houses in carloading, because most plants that have elevators move the fruit to carriers by use of belt conveyors. Elevators usually are in parts of the building not used in carloading. However, for comparative purposes an elevator-hand-truck method is constructed by use of elemental data. In a possible method for using elevators and hand trucks, it is assumed that three workers would be required to transport fruit from storage 60 feet to the elevators. These workers would ride the elevators to the off-loading floor where they would transport stacks of boxes 50 feet into the railroad car and release the stacks. A 2-man stacking and stripping crew would complete the carloading.

As shown in table 142, 9.37 man-hours would be required by this method to load 1,000 boxes. Labor requirements would be larger than by other methods. The elapsed time of 2.53 hours would be slightly longer than by other methods. More wait time would occur than by some methods, for 16 percent of the time is lost in waiting. Of the total labor, 4.87 man-hours (52 percent of the total) are used when transporting fruit to the car.

Table 142.--Labor that would be required for a 5-man crew to move 1,000 packed boxes of apples from storage and load refrigerator cars by use of an elevator and clamp-type 2-wheel hand trucks when loads are divided, braced, and stripped 1/

Operation	Workers	Productive labor	Fatigue allowance	Wait time	Total labor
	Number	Man-hours	Man-hours	Man-hours	Man-hours
Set up and clean up	5	0.26	0.0	0.09	0.35
Pick up 6-high stacks by use of 2-wheel hand trucks	3	.29	.03	.0	.32
Transport 60 feet into elevator	3	1.14	.11	.21	1.46
Release stacks in elevator	3	.29	.03	.0	.32
Elevator cycle	3	.20	.0	.40	.60
Pick up 6-high stacks by use of 2-wheel hand trucks	3	.29	.03	.0	.32
Transport 50 feet to stacking point inside car	3	.97	.10	.23	1.30
Release stacks in front of carloader	3	.50	.05	.0	.55
Stack boxes in refrigerator car	2	1.43	.29	.26	1.98
Strip every 2nd tier of boxes stacked in refrigerator car	2	.90	.09	.27	1.26
Brace doorway	1	.83	.08	.0	.91
Total man-hours	-	7.10	.81	1.46	9.37
Elapsed time--hours					2.53

1/ Labor requirements shown do not cover blocking out and manifesting loads.

Industrial Fork-Lift Truck and Pallets

Loading Refrigerator Cars

Industrial fork-lift truck plants use several different methods of loading refrigerator cars. By one of these methods the pallet load of packed boxes is set in the doorway of the car and boxes are carried to the loading position. By use of a second method a short belt conveyor is run into the car from the loading platform and pallets are off-loaded to the belt conveyor. A third method makes use of the pallet dolly. Pallet loads of packed boxes are placed on the dolly in the doorway of the car and rolled to the carloading position. While it might seem desirable to carry pallet loads into the car by industrial fork-lift truck, this is not done because the floor racks in the refrigerator cars will not support the weight.

Industrial truck and pallets alone or with sections of conveyor.--By this method the fork-lift truck transports pallet loads of packed boxes to the car and releases them either on the floor of the car or on a roller conveyor which is arranged so that the pallet load can be pushed by the lift truck into the car doorway. Inside the car members of the loading crew walking to the center of the car lift each box from the pallet and carry it back to the end of the car where it is stacked into position. It is necessary for the fork-lift truck to wait on the

Figure 125.--Moving a packed box from a pallet in the middle of a railroad car to its loading position.

carloading crew during the loading operation because the rate of carloading governs the speed of the fork-lift truck's operation. It is assumed that the fork-lift truck transports the fruit 110 feet to the car door and pushes the pallet load as far as possible into the doorway (fig. 125).

This method employs a 7-man crew, four workers who stack boxes in position in the car, two workers who strip each row of boxes, and one fork-lift truck operator. When pallets and fork-lift trucks are used to load cars by the method of placing the pallet load in the doorway, 6.72 man-hours of labor are required to load 1,000 boxes with an elapsed time of 1.74 hours (table 143). Only 0.76 of a man-hour is required to transport fruit. The bulk of the labor is used by the men walking to and from the center of the car to carry boxes to loading position.

Table 143.--Labor required for a 7-man crew to move 1,000 packed boxes of apples out of storage and load refrigerator cars by use of industrial fork-lift truck and pallets when the load is divided, braced, and stripped 1/

Operation	Workers	Productive labor	Fatigue allowance	Wait time	Total labor
	Number	Man-hours	Man-hours	Man-hours	Man-hours
Set up and clean up	7	0.18	0.0	0.31	0.49
Pick up 40-box pallet load in storage	1	2/ .12	.0	.0	.12
Transport 110 feet to refrigerator car door	1	.37	.03	.0	.40
Release pallet load in doorway of car	1	.11	.0	.13	.24
Walk to stacks average distance of 10 feet, handle empty pallets, and stack boxes in car	4	2.43	.61	.0	3.04
Strip every 2nd tier of boxes in refrigerator car	2	.90	.09	.53	1.52
Brace doorway	1	.83	.08	.0	.91
Total man-hours	-	4.94	.81	.97	6.72
Elapsed time--hours					1.74

1/ Labor requirements shown do not cover blocking out and manifesting loads.
2/ Taken from data in tabulation on page

Industrial truck, pallets, and conveyor.--One of the current methods of loading cars involves the use of lift trucks in combination with belt conveyors and gravity-type roller conveyors. By this method the fork-lift truck transports and releases the pallet load on the loading platform beside an extension of belt conveyor. One man off-loads the boxes from the pallets onto the conveyor which moves the fruit into the car where one man lifts the boxes off the conveyor and stacks them into loading position. A fourth worker strips the loads.

One of the advantages of using this method is that the worker placing fruit on the belt conveyor from the pallet loads can, when necessary, assist in blocking out and placing on the conveyor only the sizes listed on the manifest. After the car is loaded unneeded boxes are returned to storage.

Labor requirements by this method of loading refrigerator cars are 6.00 man-hours per 1,000 boxes (table 144). The elapsed time required

Table 144.--Labor required for a 4-man crew to move 1,000 packed boxes of apples out of storage and load refrigerator cars by use of fork-lift truck, pallets, belt conveyor, and gravity roller conveyor when the load is divided, braced, and stripped 1/

Operation	Workers	Productive labor	Fatigue allowance	Wait time	Total labor
	Number	Man-hours	Man-hours	Man-hours	Man-hours
Set up and clean up	3	0.21	0.0	0.11	0.32
Pick up 40-box pallet load by use of fork-lift truck	1	2/ .12	.0	.0	.12
Transport 60 feet to belt conveyor	1	.28	.03	.0	.31
Release pallets beside belt conveyor	1	.05	.0	.0	.05
Place boxes on belt conveyor	1	1.05	.21	.17	1.43
Stack boxes in refrigerator car	1	1.19	.24	.0	1.43
Strip every other tier of boxes in refrigerator car	1	.90	.09	.44	1.43
Brace doorway	1	.83	.08	.0	.91
Total man-hours	-	4.63	.65	.72	6.00
Elapsed time--hours					2.45

1/ Labor requirements shown do not cover blocking out and manifesting loads.
2/ Taken from data in tabulation on page 286.

is 2.45 hours. Slight wait time occurs because of delays in stripping operations. Total wait time amounts to 12 percent of the total man-hours. As with all industrial methods of handling, transportation labor requirements are small--only 8 percent of the total labor.

Industrial fork-lift trucks, pallets, and pallet dollies.--By this method the fork-lift truck transports unit pallet loads 110 feet from storage and releases the load on a pallet dolly in the doorway of the refrigerator car (fig. 126). In releasing the load the operator must make a "double release," since the forks of the truck do not extend far enough into the doorway of the car to set the load directly on a pallet dolly. Therefore, the fork-lift truck operator releases the load and

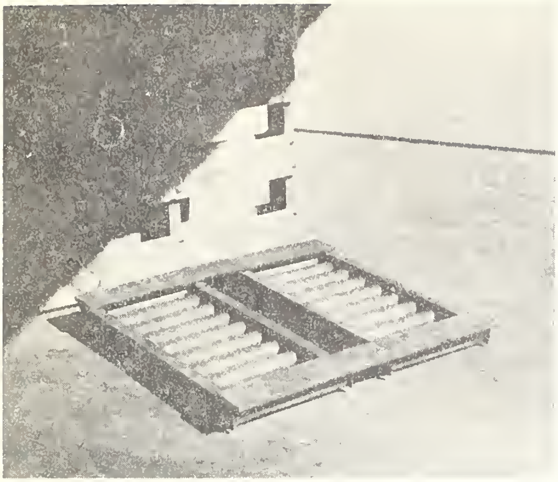

Figure 126.--Pallet dolly used to transport loaded pallet inside car.

Figure 127.--Stacking boxes of apples from pallet.

reverses the truck so that the unit load is left on the outer end of the forks, then moves forward and releases the load on the pallet dolly. Two workers inside the car push the loaded pallet dolly to the end of the car in which boxes are being stacked (fig. 127). These workers stack the boxes and strip the load.

The use of the pallet dolly eliminates the necessity for lifting boxes one at a time to place on a belt conveyor, since the unit load is held intact until it reaches the working face inside the car. This method reduces the number of handlings of boxes and helps maintain the quality of the fruit.

By use of the fork-lift truck and pallet dolly, 6.29 man-hours are required for loading 1,000 boxes, in an elapsed time of 2.65 hours (table 145). Delays occur in this operation and 19 percent of the labor is lost in waiting. Most of the wait time occurs because the fork-lift truck and operator must be present during the entire carloading, which increases both labor and equipment costs.

Comparison of fork-lift truck pallet methods.--Of the three methods which employ industrial fork-lift trucks and pallets, the method in which they are used in combination with belt conveyors and gravity roller conveyors shows the lowest labor cost, \$6.97 per 1,000 packed boxes, and lowest total cost, \$9.80 (table 146). The highest cost method involves the use of fork-lift truck and pallets alone.

Table 145.--Man-hours required for a 3-man crew to move boxes of apples from storage and load a refrigerator car by use of pallets, fork-lift trucks, and pallet dolly when the load is braced and stripped 1/

Operation	Workers	Productive labor	Fatigue allowance	Wait time	Total labor
	Number	Man-hours	Man-hours	Man-hours	Man-hours
Set up and clean up	3	0.27	0.0	0.12	0.39
Pick up 40-box load by use of fork-lift truck	1	2/ .12	.0	.0	.12
Transport 110 feet to railroad car doorway	1	.37	.03	.0	.40
Release unit load on dolly in refrigerator car	1	.15	.0	.99	1.14
Push loaded dolly to stacking point and remove empty pallets from car	2	.33	.07	.0	.40
Stack boxes in refrigerator car	2	1.57	.31	.06	1.94
Strip every 2nd tier of boxes in refrigerator car	2	.90	.09	.0	.99
Brace doorway	1	.83	.08	.0	.91
Total man-hours	-	4.54	.58	1.17	6.29
Elapsed time--hours					2.65

1/ Labor requirements shown do not cover blocking out and manifesting loads.
2/ Taken from data in tabulation on page 286.

Table 146.--Comparative labor and equipment costs to move 1,000 packed boxes of apples out of storage and load refrigerator cars by use of 3 methods which employ fork-lift trucks, pallets, belt conveyor, gravity roller conveyor and pallet dollies 1/

Method	Workers	Elapsed time	Labor and equipment required: Equipment time	Labor and equipment required: Wait time	Labor and equipment required: Total labor	Labor and equipment costs: Equipment	Labor and equipment costs: Labor 2/	Total costs: Current wages	Total costs: Assumed wages
	Number	Hours	Machine-hours	Man-hours	Man-hours	Dollars	Dollars	Dollars	Dollars
Fork-lift truck and pallets	7	1.74	3/ 1.39	0.97	6.72	3.00	7.85	10.85	12.53
Fork-lift truck, pallets, belt conveyor, and gravity roller conveyor	4	2.45	4/ 3.82	.72	6.00	2.83	6.97	9.80	11.31
Fork-lift truck, pallets, and pallet dollies	3	2.65	5/ 3.99	1.17	6.29	3.04	7.51	10.55	12.12

1/ Labor and equipment costs do not cover blocking out and manifesting loads.
2/ Computed from "current" wage rates.
3/ 4,000-pound capacity electric industrial fork-lift truck 0.76 machine-hours, 20.8 pallets (40- by 48-inch) 0.63 machine-hours, total 1.39 machine-hours.
4/ 4,000-pound capacity electric industrial fork-lift truck 0.48 machine-hours, 20.8 pallets (40- by 48-inch) 0.48 machine-hours, 60-foot belt conveyor 1.43 machine-hours, 15-foot roller conveyor 1.43 machine-hours, total 3.82 machine-hours.
5/ 4,000-pound capacity electric industrial fork-lift truck 0.67 machine-hours, 20.8 pallets (40- by 48-inch) 0.67 machine-hours, pallet dolly 2.65 machine-hours, total 3.99 machine-hours.

Loading Refrigerated Highway Trucks

The newer plants using fork-lift trucks usually load highway trucks on the receiving apron (fig. 128). The fork-lift truck transports pallet loads of fruit from storage, about 100 feet, and releases the unit load down inside the tailgate of the truck. The usual practice is to release the unit load on a pallet dolly (fig. 129). Two workers push this dolly to the front of the truck and proceed to stack the boxes into loading position.

Figure 128.--Pallet load being hoisted into highway truck parked on receiving apron.

When industrial trucks are used with pallet dollies to load highway trucks, 4.11 man-hours of labor per 1,000 boxes are required--the smallest labor requirement for loading either highway trucks or refrigerator cars by any method. Even though the labor requirements are relatively low, part of this labor is lost in wait time of the lift-truck operator because the workers stacking boxes in the car cannot keep pace with the fork-lift truck bringing unit loads to the highway truck.

Figure 129.--Pallet load being lowered onto pallet dolly in highway truck.

If this wait time could be eliminated, it would reduce both machine costs and labor costs. Eighteen percent of the time was lost in waiting. The fork-lift truck time was low, only 1.24 man-hours per 1,000 boxes, but percentagewise this is 30 percent of the total. An important advantage of the fork-lift truck in loading highway trucks is that it takes only 1.37 hours to load 1,000 boxes (table 147).

Table 147.--Labor required for a 3-man crew to move 1,000 packed boxes of apples from storage and solid load highway trucks by use of fork-lift truck, pallets and pallet dollies 1/

Operation	Workers	Productive labor	Fatigue allowance	Wait time	Total labor
	Number	Man-hours	Man-hours	Man-hours	Man-hours
Set up and clean up	3	0.27	0.0	0.12	0.39
Pick up 40-box unit load in cold storage by use of fork-lift truck	1	2/ .12	.0	.0	.12
Transport 110 feet to tailgate of highway truck	1	.37	.03	.0	.40
Release unit load on pallet dolly in highway truck	1	.15	.0	.57	.72
Push dolly to stacking point and remove empty pallets from truck	2	.41	.08	.06	.55
Stack boxes in highway truck	2	1.61	.32	.0	1.93
Total man-hours	-	2.93	.43	.75	4.11
Elapsed time--hours					1.37

1/ Labor requirements shown do not cover blocking out and manifesting loads.
2/ Taken from data in tabulation on page 286.

Industrial Fork-Lift Truck, Pallets, Low-Lift Pallet Transporter, Belt Conveyor and Gravity-Type Roller Conveyor

The equipment combination consisting of fork-lift truck, low-lift pallet transporter, belt conveyor, and gravity-type roller conveyor was not used to load refrigerator cars at the time field studies were conducted. A possible method is described below. The labor requirement by this method has been pieced together from pertinent details of other methods.

A low-lift pallet transporter would be used only if the fork-lift truck could not move the pallet loads to the belt conveyor. Such a situation might occur when a pallet addition has been built onto an older warehouse. The floors inside the older part of the warehouse may not support the heavy fork-lift truck. If this were the case and the belt conveyor used for loading out was in the original building, the low-lift transporter could be used to move pallet loads from a point at the edge of the storage room to the belt conveyor.

This combination of equipment is assumed to operate by the fork-lift truck breaking out pallet loads from the stacks and moving them approximately 40 feet to a point where the low-lift truck transporter picks up unit loads and transports them 40 additional feet to release on a belt conveyor. The operators of the pallet transporter and the fork-lift truck must closely coordinate their transportation cycles. After pallet loads have been released at the belt conveyor, one worker places boxes on the conveyor to be moved into the car. In the car, one worker stacks the boxes into position and another worker strips the load.

This combination of equipment and method would require 6.96 man-hours to load 1,000 boxes in 2.45 hours of elapsed time (table 148). Sixteen percent of this labor is for wait time, 39 percent (2.71 man-hours) for transporting the fruit from storage to the car.

Table 148.--Labor that would be required for a 5-man crew to move 1,000 packed boxes of apples out of storage and load refrigerator cars by use of fork-lift truck, low-lift pallet transporter, gravity-type roller conveyor, and belt conveyor when loads are divided, braced, and stripped 1/

Operation	Workers	Productive labor	Fatigue allowance	Wait time	Total labor
	Number	Man-hours	Man-hours	Man-hours	Man-hours
Set up and clean up	5	0.21	0.0	0.27	0.48
Pick up 40-box unit load by use of fork-lift truck	1	2/ .12	.0	.0	.12
Transport 40 feet to doorway of storage room	1	.24	.02	.0	.26
Release on floor of storage room	1	.04	.0	.22	.26
Pick up 40-box unit load by use of low-lift pallet or a transporter	1	.13	.0	.0	.13
Transport 40 feet to belt conveyor	1	.31	.06	.0	.37
Release unit load beside belt conveyor	1	.14	.0	.0	.14
Place boxes on belt conveyor	1	1.05	.21	.17	1.43
Stack boxes in refrigerator car	1	1.19	.24	.0	1.43
Strip every 2nd tier in refrigerator car	1	.90	.09	.44	1.43
Brace doorway	1	.83	.08	.0	.91
Total man-hours	-	5.16	.70	1.10	6.96
Elapsed time--hours					2.45

1/ Labor requirements shown do not cover blocking out and manifesting loads.
2/ Taken from data in tabulation on page 286.

Industrial Clamp-Type Lift Truck, Belt Conveyor, and Gravity-Type Roller Conveyor

Industrial clamp-type lift trucks were not used in Washington State apple houses for loading refrigerator cars until tests were conducted as part of the research program. One of the reasons this equipment had not been used for loading out was that the clamping arms of the lift truck marred the labels on the boxes. This difficulty was avoided by turning the labeled ends of two of the bottom boxes so that they faced inward away from the clamping arms.

To permit the efficient use of industrial-clamp trucks for loading-out operations, packed boxes of fruit must be suitably arranged in storage stacks and suitably segregated when returned to storage from the packing line. First, if boxes are hand trucked from the segregation area to storage, space must be left after every second row of stacks in storage to permit the insertion of the clamp truck arms. Second, packed boxes must be specially segregated as they are stored, placing in adjacent rows the varieties, grades, and sizes that are usually marketed together.

When the industrial clamp truck is used it is assumed that the truck moves the fruit 50 feet to the belt conveyor where it is released. When sufficient fruit has been moved up to keep the carloading crew occupied, the industrial truck moves on to other operations. One worker places boxes of apples on the belt conveyor which moves them into the car. One worker inside the car stacks the boxes in loading position, while another worker strips the load.

As shown in table 149, this method of using industrial clamp trucks, belt conveyors, and roller conveyors to load 1,000 boxes requires 6.44 man-hours of labor. An elapsed time of 2.45 hours is required per 1,000 boxes. Some time is lost by the worker who strips the load, bringing the total wait time to 12 percent of the total labor. Thirty-five percent of the total labor, or 2.27 man-hours, is used in moving fruit to the car.

Table 149.—Labor required for a 4-man crew to move 1,000 packed boxes of apples out of storage and load refrigerator cars by use of industrial clamp-type lift truck, belt conveyor, and gravity roller conveyor when loads are divided, braced, and stripped 1/

Operation	Workers	Productive labor	Fatigue allowance	Wait time	Total labor
	Number	Man-hours	Man-hours	Man-hours	Man-hours
Set up and clean up	4	0.21	0.0	0.19	0.40
Pick up 20-box load by use of clamp-type lift truck	1	.26	.0	.0	.26
Transport 50 feet to belt conveyor	1	.46	.04	.0	.50
Release unit load beside belt conveyor	1	.08	.0	.0	.08
Place boxes on belt conveyor	1	1.05	.21	.17	1.43
Stack boxes in refrigerator car	1	1.19	.24	.0	1.43
Strip every 2nd tier of boxes stacked	1	.90	.09	.44	1.43
Brace doorway	1	.83	.08	.0	.91
Total man-hours	-	4.98	.66	.80	6.44
Elapsed time--hours					2.45

1/ Labor requirements shown do not cover blocking out and manifesting loads.

Comparison of Methods and Types of Equipment for Loading Out Refrigerator Cars

Table 150 shows the comparative labor and equipment costs for loading out 1,000 packed boxes of apples by use of various methods and types of equipment previously described. The data apply to the loading of refrigerator cars when loads are divided, braced, and stripped. Cost for a carload of 800 boxes would be approximately 80 percent of the cost per 1,000 boxes. Of the three major types and combinations of types of equipment used for loading out refrigerator cars, when loads are divided, braced, and stripped, the costs are lowest by use of 2-wheel hand trucks. However, the use of hand trucks alone is limited to one-story plants. Moreover, plants that use industrial trucks for other operations would hardly consider loading out by use of hand trucks since they must obtain

Table 150.--Comparative labor and equipment costs by use of specified methods and types of equipment for moving 1,000 packed boxes of apples from storage and loading refrigerator cars when loads are divided, braced, and stripped 1/

Type of equipment and method	Elapsed time	Labor and equipment required: Equipment time	Labor and equipment required: Wait time	Labor and equipment required: Total labor	Labor and equipment costs: Equipment 2/	Labor and equipment costs: Labor 3/	Total costs: Current wages	Total costs: Assumed wages 4/
	Hours	Machine-hours	Man-hours	Man-hours	Dollars	Dollars	Dollars	Dollars
Clamp-type 2-wheel hand trucks: 3 workers hand-truck 110 feet to refrigerator car, 2 workers stack boxes, 1 worker strips load and braces doorway	2.01	3.08	0.68	7.50	0.07	8.63	8.70	10.58
When blocking out and manifesting are added	2.01	5/ 4.87	.81	11.53	.11	13.26	13.37	16.25
Belt conveyor, gravity-type roller conveyor and hand trucks: 2 workers hand-truck 50 feet to belt conveyor, 1 worker places on belt conveyor, 1 worker stacks off belt conveyor, 1 worker strips load and braces doorway	2.44	4.65	.96	7.47	1.29	8.59	9.88	11.75
When blocking out and manifesting are added	2.44	5/ 6.44	1.09	11.50	1.33	13.22	14.55	17.42
Floor chain conveyor and hand trucks: 1 worker hand-trucks 30 feet, 1 worker hand-trucks 20 feet from floor chain conveyor, 2 workers stack and strip load, 1 worker braces load	2.33	6/ 4.08	.22	6.62	2.65	7.61	10.26	11.92
When blocking out and manifesting are added	2.33	5/ 5.87	.35	10.65	2.69	12.24	14.93	17.59
Elevator and hand trucks: 7/ 3 workers hand-truck 60 feet to elevator, ride elevator, hand-truck 50 feet to refrigerator car, 2 workers stack and strip boxes, 1 worker braces load	2.53	8/ 6.49	1.46	9.37	5.32	10.78	16.10	18.44
When blocking out and manifesting are added	2.53	5/ 8.28	1.59	13.40	5.36	15.41	20.77	24.12
Fork-lift truck and pallets alone: 1 worker and fork-lift truck transports 40-box load 110 feet to refrigerator car, 4 workers stack boxes, 2 workers strip boxes, 1 worker braces load	1.74	1.39	.97	6.72	3.00	7.85	10.85	12.53
When blocking out and manifesting are added	1.74	9/ 2.24	.97	8.12	5.17	9.60	14.77	16.80
Fork-lift truck, pallets, belt conveyor, and gravity-type roller conveyor: 1 worker and fork-lift truck transports 40-box load 50 feet to belt conveyor, 1 worker places on belt conveyor, 1 worker stacks off conveyor, 1 worker strips and braces load	2.45	3.82	.72	6.00	2.83	6.97	9.80	11.31
When blocking out and manifesting are added	2.45	9/ 4.77	.72	7.40	5.00	8.72	13.72	15.57
Fork-lift truck, pallets, and pallet dollies: 1 worker and fork-lift truck transports 110 feet to refrigerator car, 2 workers push dolly, stack and strip boxes, 1 worker braces load	2.65	3.99	1.17	6.29	3.04	7.51	10.55	12.12
When blocking out and manifesting are added	2.65	9/ 4.94	1.17	7.69	5.21	9.26	14.47	16.39
Fork-lift truck, low-lift pallet transporter, pallets, belt conveyor, and gravity-type roller conveyor: 1 worker and fork-lift truck transports 40 feet, 1 worker and low-lift pallet transporter transports 40 feet, 1 worker places on conveyor, 1 worker stacks off conveyor, 1 worker strips and braces load	2.45	10/ 5.20	1.10	6.96	4.98	8.10	13.08	14.82
When blocking out and manifesting are added	2.45	9/ 6.15	1.10	8.36	7.15	9.85	17.00	19.09
Industrial clamp-type lift truck, belt conveyor and gravity-type roller conveyor: 1 worker and clamp truck transports 50 feet, 1 worker places on conveyor, 1 worker stacks off conveyor, 1 worker strips and braces load	2.45	11/ 3.70	.80	6.44	1.96	7.53	9.49	11.10
When blocking out and manifesting are added	2.45	5/ 5.49	.80	8.68	4.50	10.37	14.87	17.04

1/ Transportation distances involved in blocking out loads are standardized at 100 feet when industrial trucks are used and at 50 feet when clamp-type 2-wheel hand trucks are used. In the loading-out operations that follow blocking out, transportation distances are standardized at 110 feet, making a total of 210 feet by use of industrial truck methods and a total of 160 feet by use of hand truck methods.

2/ Equipment costs computed from data on ownership and operating costs shown in table 2.

3/ "Current" labor costs computed from wage rates of $1.15 per hour for unskilled labor and $1.30 per hour for semiskilled workers (key workers such as industrial truck operators).

4/ Assumed labor costs computed from wage rates of $1.40 per hour for unskilled labor and $1.55 per hour for semiskilled workers.

5/ Increase is accounted for by additional hand truck time of 1.79 machine-hours.

6/ Clamp-type 2-wheel hand truck 2.72 machine-hours, 100 foot belt conveyor 1.36 machine-hours, total 4.08 machine-hours.

7/ Vertical transportation distance is not included.

8/ Clamp-type 2-wheel hand truck 4.87 machine-hours, 8,000-pound capacity elevator 1.62 machine-hours, total 6.49 machine-hours.

9/ Increase is accounted for by additional fork-lift truck time of 0.95 machine-hours.

10/ 4,000-pound capacity electric fork-lift truck 0.64 machine-hours, 4,000-pound capacity electric low-lift pallet transporter 0.64 machine-hours, 20.8 pallets (48-box) 1.06 machine-hours, 30 foot belt conveyor 1.43 machine-hours, 15 foot roller conveyor 1.43 machine-hours, total 5.20 machine-hours.

11/ 1,000-pound capacity electric clamp-type lift truck 0.84 machine-hours, 60 foot belt conveyor 1.43 machine-hours, 15 foot gravity roller conveyor 1.43 machine-hours, total 3.70 machine-hours.

the maximum amount of use from their equipment. There are advantages in using industrial trucks for carloading that cannot be evaluated in monetary terms. For instance, more gentle handling tends to retain fruit quality. Smaller crew sizes are another important non-monetary advantage to lift truck handling. When fork-lift trucks and pallets are used with either pallet dollies or roller conveyors, a crew of only three men is needed for operations following blocking out.

The pallet and fork-lift truck method of loading by depositing pallet loads in the car doorway, and having workers carry the boxes to loading position, requires the lowest elapsed time to load a car. It also requires the largest crew size. In contrast, the fork-lift truck using a pallet dolly required the longest elapsed time but a crew of only three men.

In multistory plants where fruit is moved from one floor level to another, the conveyor-hand-truck method is most efficient, and the elevator-hand-truck method least efficient.

Since blocking out and manifesting loads are a part of the cycle of loading out operations, labor and equipment costs in table 150 are shown separately for those operations that follow blocking out, and when blocking out and manifesting are included. The costs are shown separately because the amount of labor required to block out and manifest loads is not directly associated with the particular method used for subsequent operations.

Use of fork-lift trucks requires 0.95 man-hour per 1,000 boxes for blocking-out operations, and industrial-clamp trucks, 1.79 man-hours. Use of 2-wheel hand trucks requires 3.58 man-hours. Transportation distances of 100 feet by the industrial trucks and 50 feet by hand trucks represent industry practices. To the labor required for blocking out, 0.45 man-hour has been added to cover the average labor for manifesting.

Comparison of Methods and Types of Equipment for Loading Out Highway Trucks

Comparative labor and equipment costs by use of the three major combinations of equipment used to load highway trucks are shown in table 151. The 2-wheel hand truck method is the lowest cost method. The method using the fork-lift truck and pallet dolly has the lowest labor. Equipment and labor costs were almost equal in this case. It should be noticed that the elapsed time as well as the cost to load a highway truck was less than to load the same number of boxes into refrigerator cars.

In the conventional-type plant, when storage on the main floor is not too distant from the loading platform, the hand truck method is the most efficient for loading highway trucks. If fruit is to be moved from floors other than the main floor the belt-conveyor method is the most desirable in the conventional-type plant, especially if the conveyor brings the fruit directly onto the highway truck. Newer-type plants using industrial equipment would find the use of pallet dollies efficient in their loading operations.

Table 151.--Comparative labor and equipment costs by use of specified methods and types of equipment for moving 1,000 packed boxes of apples out of storage and solid loading highway trucks 1/

Method	Elapsed time	Labor and equipment required: Equipment time	Labor and equipment required: Wait time	Labor and equipment required: Total labor	Labor and equipment costs: Equipment 2/	Labor and equipment costs: Labor 3/	Total costs: Current wages	Total costs: Assumed wages 4/
	Hours	Machine-hours	Man-hours	Man-hours	Dollars	Dollars	Dollars	Dollars
Clamp-type 2-wheel hand truck								
Three workers hand-truck 130 feet to stacking point, 2 workers stack boxes	1.16	3.27	0.55	5.80	0.08	6.67	6.75	8.20
When blocking out and manifesting are added	1.16	5/ 5.06	.68	9.83	.12	11.30	11.42	13.88
Belt conveyor and hand truck								
Two workers hand-truck 60 feet to conveyor, 1 worker places on, 1 worker pushes boxes, 2 workers stack inside truck	1.44	4.48	1.56	7.70	1.21	8.86	10.07	11.99
When blocking out and manifesting are added	1.44	5/ 6.27	1.69	11.73	1.25	13.49	14.74	17.67
Fork-lift truck and pallet dolly								
One fork-lift truck transports 110 feet, 2 workers push dolly and stack boxes in truck	1.37	6/ 3.28	.75	4.11	4.25	4.93	9.18	10.21
When blocking out and manifesting are added	1.37	7/ 4.23	.75	5.51	6.42	6.68	13.10	14.48

1/ Transportation distances involved in blocking out loads are standardized at 100 feet when industrial trucks are used and at 50 feet when clamp-type 2-wheel hand trucks are used. In the loading out operations that follow blocking out, transportation distances are standardized at 130 feet, 20 feet of which is inside the carrier. The total transportation distance when industrial trucks are used is 230 feet. When hand trucks are used the total distance is 180 feet.

2/ Equipment costs computed from data on ownership and operating costs shown in table 2.

3/ "Current" labor costs computed from wage rates of $1.15 per hour for unskilled labor and $1.30 per hour for semiskilled workers (key workers such as industrial truck operators).

4/ Assumed labor costs computed from wage rates of $1.40 per hour for unskilled labor and $1.55 per hour for semiskilled workers.

5/ Increase is due to additional hand truck time of 1.79 machine-hours.

6/ 4,000-pound capacity electric fork-lift truck 1.24 machine-hours, pallet dolly 1.37 machine-hours, 20.8 pallets (48-box) 0.67 machine-hours, total 3.28 machine-hours.

7/ Increase is due to additional fork-lift truck time of 0.95 machine-hours.

METHODS AND EQUIPMENT FOR MOVING APPLES DIRECTLY FROM THE PACKING LINE AND LOADING REFRIGERATOR CARS

Loading apples directly from the packing line is not a common practice in Washington State, largely because the rate at which packed boxes of fruit move off the packing line is too slow a pace for extensive carloading operations. A single packing line turns out approximately 210 boxes per hour so that from four to eight hours are required to load a railroad car, the exact time depending on the number of sizes and grades listed on the manifest.

The more usual practice of loading out fruit from the line is first to move the packed boxes through the segregation area to select the sizes to be loaded out. These sizes are then hand trucked to a temporary block as part of a blocked-out load. When this procedure is followed, loading operations are performed by use of the methods described in the previous section. Although this practice may be referred to as loading directly from the packing line, it makes use of a temporary storage block so that all of the work elements are identical to the various loading methods described in moving fruit from storage and loading out except that high-piled boxes are not broken out.

The extent to which boxes of apples are loaded directly from the packing line into refrigerator cars depends somewhat on market conditions and, occasionally, on the market connections of shippers. In a sellers' market, buyers are more likely to accept the normal run of sizes which permits more of the fruit from the packing line to be loaded directly into a car. Some firms have market outlets which accept a larger range of sizes than others. Such firms load out a larger number of cars of the fruit directly from the packing line.

Usually more cars of apples are loaded directly from the packing line early in the season because at that time shippers endeavor to place as many carloads of apples as possible on the early market. This period may last from two to three weeks before heavy receiving gets under way.

When boxes of apples are loaded directly from the packing line they follow the regular path to the segregation area where boxes of sizes and grades that are not on the manifest are removed and placed in segregated stacks to go to storage. The remaining boxes are moved to the carrier. The range of sizes and grades to be loaded directly affects the number of boxes arriving at the refrigerator car per hour, and the elapsed time required to load a car is relatively short or long depending on these factors. However, there is considerable delay time on the part of the carloader in any case.

The work elements involved in loading a refrigerator car or highway truck are about the same as for methods previously discussed except for work inside the car. Methods for loading refrigerator cars directly from the packing line can be adapted to loading highway trucks by referring to previous analysis. However, highway trucks are not loaded from the packing line as frequently as refrigerator cars, because highway trucks cannot be detained any great length of time since they are usually being used to capacity in the season of the year when most loading is done directly from the packing line. A one-half day tie-up of a highway truck may mean 200 or 300 miles of travel, thus reducing the number of loads and the return on the carrier investment.

Belt conveyors and gravity-type roller conveyors, which are joined to provide a conveyor line from the segregating area to the working face in the car, are used almost exclusively for loading boxes directly from the packing line. Figures 130 and 131 show how conveyor lines are set up for loading refrigerator cars.

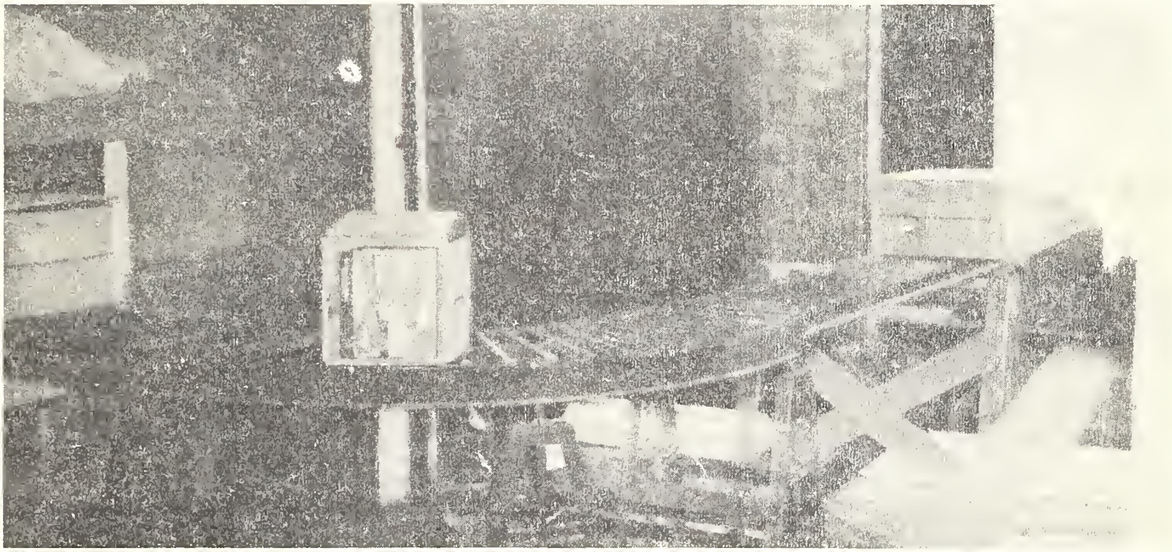

Figure 130.--Boxes on a roller conveyor going into a refrigerator car directly from the end of line.

When boxes are loaded directly from the line only one worker is used to carry out all phases of carloading, placing the boxes, lathing and doing the bracing. Boxes already are on conveyor lines in the segregating area so that no loader is required. In analyzing this method the plant is assumed to have one packing line with an output of 210 boxes per hour. It also is assumed that all of the boxes packed, regardless of size and grade, are loaded into one car. Under these

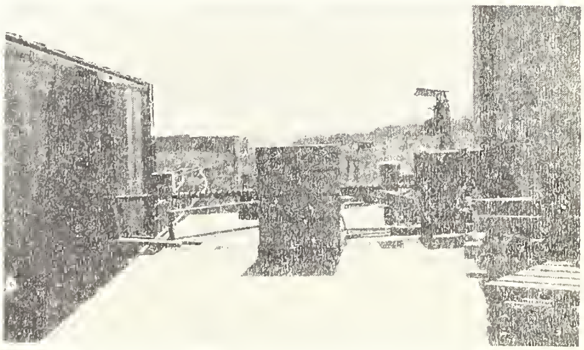

Figure 131.--Boxes of apples moving from the end of a packing line into a refrigerator car.

assumptions the minimum amount of labor would be required for loading a railroad car directly from the washing and packing line.

Under the conditions assumed, this method requires 5.88 man-hours to load 1,000 boxes in an elapsed time of 5.88 hours (table 152). Waiting accounted for 40 percent of the time. The delays occurred because boxes were not arriving in the car fast enough to keep the one worker occupied.

Table 152.--Labor required for 1 worker to move 1,000 packed boxes of apples from the packing line and load refrigerator cars by use of belt conveyor and gravity-type roller conveyor when loads are divided, braced, and stripped

Operation	Workers	Productive labor	Fatigue allowance	Wait time	Total labor
	Number	Man-hours	Man-hours	Man-hours	Man-hours
Set up and clean up	1	0.21	0.0	0.0	0.21
Stack boxes in the railroad car	1	1.19	.24	2.34	3.77
Strip every other tier in the car	1	.90	.09	.0	.99
Brace doorway of the car	1	.83	.08	.0	.91
Total man-hours	-	3.13	.41	2.34	5.88
Elapsed time--hours					5.88

The cost of moving apples directly from the packing line and loading out by use of this method is $10.90 per 1,000 boxes at current wage rates (table 153), over one-third of this being machine cost for use of a belt conveyor and roller conveyors.

Table 153.--Labor and equipment costs for 1 worker to move 1,000 packed boxes of apples from the packing line and load refrigerator cars by use of belt conveyor and gravity-type roller conveyors when loads are divided, braced, and stripped 1/

Method	Labor and equipment required			Labor and equipment costs			
	Equipment time	Wait time	Total labor	Equipment	Labor 2/	Total costs: Current wages	Total costs: Assumed wages
	Machine-hours	Man-hours	Man-hours	Dollars	Dollars	Dollars	Dollars
Loading from the end of the line with belt conveyor and sectional rollers, 1 worker loading inside the railroad car	3/ 9.52	2.34	5.88	4.14	6.76	10.90	12.37

1/ Costs shown do not cover blocking out and manifesting loads.
2/ Computed from "current" wage rates.
3/ 100-foot belt conveyor and 15-foot gravity roller conveyor 4.76 machine-hours each, total 9.52 machine-hours.

COMPARISON OF COMBINATIONS OF TYPES OF MATERIALS-HANDLING EQUIPMENT USED FOR MOVING APPLES INTO, WITHIN, AND OUT OF STORAGE HOUSES

Tables 154 and 155 show respectively for common and improved methods the comparative labor and equipment requirements, and the labor and equipment costs, for moving 1,000 boxes of apples into, within, and out of storage houses by use of the six principal combinations of materials-handling equipment used in Washington State houses when both packed and unpacked boxes of fruit are stored. The storage of fruit, both before and after it is packed, necessitates four cycles of operations, two of them within the plant, both of them paced by the rate of the packing line. However, no such limitations apply to the cycles of operations involved in moving fruit into and out of the plant.

Although labor and equipment costs have been computed for 1,000 boxes of apples, two of the cycles of operations cover the handling of unpacked boxes and two of these cycles cover packed boxes. In computing costs on a plant-wide basis consideration should be given to the fact that for each 1,000 boxes of unpacked fruit handled, there would be only 700 boxes of packed fruit to handle, which could materially alter the cost relationships shown.

When pallet loads of fruit are built on road trucks in the orchard, labor and equipment costs for handling 1,000 boxes of apples, at the plant, by industrial fork-lift trucks and pallets are \$31.99 for the common methods and \$31.89 for the improved. Even if the plant operator pays the increase in orchard-handling costs of \$1.98 per 1,000 boxes for building pallet loads in the orchard, handling costs at the plant by use of fork-lift trucks and pallets still would be less than handling by use of 24-box capacity industrial clamp-type lift trucks, which is the next best combination of equipment.

Both types of powered lift trucks are relatively efficient for performing receiving operations and for moving fruit from storage to the packing line, provided loads have been properly built before arrival and provided further that in supplying the packing line some type of accumulator device is used. However, neither type is as efficient in loading-out operations as are clamp-type 2-wheel hand trucks, which permit the handling of 6-box unit loads into the car and throughout the loading operation. As previously pointed out, industrial trucks cannot enter a refrigerator car for loading principally because the car floor will not support it. Pallet or unit loads, therefore, must be deposited in the car door and either broken down box by box at that point for stowing, or pushed on pallet dollies to the loading face and broken down for properly stowing boxes.

Use of the types of equipment applicable to handling operations in multistory buildings result in the highest labor and equipment costs. These are: (1) Elevators and hand trucks with costs of \$92.81 per

Table 154.--Comparative labor and equipment costs for handling 1,000 boxes of apples through four specified cycles of operations involved by common methods, when moving fruit into, within, and out of storage houses by use of specified types and combinations of types of equipment 1/

Type of equipment and cycles of operations	Workers	Labor and equipment required: Equipment	Labor and equipment required: Labor	Labor and equipment costs: Equipment 2/	Labor 3/	Total costs: Current wages	Total costs: Assumed wages 4/
	Number	Machine-hours	Man-hours	Dollars	Dollars	Dollars	Dollars
Clamp-type 2-wheel hand trucks							
Unloading unpacked boxes from road trucks and moving into storage (12-box high stacks)	7	3.14	7.33	0.07	8.43	8.50	10.33
Moving unpacked boxes from storage to the packing line (broken out of 12-box high stacks)	3	9.70	9.39	.24	11.49	11.73	14.23
Moving packed boxes from packing line to storage (manual high-piling in 10-box high stacks) 5/	3	19.04	19.04	.53	21.90	22.43	27.19
Moving packed boxes from storage and loading refrigerator cars (includes blocking out and manifesting)	6/ 7	4.87	11.53	.11	13.26	13.37	16.25
Totals	20	36.75	47.29	.95	55.08	56.03	68.00
Clamp-type 2-wheel hand trucks and belt conveyors							
Unloading unpacked boxes from road trucks and moving into storage (12-box high stacks) 7/	10	4.04	10.10	.92	11.62	12.54	15.06
Moving unpacked boxes from storage to the packing line (broken out of 12-box high stacks)	3	10.60	7.27	4.04	8.36	12.40	14.21
Moving packed boxes from packing line to storage (manual high-piling in 10-box high stacks) 5/	3	19.04	14.28	4.37	16.42	20.79	24.36
Moving packed boxes from storage and loading refrigerator cars (includes blocking out and manifesting)	6/ 6	6.44	11.50	1.33	13.22	14.55	17.42
Totals	22	40.12	43.15	10.66	49.62	60.28	71.05
Clamp-type 2-wheel hand trucks and floor chain conveyors							
Unloading unpacked boxes from road trucks and moving into storage (12-box high stacks)	8	4.40	7.00	1.10	8.05	9.15	10.90
Moving unpacked boxes from storage to the packing line (broken out of 12-box high stacks)	2	9.64	6.66	2.09	7.66	9.75	11.41
Moving packed boxes from packing line to storage (manual high-piling in 10-box high stacks) 5/ 8/	3	19.04	14.28	4.37	16.42	20.79	24.36
Moving packed boxes from storage and loading refrigerator cars (includes blocking out and manifesting)	6/ 5	5.87	10.65	2.69	12.24	14.93	17.59
Totals	18	38.95	38.59	10.25	44.37	54.62	64.26
Clamp-type 2-wheel hand trucks and elevator 9/							
Unloading unpacked boxes from road trucks and moving into storage (12-box high stacks) 10/	9	10.43	11.92	5.00	13.71	18.71	21.69
Moving unpacked boxes from storage to the packing line (broken out of 12-box high stacks)	3	11.10	10.93	8.51	12.57	21.08	23.81
Moving packed boxes from packing line to storage (manual high-piling in 10-box high stacks) 5/	4	22.10	19.04	10.35	21.90	32.25	37.01
Moving packed boxes from storage and loading refrigerator cars (includes blocking out and manifesting	6/ 6	8.28	13.40	5.36	15.41	20.77	24.12
Totals	22	51.91	55.29	29.22	63.59	92.81	106.63
Industrial fork-lift trucks and 48-box pallets							
Unloading unpacked boxes from road trucks and moving into storage (18-box or 3-pallet load high stacks) 11/	2	1.20	1.20	2.58	1.47	4.05	4.35
Moving unpacked boxes from storage to the packing line (pallet loads removed from 3-high stacks) 12/	1	4.67	.67	3.19	.87	4.06	4.22
Moving packed boxes from packing line to storage (15-box or 3-pallet load high stacks) 5/	2	6.10	5.43	3.07	6.34	9.41	10.77
Moving packed boxes from storage and loading refrigerator cars (includes blocking out and manifesting) 13/	6/ 3	4.94	7.69	5.21	9.26	14.47	16.39
Totals	8	16.91	14.99	14.05	17.94	31.99	35.73
Industrial clamp-type lift trucks (24-box capacity--unpacked fruit)							
Unloading unpacked boxes from road trucks and moving into storage (12-box or 2-unit load high stacks) 14/	2	4.29	2.86	2.22	3.50	5.72	6.44
Moving unpacked boxes from storage to the packing line (24-box load removed as unit)	1	4.57	4.57	1.84	5.44	7.28	8.42
Moving packed boxes from packing line to storage (20-box unit loads--10 boxes high) 5/	2	6.31	6.31	2.39	7.49	9.88	11.46
Moving packed boxes out of storage and loading refrigerator cars (includes blocking out and manifesting) 15/	6/ 4	5.49	8.68	4.50	10.37	14.87	17.04
Totals	9	20.66	22.42	10.95	26.80	37.75	43.36

1/ Except as otherwise noted transportation distances have been standardized as follows: (1) Unloading unpacked boxes and moving into storage 100 feet; (2) moving unpacked boxes from storage to the packing line 190 feet; (3) moving packed boxes from the packing line to storage 175 feet; (4) moving packed boxes out of storage and loading refrigerator cars 210 feet by use of industrial trucks and 160 feet by use of other types of equipment. Refrigerator cars are loaded in divided loads which are stripped and braced.

2/ Equipment costs computed from data on ownership and operating costs shown in table 2.

3/ "Current" labor costs computed from wage rates of $1.15 per hour for unskilled labor and $1.30 per hour for semiskilled workers (key workers such as industrial truck operators).

4/ Assumed labor costs computed from wage rates of $1.40 per hour for unskilled labor and $1.55 per hour for semiskilled workers.

5/ Sections of gravity-type roller conveyor are used with all equipment combinations shown for segregating packed boxes of fruit while these boxes are being moved from the packing line to storage.

6/ When blocking out and manifesting are performed simultaneously with loading additional workers would be required. When loads are blocked out prior to loading, these operations are performed by one or more workers from loading crew.

7/ In equipment time and costs, allowance is made for 15 feet of gravity roller conveyor.

8/ Floor chain conveyors are not used for moving packed boxes to storage. Costs and other data shown for performing this cycle of operations cover the use of belt conveyors, gravity-type roller conveyors, and hand trucks.

9/ Vertical transportation distance not included in elevator methods.

10/ Standard transportation distance increased to 150 feet because 50 feet additional distance is involved in moving stacks into and out of two temporary storage blocks or banks.

11/ Boxes received palletized.

12/ Sections of gravity-type roller conveyor used at dumper as accumulator for pallet loads.

13/ Pallet loads released in car door on pallet dollies.

14/ Six-high stacks of boxes hand trucked from road truck bed to receiving platform. Standard transportation distance increased to 110 feet because 10 feet additional distance is involved in use of temporary storage block on platform.

15/ Industrial-clamp trucks are used for loading out refrigerator cars in combination with belt conveyor and gravity-type roller conveyors.

Table 155.—Comparative labor and equipment costs for handling 1,000 boxes of apples through four specified cycles of operations involved by improved methods when moving fruit into, within, and out of storage houses by use of specified types and combinations of types of equipment 1/

Type of equipment and cycles of operations	Workers	Labor and equipment required: Equipment	Labor and equipment required: Labor	Labor and equipment costs: Equipment 2/	Labor and equipment costs: Labor 3/	Total costs: Current wages	Total costs: Assumed wages 4/
	Number	Machine-hours	Man-hours	Dollars	Dollars	Dollars	Dollars
Clamp-type 2-wheel hand trucks and mechanical high-piler							
Unloading unpacked boxes from road trucks and moving into storage (12-box high stacks)	4	4.19	4.19	0.70	4.82	5.52	6.57
Moving unpacked boxes from storage to the packing line (broken out of 12-box high stacks)	3	9.96	7.75	1.49	8.91	10.40	12.34
Moving packed boxes from packing line to storage (mechanical high-piling in 10-box high stacks) 5/	3	19.04	14.28	3.23	16.42	19.65	23.22
Moving packed boxes from storage and loading refrigerator cars (includes blocking out and manifesting)	6/ 7	4.87	11.53	.11	13.26	13.37	16.25
Totals	17	38.06	37.75	5.53	43.41	48.94	58.38
Clamp-type 2-wheel hand trucks, belt conveyors, and mechanical high-piler							
Unloading unpacked boxes from road trucks and moving into storage (12-box high stacks) 7/	7	5.05	7.07	1.53	8.13	9.66	11.43
Moving unpacked boxes from storage to the packing line (broken out of 12-box high stacks)	3	9.65	5.32	4.58	6.12	10.70	12.03
Moving packed boxes from packing line to storage (manual high-piling in 10-box high stacks 5/	2	19.04	9.52	4.37	10.95	15.32	17.70
Moving packed boxes from storage and loading refrigerator cars (includes blocking out and manifesting)	6/ 6	6.44	11.50	1.33	13.22	14.55	17.42
Totals	18	40.18	33.41	11.81	38.42	50.23	58.58
Clamp-type 2-wheel hand trucks, floor chain conveyors, and mechanical high-piler							
Unloading unpacked boxes from road trucks and moving into storage (12-box high stacks)	5	6.30	5.25	1.94	6.04	7.98	9.29
Moving unpacked boxes from storage to the packing line (broken out of 12-box high stacks)	2	9.87	4.36	3.32	5.01	8.33	9.42
Moving packed boxes from packing line to storage (manual high-piling in 10-box high stacks) 5/ 8/	2	19.04	9.52	4.37	10.95	15.32	17.70
Moving packed boxes from storage and loading refrigerator cars (includes blocking out and manifesting)	6/ 5	5.87	10.65	2.69	12.24	14.93	17.59
Totals	14	41.08	29.78	12.32	34.24	46.56	54.00
Clamp-type 2-wheel hand trucks, elevator, and mechanical high-piler 9/							
Unloading unpacked boxes from road trucks and moving into storage (12-box high stacks) 10/	8	11.16	9.92	4.92	11.41	16.33	18.81
Moving unpacked boxes from storage to the packing line (broken out of 12-box high stacks)	3	14.62	8.98	10.67	10.33	21.00	23.24
Moving packed boxes from packing line to storage (manual high-piling in 10-box high stacks) 5/	4	22.10	19.04	10.35	21.90	32.25	37.01
Moving packed boxes from storage and loading refrigerator cars (includes blocking out and manifesting)	6/ 6	8.28	13.40	5.36	15.41	20.77	24.12
Totals	21	56.16	51.34	31.30	59.05	90.35	103.18
Industrial fork-lift trucks and 48-box pallets							
Unloading unpacked boxes from road trucks and moving into storage (18-box or 3 pallet load high stacks) 11/	2	1.28	.96	2.75	1.20	3.95	4.19
Moving unpacked boxes from storage to the packing line (pallet loads removed from 3-high stacks) 12/	1	4.67	.67	3.19	.87	4.06	4.22
Moving packed boxes from packing line to storage (15-box or 3-pallet load high stacks) 5/	2	6.10	5.43	3.07	6.34	9.41	10.77
Moving packed boxes from storage and loading refrigerator cars (includes blocking out and manifesting) 13/	6/ 3	4.94	7.69	5.21	9.26	14.47	16.39
Totals	8	16.99	14.75	14.22	17.67	31.89	35.57
Industrial clamp-type lift trucks (24-box capacity—unpacked fruit)							
Unloading unpacked boxes from road trucks and moving into storage (12-box or 2-unit load high stacks) 14/	2	3.84	2.56	3.14	3.13	6.27	6.91
Moving unpacked boxes from storage to the packing line (24-box load removed as unit) 15/	1	4.57	1.24	2.92	1.61	4.53	4.84
Moving packed boxes from packing line to storage (20-box unit loads—10 boxes high) 5/	2	6.31	6.31	2.39	7.49	9.88	11.46
Moving packed boxes out of storage and loading refrigerator cars (includes blocking out and manifesting) 16/	6/ 4	5.49	8.68	4.50	10.37	14.87	17.04
Totals	9	20.21	18.79	12.95	22.60	35.55	40.25

1/ Except as otherwise noted transportation distances have been standardized as follows: (1) Unloading unpacked boxes and moving into storage 100 feet; (2) moving unpacked boxes from storage to the packing line 190 feet; (3) moving packed boxes from the packing line to storage 175 feet; (4) moving packed boxes out of storage and loading refrigerator cars 210 feet by use of industrial trucks and 160 feet by use of other types of equipment. Refrigerator cars are loaded in divided loads which are stripped and braced.

2/ Equipment costs computed from data on ownership and operating costs shown in table 2.

3/ "Current" labor costs computed from wage rates of $1.15 per hour for unskilled labor and $1.30 per hour for semiskilled workers (key workers such as industrial truck operators).

4/ Assumed labor costs computed from wage rates of $1.40 per hour for unskilled labor and $1.55 per hour for semiskilled workers.

5/ Sections of gravity-type roller conveyor are used with all equipment combinations shown for segregating packed boxes of fruit while these boxes are being moved from the packing line to storage.

6/ When blocking out and manifesting are performed simultaneously with loading additional workers would be required. When loads are blocked out prior to loading, these operations are performed by one or more workers from loading crew.

7/ In equipment time and costs, allowance is made for 15 feet of gravity roller conveyor.

8/ Floor chain conveyors are not used for moving packed boxes to storage. Costs and other data shown for performing this cycle of operations cover the use of belt conveyors, gravity-type roller conveyors, and hand trucks.

9/ Vertical transportation distance not included in elevator methods.

10/ Standard transportation distance increased to 150 feet because 50 feet additional distance is involved in moving stacks into and out of two temporary storage blocks or banks.

11/ Boxes received palletized. Standard transportation distance increased to 110 feet because pallet loads are unloaded to apron in temporary block, later removed to storage.

12/ Sections of gravity-type roller conveyor used at dumper as accumulator for pallet loads.

13/ Pallet loads released in car door on pallet dollies.

14/ Road truck bed stabilized by use of hydraulic unit.

15/ 24-box unit loads released on floor chain accumulator behind dumper.

16/ Industrial-clamp trucks are used for loading out refrigerator cars in combination with belt conveyor and gravity-type roller conveyors.

1,000 boxes, and (2) belt conveyors and hand trucks with costs of $60.28 per 1,000 boxes. When the improved methods are used these costs are respectively reduced to $90.35 and $50.23.

In the smaller one-floor plants where the annual hours of use of equipment might be less than those shown in table 2 and where transportation distances might be shorter than the standard distances used for analytical purposes, clamp-type 2-wheel hand trucks should be about as efficient as industrial trucks. Labor and equipment costs by use of hand trucks are $56.03 per 1,000 boxes when the common methods are used and $48.94 when improved methods are employed. These costs are significantly above the industrial truck costs but this difference could be narrowed considerably by shorter transportation distances.

Conversely, for longer distances than those used for analytical purposes, the relative advantage of industrial trucks would increase. Moreover, in the event of increases in wage rates, industrial trucks would become relatively more efficient.

Obviously handling costs could be reduced if some of the pre-shipment storage operations (for both unpacked and packed boxes) could be eliminated. Table 156 shows comparative labor and equipment costs by use of the six combinations of equipment when apples are moved directly to the packing line. Apples can be received directly to the packing line from orchard trailers, by use of sections of gravity-type roller conveyor, and loaded into refrigerator cars directly from the packing line, by use of belt conveyors and gravity-type roller conveyors, for $13.50 per 1,000 boxes. However, the elimination of all storage operations is possible only for the early varieties and then only to a limited extent.

Packing all or most of the apples as they are received also is desirable from the viewpoint of reducing handling costs. By use of most of the combinations of equipment fruit can be received to the packing line at about the same costs incurred in receiving to storage. Receiving directly to the line therefore eliminates the costs involved in moving it from storage to the line. However, as previously pointed out,receiving directly to the packing line also has its disadvantages which in many plants offset the savings in handling costs.

In multiple-story plants belt conveyors and 2-wheel hand trucks are the most efficient types of equipment unless plant can be renovated to permit use of industrial trucks. Plants that have elevators should find that the use of light weight industrial-clamp trucks would materially reduce handling costs. By use of elevators, these trucks could be moved from floor to floor and permit considerable flexibility in their use.

Figure 132 shows an industrial-clamp truck operating in an older building. However, ceiling heights and floor structures may determine

Table 156.--Comparative labor and equipment costs for handling 1,000 boxes of apples through three specified cycles of operations involved in moving fruit into, within, and out of storage houses by use of specified types and combinations of types of equipment 1/

Type of equipment and cycles of operations	Workers	Labor and equipment required: Equipment	Labor and equipment required: Labor	Labor and equipment costs: Equipment 2/	Labor and equipment costs: Labor 3/	Total costs: Current wages	Total costs: Assumed wages 4/
	Number	Machine-hours	Man-hours	Dollars	Dollars	Dollars	Dollars
Clamp-type 2-wheel hand trucks and mechanical high-piler							
Unloading and moving apples directly to the packing line	3	5.35	5.35	0.13	6.15	6.28	7.62
Moving packed boxes from packing line to storage (mechanical high-piling in 10-box stacks) 5/	3	19.04	14.28	3.23	16.42	19.65	23.22
Moving packed boxes from storage and loading refrigerator cars (includes blocking out and manifesting)	6/7	4.87	11.53	.11	13.26	13.37	16.25
Totals	13	29.26	31.16	3.47	35.93	39.30	47.09
Clamp-type 2-wheel hand trucks, belt conveyors and mechanical high-piler							
Unloading and moving apples directly to the packing line	3	8.32	4.99	.95	5.74	6.69	7.94
Moving packed boxes from packing line to storage (manual high-piling in 10-box high stacks) 5/	2	19.04	9.52	4.37	10.95	15.32	17.70
Moving packed boxes from storage and loading refrigerator cars (includes blocking out and manifesting)	6/6	6.44	11.50	1.33	13.22	14.55	17.42
Totals	11	33.80	26.01	6.65	29.91	36.56	43.06
Clamp-type 2-wheel hand trucks, floor chain conveyors and mechanical high-piler							
Unloading and moving apples directly to the packing line 7/	2	5.66	2.33	3.92	2.68	6.60	7.18
Moving packed boxes from packing line to storage (manual high-piling in 10-box high stacks) 5/	2	19.04	9.52	4.37	10.95	15.32	17.70
Moving packed boxes from storage and loading refrigerator cars (includes blocking out and manifesting)	6/5	5.87	10.65	2.69	12.24	14.93	17.59
Totals	9	30.57	22.50	10.98	25.87	36.85	42.47
Clamp-type 2-wheel hand trucks, elevator and mechanical high-piler 8/							
Unloading and moving apples directly to the packing line 9/	3	5.35	5.35	.13	6.15	6.28	7.62
Moving packed boxes from packing line to storage (manual high-piling in 10-box high stacks) 5/	4	22.10	19.04	10.35	21.90	32.25	37.01
Moving packed boxes from storage and loading refrigerator cars (includes blocking out and manifesting)	6/6	8.28	13.40	5.36	15.41	20.77	24.12
Totals	13	35.73	37.79	15.84	43.46	59.30	68.75
Industrial fork-lift trucks and 48-box pallets							
Unloading and moving apples directly to the packing line 10/	2	1.52	1.21	3.27	1.51	4.78	5.08
Moving packed boxes from packing line to storage (15-box or 3-pallet load high stacks) 5/	2	6.10	5.43	3.07	6.34	9.41	10.77
Moving packed boxes from storage and loading refrigerator cars (includes blocking out and manifesting) 11/	6/3	4.94	7.69	5.21	9.26	14.47	16.39
Totals	7	12.56	14.33	11.55	17.11	28.66	32.24
Industrial clamp-type lift trucks (24-box capacity--unpacked fruit)							
Unloading and moving apples directly to the packing line	2	4.93	4.93	1.96	5.79	7.75	8.98
Moving packed boxes from packing line to storage (20-box unit loads--10-boxes high) 5/	2	6.31	6.31	2.39	7.49	9.88	11.46
Moving packed boxes out of storage and loading refrigerator cars (includes blocking out and manifesting) 12/	6/2	5.49	8.68	4.50	10.37	14.87	17.04
Totals	6	16.73	19.92	8.85	23.65	32.50	37.48

1/ Except as otherwise noted transportation distances have been standardized as follows: (1) Unloading and moving apples directly to the packing line 70 feet; (2) moving packed boxes from the packing line to storage 175 feet; (3) moving packed boxes out of storage and loading refrigerator cars 210 feet by use of industrial trucks and 160 feet by use of other types of equipment. Refrigerator cars are loaded in divided loads which are stripped and braced.

2/ Equipment costs computed from data on ownership and operating costs shown in table 2.

3/ "Current" labor costs computed from wage rates of \$1.15 per hour for unskilled labor and \$1.30 per hour for semiskilled workers (key workers such as industrial truck operators).

4/ Assumed labor costs computed from wage rates of \$1.40 per hour for unskilled labor and \$1.55 per hour for semiskilled workers.

5/ Sections of gravity-type roller conveyor are used with all equipment combinations shown for segregating packed boxes of fruit while these boxes are being moved from the packing line to storage.

6/ When blocking out and manifesting are performed simultaneously with loading additional workers would be required. When loads are blocked out prior to loading, these operations are performed by one or more workers from loading crew.

7/ Transportation distance increased to 170 feet (70 feet by hand truck, 100 feet by floor chain conveyor).

8/ Vertical transportation distance not included in elevator methods.

9/ Elevators are not used for this operation.

10/ Boxes received palletized.

11/ Pallet loads released in car door on pallet dollies.

12/ Industrial-clamp trucks are used for loading out refrigerator cars in combination with belt conveyor and gravity-type roller conveyors.

whether or not industrial-clamp trucks can be used in an existing plant. Plant renovation must be considered in connection with the use of industrial trucks in older buildings.

It is possible that the efficiency of handling operations in multiple-story plants can be increased by using industrial trucks to elevate fruit to upper floors and using light weight trucks to move fruit to storage. The possibility will be explored in a subsequent report, which will cover innovations in apple handling methods and equipment.

When labor is plentiful and only a small investment in equipment is to be made, the hand-truck method of handling is most practical. However, hand trucks are not adapted to larger sized plants because transportation

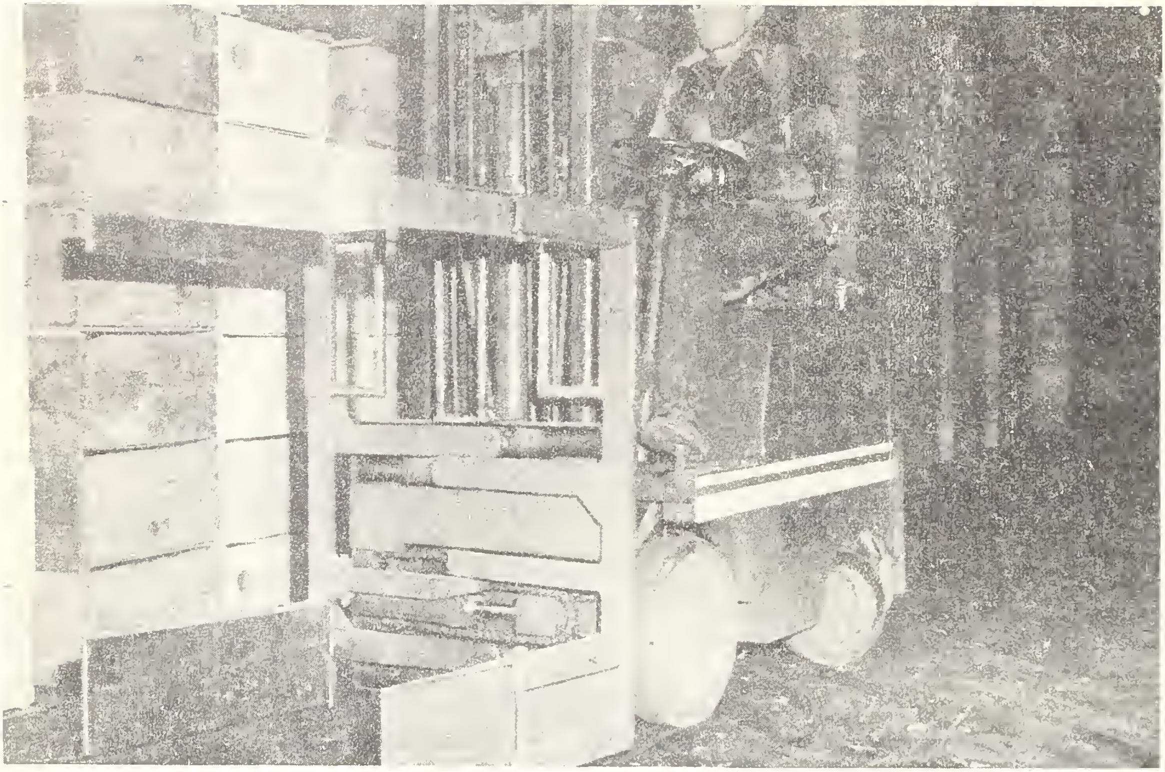

Figure 132.--An industrial clamp truck being used in an older building.

distances become too great. Generally, the scarcity of labor during the harvest season makes it inadvisable to construct plants equipped with hand trucks.

The industrial-clamp truck appears to have definite advantages over the fork-lift truck and pallets. When pallet costs are included, capital costs are less for the industrial-clamp-truck operation. Data shows that the 24-box industrial-clamp truck operated at approximately the same efficiency as the 48-box fork-lift truck. The 36-box clamp truck should be more efficient than a 48-box pallet operation. More extensive remodeling must be done usually to convert a conventional plant to a fork-lift-truck operation than to industrial-clamp-truck operation. For that reason, in a plant-remodeling program it undoubtedly would be proportionately more desirable to use the clamp-type lift truck. However, when new storage facilities are being constructed other factors should be taken into consideration.

The industrial-clamp truck can stack boxes efficiently only 12 boxes high. 48/ The fork-lift truck can efficiently tier three high or

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48/ It is possible with use of top pallet or tying type pallet that industrial-clamp trucks could tier 3 high.

18 boxes high. The cost of constructing a plant probably is less on a per box basis for a plant tiering 3 high than for a plant tiering 2 high. Therefore, part of the decision as to whether clamp trucks or fork-lift trucks should be used depends upon the construction costs of new storage facilities.

Another important consideration is that the elapsed time to unload with the larger industrial fork-lift truck is notably less than the small industrial-clamp truck. Elapsed time is especially important in receiving because it is desirable that trucks not be held long at the plants.

A possible additional factor that might enter into the decision to use industrial fork-lift trucks or clamp trucks hinges on the growing use of cartons. It is difficult to store cartons higher than two tiers, which means that in the future it might be desirable to construct storage plants for two-tier operations.

APPENDIX

Washington State Apple Packing and Storage Plants in Which Research was Conducted

Allen Brothers, Naches
Brewster Cooperative Growers, Brewster
Cashmere Fruit Growers, Cashmere
Congdon Orchards, Yakima
Cowiche Growers, Cowiche
Cubberly, F. H., Fruit Company, Tieton
Forney Fruit and Produce Company, Yakima
Garretson, Lloyd, Company, Yakima
Gilbert Orchards, Wiley City
Hi-Line Growers, Westbrook
Karr Warehouse, Yakima
Lake Chelan Fruit Growers, Wenoka House, Chelan
Larabee Packing Company, Tonasket
Mahre Brothers, Gromore
Methow Valley Growers Service, Incorporated, Pateros
Monitor Federated Growers, Monitor
Ninth Street Skookum, Wenatchee
Okanogan Cooperative Growers, Okanogan
Okanogan Growers Union, Okanogan
Oroville United Growers, Oroville
Pacific Fruit and Produce, Yakima
Perham Fruit Corporation, Tieton
Peshastin Fruit Growers, Peshastin
Prentice Packing and Cold Storage Company, Westbrook
Ranier Fruit Company, Yakima
Scogin Orchards, Yakima
Snow King Orchards, Tieton
Thorndyke and Sons, Oroville
Tonasket Ellisforde Growers, Tonasket
Wenatchee-Wenoka Growers, Wenatchee
Yakima Fruit Growers Association, Wapato
Yakima Fruit Growers Association, Weikel

Equipment Manufacturers and Distributors Who Cooperated in Research

Air-Mack Equipment Company, Seattle, Wash.
Clark Equipment Company, Grand Rapids, Mich.
Food Machinery Corporation, Yakima, Wash.
Grand Specialties Company, Chicago, Ill.
Materials Handling Company, Seattle, Wash.
Mathews Conveyor Company, San Carlos, Calif.

Preston Faller Company, Seattle, Wash.
Transitier Truck Company, Portland, Ore.
Van Doren Machine Shops, Wenatchee, Wash.
Youngs' Iron Works, Seattle, Wash.

Equipment Costs

In order to make comparisons between different types of equipment for performing the various cycles of operations in apple packing and storage houses, it was necessary to arrive at an hourly cost figure for each of the types of equipment included in the study. These figures were applied against the machine-hours required in performing the different operations. The product of the machine-hours times the hourly cost of the equipment gives the equipment cost for the operation. Tables 157 to 160 are self-explanatory and show the basis for the development of the hourly cost for each type of equipment.

Table 157.—Yearly taxes per $1,000 of acquisition cost of equipment used in operating apple packing and storage plants in Washington State, 1952 1/

Location	Assessed valuation 2/	Levy per $1,000 per assessed value 3/	Annual tax per $1,000 of acquisition
	Dollars	Dollars	Dollars
Municipal	242.80	46.00	11.16
Rural	242.80	39.00	9.47
Average	242.80	44.00	10.68

1/ Acquisition prices are interpreted as fair replacement costs.
2/ Assessed valuation equals 35 percent of acquisition price for the first 2 years, 20 percent for the next 5 years. $242.80 is average yearly assessed valuation per $1,000 of acquisition price for 7 years.
3/ Levies will vary as a result of special circumstances in the immediate area.
Source: Office of Yakima County Assessor.

Table 158.—Yearly insurance premium per $1,000 of appraised value of warehouse and equipment for Washington State apple packing and storage plants 1/

Location	Range	Construction	Fire area	Insurable value	Premium per $100 insurable value	Premium per $1,000 appraisal value
				Dollars	Dollars	Dollars
Central municipal	minimum	reinforced concrete	protected industrial	900.00	0.50	4.50
	mode	masonry and wooden	protected industrial	900.00	.75	6.75
	maximum	frame	protected industrial	900.00	1.15	10.35
Rural agricultural	minimum	reinforced concrete	unprotected agricultural	900.00	1.00	9.00
	mode 2/	masonry and wooden	unprotected agricultural	900.00	1.20	10.80
	maximum 3/	frame	unprotected agricultural	900.00	1.75	15.75

1/ Appraised value is the valuation placed by independent appraisers. This valuation is of special benefit in placing a value on older plants and equipment as it considers replacement, not new cost, and takes into consideration condition and age. 90 percent of the current appraised value is equal to the insured value. 80 percent of the appraised value is equal to the maximum recovery.

2/ A number of plants of conventional construction had rates of around $1.50. The figure of $1.20 is the result of most rural plants being grouped in small communities.

3/ This plant is a ranch structure located in the orchard and of frame construction.

Source: Advisory rates by Washington State Surveying and Rating Bureau.

Table 159.—Insurance premium on industrial trucks in use in Washington State apple packing and storage plants 1/

Term of policy	Acquisition price	Insurable value	Premium per $100 insurable value	Premium per $1,000 acquisition price	Premium per year per $1,000 acquisition price
	Dollars	Dollars	Dollars	Dollars	Dollars
1 year	1,000	900	1.00	9.00	9.00
3 years	1,000	900	2.87	25.83	8.61

1/ Most of the industrial truck insurance policies are written on separate riders covered by automotive insurance companies. The 3-year policy is not as advantageous as it appears because the amount recoverable decreases each year. The same factor in the 1-year term policies would be represented by less insurable value and a reduction in premium.

Table 160.—Cost of ownership and operation of various types of materials-handling equipment used in apple packing and storage plants, 1952

Type of equipment	Amount of equipment	Initial cost 1/	Years depreciation	Assumed use per year	Ownership cost per year: Depreciation	Ownership cost per year: Interest at 5 percent	Ownership cost per year: Insurance and taxes at 2 percent	Ownership cost per year: Total	Operation cost per year: Gas, oil, and electricity 2/	Operation cost per year: Maintenance	Operation cost per year: Total	Total ownership and operating cost: Cost per year	Total ownership and operating cost: Per hour of use
		Dollars	Number	Hours	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars
Clamp-type 2-wheel hand truck	one	74.10	20	400	3.70	1.85	1.48	7.03		2.50	2.50	9.53	0.024
Belt conveyor (100 feet)													
Belting ($2.30 per foot)	205 feet	471.50	15		31.43								
Dip and load section	one	99.75	25		3.99								
Curved end section	one	49.75	25		1.99								
Motor	one	222.00	25		8.88								
Drive	one	142.50	25		5.70								
Idle ends	two	83.00	25		3.32								
Floor supports	nine	54.00	25		2.16								
Roller sections	ten	395.00	25		15.80								
Installation (5 percent)		75.87			3.03								
Total		1,593.37	15-25	200	76.30	39.83	31.86	147.99	4.00	15.00	19.00	166.99	0.83
Floor chain conveyor (100 feet)													
Chain	200 feet	1,650.00											
Drive	one	780.00											
Idle ends	one	162.00											
Installation (10 percent)		259.00											
Freight		67.00											
Total		2,918.00	15	300	194.53	72.95	58.36	325.84	6.00	15.00	21.00	346.84	1.16
Roller conveyor (100 feet)													
Sections	ten	325.00											
Floor supports	eleven	55.00											
90° curve	one	35.75											
Freight		76.50											
Total		492.25	15	200	32.85	12.31	9.84	55.00		1.50	1.50	56.50	0.28
Portable mechanical lift													
Machine	one	600.00	10		60.00								
Batteries	four	80.00	2		40.00								
Total		680.00	2-10	300	100.00	17.00	13.60	130.60			3/ 46.85	177.45	0.59
Industrial clamp truck (800-pound capacity—gas—12-box load)													
Machine	one	1,080.00											
Freight		72.00											
Total		1,152.00	10	250	115.20	28.80	23.04	167.04	34.00	30.00	64.00	231.04	0.92
Stackmaker 4/													
Machine	one	2,500.00	15	150	166.67	62.50	50.00	279.17	2.25	5/ 20.00	22.25	301.42	2.01
Stackbreaker 6/													
Machine	one	2,000.00	15	7/ 350	133.33	50.00	40.00	223.33	5.25	5/ 20.00	25.25	248.58	.71
Elevator 8/	one	13,375.00	20	400	668.75	334.37	267.50	1,270.62	5.00	10.00	15.00	1,235.62	3.21
Booster to accelerate packed boxes going into refrigerated car 9/													
Motor	one	100.00											
Labor and material		300.00											
Total		400.00	15	200	26.67	10.00	8.00	44.67	2.00	20.00	22.00	66.67	0.33
Hydraulic device to stabilize road truck bed 10/													
Hydraulic units	one	850.00											
Motor	one	100.00											
Switch and wiring		100.00											
Installation		100.00											
Total		1,150.00	15	150	76.67	28.75	23.00	128.42	11/ 0.20	9.80	10.00	138.42	0.92
Innovation to stabilize road truck bed 12/													
Material		20.00											
Labor		30.00											
Total	one	50.00	15	150	3.33	1.25	1.00	5.58				5.58	0.04
Industrial clamp-type lift truck (1,000-pound capacity—gas—24-box load)													
Machine	one	2,227.00											
Clamp	one	627.00											
Freight		178.00											
Total		3,032.00	10	400	303.20	75.80	60.64	439.64	124.00	88.00	13/ 212.00	651.64	1.63
Industrial clamp-type lift truck (1,000-pound capacity—electric—24-box load)													
Machine	one	2,472.00	20		123.60								
Clamp	one	627.00	20		31.35								
Battery	one	762.00	7½		101.60								
Charger	one	450.00	20		22.50								
Freight		182.00			9.10								
Total		4,493.00	7½-20	400	288.15	112.32	89.86	490.33	14/	14/	76.00	566.33	1.42
Industrial clamp-type lift truck (2,000-pound capacity—gas—36-box load)													
Machine	one	2,641.00											
Clamp	one	627.00											
Freight		292.00											
Total		3,560.00	10	400	356.00	89.00	71.20	516.20	131.50	80.50	212.00	728.20	1.82
Industrial clamp-type lift truck (2,000-pound capacity—electric—36-box load)													
Machine	one	3,567.00	20		178.35								
Clamp	one	627.00	20		31.35								
Battery	one	1,092.00	7½		145.60								
Charger	one	450.00	20		22.50								
Freight		328.00			16.40								
Total		6,064.00	7½-20	400	394.20	151.60	121.28	667.08	38.00	38.00	76.00	743.08	1.86

See footnotes at end of table.

Continued -

Table 160.—Cost of ownership and operation of various types of materials-handling equipment used in apple packing and storage plants, 1952 - Continued

Type of equipment	Amount of equipment	Initial cost 1/	Years depreciation	Assumed use per year	Ownership cost per year: Depreciation	Ownership cost per year: Interest at 5 percent	Ownership cost per year: Insurance and taxes at 2 percent	Ownership cost per year: Total	Operation cost per year: Gas, oil, and electricity 2/	Operation cost per year: Maintenance	Operation cost per year: Total	Total ownership and operating cost: Cost per year	Total ownership and operating cost: Per hour of use
		Dollars	Number	Hours	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars
Industrial fork-lift truck (2,000-pound capacity—gas—36-box load) 15/													
Machine	one	16/ 2,741.00											
Freight		292.00											
Total		3,033.00	10	400	303.30	75.82	60.66	439.78	131.50	80.50	212.00	651.78	1.63
Industrial fork-lift truck (2,000-pound capacity—electric—36-box load) 15/													
Machine	one	16/ 3,667.00	20		183.35								
Battery	one	1,092.00	7½		145.60								
Charger	one	450.00	20		22.50								
Freight		328.00			16.40								
Total		5,537.00	7½-20	400	367.85	138.42	110.74	617.01	38.00	38.00	76.00	693.01	1.73
Industrial fork-lift truck (4,000-pound capacity—gas—48-box load)													
Machine	one	3,598.00											
Freight		444.00											
Total		4,042.00	10	400	404.20	101.05	80.84	586.09	165.00	91.00	256.00	842.09	2.10
Industrial fork-lift truck (4,000-pound capacity—electric—48-box load)													
Machine	one	4,729.00	20		236.45								
Battery	one	1,397.00	7½		186.27								
Charger	one	690.00	20		34.50								
Freight		455.00			22.75								
Total		7,271.00	7½-20	400	479.97	181.77	145.42	807.16	48.05	55.95	104.00	911.16	2.28
Low-lift pallet transporter (4,000-pound capacity—electric—48-box load) 17/													
Machine	one	1,326.00	20		66.30								
Battery	one	289.00	7½		38.53								
Charger	one	345.00	20		17.25								
Freight		137.00	20		6.85								
Total		2,097.00	7½-20	200	128.93	52.42	41.94	223.29	14/	14/	76.00	299.29	1.50
Dunnage strips used between industrial clamp truck unit loads to stabilize stacks in storage (24-box loads—2-loads high) 1 inch by 4 inches by 2-foot strips for 1,000 boxes at $50.00 per 1,000 board feet	41.6 bd. ft.	2.08	5	18/ 4.69	0.42	0.05	0.04	0.51				0.51	0.11
Pallets—36-box (36 inches by 40 inches) Pallets for 1,000 boxes at $2.80	27.8	77.84	15	18/ 4.74	5.19	1.95	1.56	8.70		0.46	19/ 0.46	9.16	1.93
Pallets—48-box (40 inches by 48 inches) Pallets for 1,000 boxes at $3.00	20.8	62.70	15	18/ 3.64	4.18	1.57	1.27	7.02		0.35	19/ 0.35	7.37	2.02
Pallet dolly for loading out Dolly	one	42.85	5	200	8.57	1.07	0.86	10.50		1.00	1.00	11.50	0.06

1/ Based on cost in Washington State.
2/ Average costs in the industry—gasoline at $0.25 a gallon, oil at $0.40 a quart, electricity at $0.01 a kilowatt hour.
3/ Operation costs cover recharging storage battery after every 2 hours of use for stacking, after every 8 hours for breaking out high-piled boxes, at rate of $0.50 per battery charge (150 hours stacking, 150 hours stackbreaking). This cost may be reduced if a plant installs its own charger.
4/ Machine builds single boxes into 6-high stacks of boxes.
5/ Cost may be reduced with improved models.
6/ Machine breaks down 6-high stacks of boxes to single boxes.
7/ Relatively large number of hours because machine breaks stacks for packing line.
8/ Eight-thousand pound capacity, lift 40 feet, 10 horsepower motor, push button "dead man" control, lift speed 20 feet per minute, platform 8 by 10 feet.
9/ Made by plant, not available commercially. Used instead of a man to push boxes on a roller conveyor from the doorway to the ends of a refrigerator car.
10/ A hydraulic unit which holds truck bed solid against a loading dock and allows industrial equipment to operate on truck bed.
11/ Electric motor runs only part of the time that the hydraulic dock is in use.
12/ Made by plant. Metal frame wedge projecting from the loading dock. As truck is backed up, the metal frame pries the end of truck bed to an even height with loading dock to allow industrial equipment to operate on road truck bed. (Will usually operate properly with only the one or two road trucks it is made for.)
13/ The operation cost for this 1,000-pound gasoline powered industrial clamp-type lift truck appears high compared to the 2,000-pound and 4,000-pound machines. Costs taken from plant using two 1,000-pound lift trucks over period of 4 years.
14/ No actual costs available; taken from 2,000-pound electric industrial lift trucks.
15/ Recently there has been a trend toward buying the 4,000-pound capacity fork truck in 36-box pallet plants which tier pallets 3 high, because extra lift height must be added to the standard 2,000-pound model. The additional cost of about $100 between the 4,000-pound and 3,000-pound model makes the jump to 4,000-pound trucks worthwhile to most operators.
16/ One hundred dollars added for extra lift necessary.
17/ Operator walking type.
18/ Estimated hours of use arrived at by counting the time during which the pallets or dunnage strips are being handled, based on the number of hours of work required per 1,000 boxes in all phases of handling. (Storage time not considered.)

	Receiving to storage	Storage to line	Line to storage	Storage to shipping out	Miscellaneous (culls, empty boxes, etc.)	Total man-hours per 1,000 boxes
Dunnage strips	1.04	1.13	1.48	1.04	-	4.69
36-box pallet	.72	.78	.85	.81	1.58	4.74
48-box pallet	.55	.62	.63	.63	1.21	3.64

19/ Maintenance at $0.25 per pallet life.

Standard Data

Fatigue allowances for performing various jobs in apple packing and storage houses

Job	Fatigue allowance Percent
Manual stacking of boxes on to or off of orchard trailers and road trucks	20
Handling empty pallets	20
Jacking stacks of boxes into position on pallets in a railroad car	10
Manual unloading of boxes from orchard trailers and road trucks to belt conveyor and pallets or hand stacking loads for a hand truck	20
Manual stacking boxes on to or off of a belt conveyor	20
Manual high-piling 10, 11 or 12 high	25
Manual high-piling 9 high	20
Manual breaking out high-piled boxes from 10, 11 or 12-high stacks	20
Manual breaking out high-piled boxes from 9-high stacks	15
Operating a mechanical high-piler in high-piling or breaking down high-piled boxes	10
Manual stacking boxes in loading out	20
Manual stripping of a carload with lath	10
Hand trucking boxes of apples or empty boxes	10
Moving fruit by industrial fork-lift truck or industrial clamp truck	5

Average labor requirements per 1,000 unpacked boxes of apples for set up and clean up before and after unloading road trucks and orchard trailers by use of various types of equipment at apple packing and storage plants 1/

	Labor required Man-hours
Unloading road truck by use of hand trucks:	
Hand truck crew:	
Set up: Begins when ropes holding boxes on trucks are released. Consists of removing ropes, end gate or V-boards 2/, and center tie ropes, placing bridge-plate, and getting hand truck. Ends when hand trucker begins to take stacks from road truck bed.	0.07

See footnotes at end of tabulation

Continued -

	Labor required Man-hours
Clean up: Begins when hand trucks placed in a storage area. Consists of removing bridgeplate, placing end gate or V-boards on truck bed, and adjusting tie ropes. Ends when road truck is free to leave receiving area.	0.05
Unloading road truck by use of belt conveyors and hand trucks:	
Truck crew:	
Set up: Begins when hold ropes are released. Consists of removing hold ropes, end gate or V-boards, and center tie ropes, and positioning extensions. Ends when worker begins to place boxes on belt conveyor.	.09
Clean up: Begins when worker picks up extensions. Consists of removing extensions, placing end gate or V-boards on truck bed, and adjusting tie ropes. Ends when road truck is free to leave receiving area.	.07
Warehouse crew:	
Set up: Begins when worker starts belt conveyor. Consists of waiting for boxes to arrive in work area on belt conveyor. Ends when worker begins to stack boxes off belt conveyor.	.13
Clean up: Begins when last box is off belt conveyor. Consists of stopping belt conveyor. Ends when belt conveyor stops.	.01
Hand truck crew:	
Set up: Begins when belt conveyor starts. Consists of hand trucker bringing hand truck to work area and waiting for first stack. Ends when hand trucker begins to take stack from work area.	.13
Clean up: Begins when last stack is placed in storage. Consists of placing hand truck in storage area. Ends when hand trucker leaves his hand truck.	.01

See footnotes at end of tabulation

Continued -

	Labor required Man-hours
Unloading orchard trailer by hand trucks or belt conveyors and hand trucks:	
Truck crew:	
Set up: Begins when tractor operator walks to trailer. Consists of walking to trailer and positioning himself on trailer bed. Ends when first box is picked up.	0.05
Clean up: Begins when last box is stacked off field trailer. Consists of walking to tractor. Ends when tractor engine starts.	.05
Warehouse crew:	
Set up: Begins when worker starts belt conveyor. Consists of waiting for boxes to arrive in work area on belt conveyor. Ends when worker begins to stack boxes off belt conveyor.	.13
Clean up: Begins when last box is off belt conveyor. Consists of stopping belt conveyor. Ends when belt conveyor stops.	.01
Hand truck crew:	
Set up: Begins when belt conveyor starts. Consists of hand trucker bringing hand truck to work area and waiting for first stack. Ends when hand trucker begins to take stack from work area.	.13
Clean up: Begins when last stack is placed in storage. Consists of placing hand truck in storage area. Ends when hand trucker leaves his hand truck.	.01

1/ Set up consists of labor required to prepare road truck or orchard trailer for unloading at warehouse. Clean up consists of labor required to prepare road truck or orchard trailer for return to the orchard. Labor requirements cover 288 boxes per road truckload and 144 boxes per orchard trailer.

2/ Two boards held together and parallel by straps of leather. Boards folded in shape of a V and are used to hold stacks of boxes in place on the road truck bed.

Average labor requirements per 1,000 unpacked boxes of apples for set up and clean up before and after unloading road trucks and orchard trailers by use of industrial clamp type or fork-lift trucks at apple packing and storage plants 1/

	Labor required Man-hours
Unloading road truck by use of industrial clamp truck:	
Set up: Begins when tie ropes are released. Consists of removing tie ropes, V-boards 2/, and stabilizing truck bed by activating a hydraulic unit. Ends when truck bed is held rigidly in place.	0.09
Clean up: Begins when V-boards are picked up. Consists of adjusting tie ropes and V-boards on truck bed, and releasing hydraulic unit. Ends when hydraulic unit is depressed and truck is free to move away from dock.	.06
Unloading orchard trailer by use of industrial clamp truck:	
Set up: Begins when tractor operator walks to trailer. Consists of walking to trailer and positioning himself on trailer bed. Ends when first box is picked up.	.05
Clean up: Begins when last box is stacked off field trailer. Consists of walking to tractor. Ends when tractor engine starts.	.05
Unloading road truck by fork-lift truck:	
Set up: Begins when tie ropes are released. Consists of removing tie ropes and V-boards. Ends when ropes and boards are positioned under road truck.	3/ .08
Clean up: Begins when V-boards are picked up. Consists of adjusting tie ropes and V-boards on truck bed. Ends when road truck is free to leave receiving area.	3/ .05
Unloading orchard trailer by fork-lift truck:	
Unpalletized field trailer 4/	

See footnotes at end of tabulation

Continued -

	Labor required Man-hours
Set up: Begins when tractor operator gets first pallet. Consists of carrying pallets to trailer and positioning pallets around trailer. Ends when last pallet is positioned.	0.19
Clean up: Begins when last box is stacked off field trailer. Consists of walking to tractor. Ends when tractor engine starts.	.05
Unpalletized field trailer 5/:	
Set up: Begins when fork-lift truck picks up pallets. Consists of fork-lift truck moving pallets to trailer, fork-lift truck placing pallets around trailer and tractor operator positioning pallets. Ends when last pallet is positioned.	.12
Clean up: Begins when last box is stacked off field trailer. Consists of walking to tractor. Ends when tractor engine starts.	.05
Partly palletized field trailer 4/:	
Set up: Begins when tractor operator walks to trailer. Consists of walking to trailer and positioning himself on trailer bed. Ends when first box is picked up.	.05
Clean up: Begins when last box is stacked off field trailer. Consists of walking to tractor. Ends when tractor engine starts.	.05
Completely palletized field trailer 4/:	
Set up: Begins when tractor operator walks to trailer. Consists of removing tie ropes and V-boards. Ends when V-boards are positioned under trailer.	.18
Clean-up: Begins when tractor operator picks up V-boards. Consists of adjusting tie ropes and V-boards on trailer bed. Ends when tractor engine starts.	.05

See footnotes at end of tabulation

Continued -

Footnotes to tabulation

1/ The set up consists of time taken to prepare road truck or field trailer for unloading at the warehouse; the clean up consists of time taken to prepare road truck or field trailer for return to orchard. These times are applicable to the unloading of all trucks when industrial clamp trucks or fork-lift trucks are used regardless of capacity.

2/ V-boards are two boards held together parallel by straps of leather. Boards folded in shape of a V and are used to hold stacks of boxes in place on the road truck bed.

3/ When tie ropes across the width of the truck bed are used in addition to the two ropes running the length normally used to secure the loads the respective set up and clean up times amount to 0.14 man-hour and 0.06 man- hour.

4/ The tractor operator performs all the set up and clean up work, including moving pallets to trailer when needed.

5/ The fork-lift truck does most of the work in distributing pallets. Tractor operator merely adjusts pallets.

Note: Times recorded are for a 1-man crew. However, the man-hours per 1,000 boxes for a larger crew would be the same as the 1-man crew, if the men worked independently and did not unavoidably interfere with one another. Times assume 288 boxes per truckload.

Comparative labor requirements per 1,000 unpacked boxes of apples for performing selected operations associated with unloading from orchard trailers and road trucks at apple packing and storage plants

Description of operation 2/:	Labor required 1/ Man-hours
Hand stack boxes from trailer to belt conveyor. Boxes lifted from position on trailer to belt conveyor.	1.18
Hand stack boxes 3 to 6 high on trailer bed for hand truckers.	.97
Hand stack boxes 6 high on pallets placed beside trailer on apron. Worker stacks most of the boxes on each pallet while standing on the ground. Boxes in the middle of the trailer are swung to the partially loaded pallets by the worker standing on the trailer bed. 3/	1.49
Hand stack boxes to pallets when load is partially palletized. Usually about half of the boxes on the trailer are resting on pallets which are staggered on the trailer bed. The remainder of boxes are	

See footnotes at end of tabulation.

Continued -

	Labor required 1/ Man-hours
stacked on the pallet at the receiving area. (Fork truck may remove the partially loaded pallets and place them beside the trailer for more convenient stacking by worker.) 3/	0.84
Hand stack boxes from a road truck to a belt conveyor. Boxes lifted from position on the truck bed to belt or roller conveyor.	
One-man crew.	1.09
Two-man crew. 4/	1.28
Hand stack boxes from a road truck to a pallet resting on the platform. The stacker gets pallet and places it near the end of the truck bed. Each box handled individually and placed on pallet. As room is made on the truck bed, pallets are placed near the end of the truck bed. 3/	2.15

1/ Labor shown is for one worker unless otherwise noted; however, the man-hours per 1,000 boxes for a larger crew would be the same as for one worker if the crew members worked independently and did not interfere with one another.

2/ Hand stacking begins when worker starts to move first box and ends when last box has been released.

3/ Either 36-or 48-box pallet loads.

4/ Greater time for a 2-man crew is due to interference at point where boxes are placed on the belt.

Comparative labor requirements for a warehouse crew to stack 1,000 unpacked or packed boxes of apples on to and off of a belt or roller conveyor at apple packing and storage plants

Description of operation 2/:	Labor required 1/ Man-hours
Lift boxes of unpacked fruit from their position in stack and place on conveyor. 3/	
Stack beside conveyor in single row.	0.90

See footnotes at end of tabulation

Continued -

	Labor required 1/ Man-hours
Stack beside conveyor in double row.	1.10
Lift boxes of unpacked fruit from their position on pallet and place on conveyor. 4/	
Stack beside conveyor on pallet.	1.30
Lift boxes and cartons of packed fruit from their position in nearby stack and place on conveyor. 3/	
Stack beside conveyor in single row.	.94
Stack beside conveyor in double row.	1.05
Lift boxes of unpacked fruit from conveyor and place in stacks near conveyor. 5/	
Stack beside conveyor in single row.	1.13
Stack beside conveyor in double row.	1.31
Lift boxes of packed fruit from conveyor and place in proper stack (segregation). 6/	
Segregating into 3 or 4 stacks.	1.56
Segregating into 5 to 8 stacks.	1.91
Segregating into 9 or more stacks.	2.19
Segregating into 4 or 5 pallets	2.27

1/ Times recorded are for one worker unless otherwise noted; however, the labor per 1,000 boxes for a larger crew would be the same as for one worker if the crew members worked independently and did not unavoidably interfere with one another.

2/ The operations begin when the worker starts to reach for the first box, consists of stacking boxes on (or off) the conveyor, and ends when the worker releases the last box.

3/ Time for stacking boxes on conveyor from stacks, two rows wide, along the conveyor is greater than time for stacking from a single row because the worker must swing the boxes a greater distance.

4/ Boxes on pallets placed alongside the conveyor, with sides of boxes parallel to conveyor and rows four deep. Does not include time to handle pallets of 0.09 man-hour per 1,000 boxes for 36-box pallet and 0.07 man-hour per 1,000 boxes for 48-box pallet.

Continued -

5/ Time for building two rows of stacks along the conveyor is greater than time for building a single row, because worker must swing boxes a greater distance and this makes placement more difficult.

6/ The segregation area is only position where packed boxes are stacked off conveyor except in carloading. Stacking off when segregating consists of noticing the size marked on the box and placing in the proper stack. A great many conditions can alter the time required to segregate, and the times presented here are general averages. The times are separated according to the number of stacks to which the worker must carry boxes.

Comparative labor requirements per 1,000 unpacked boxes to high-pile and break out high-piled boxes by use of manual method in apple packing and storage plants

Description of operation	Labor required Man-hours
High-piling boxes: 1/	
Two workers piling boxes from 6 high to 10 high	4.10
Two workers piling boxes from 6 high to 12 high	4.54
Breaking out high-piled boxes: 2/	
Two workers breaking out boxes from 10 high to 6 high (Top worker stands on bench) 3/	3.65
Two workers breaking out boxes from 12 high to 6 high	4.03
One worker breaking out boxes from 9 high to 6 high	2.50
Two workers breaking out boxes from 10 high to 4 high using a roller conveyor 4/	1.85

1/ Work performed by a 2-man warehouse crew in stacking boxes above the sixth tier by hand. The top worker stands on top of the 6-high stacks and positions the boxes, while the bottom worker stands on the floor and lifts the boxes to the top worker.

2/ Work performed by a 2-man warehouse crew in breaking out the stacks of boxes by hand. The top worker stands on the 6-high stacks and lifts down the boxes above the 6-high stacks to the bottom worker who builds stacks on the floor.

3/ At warehouse where boxes are high-piled to 10 high or less, the top worker sometimes stands on a bench while the bottom worker stands on the floor.

Continued -

4/ The roller conveyor is placed upon the 4-high stacks between the belt conveyor and the top worker. A slight slope of the conveyor allows the boxes to roll down to the bottom worker. The bottom worker merely swings the boxes from the roller conveyor onto the moving belt conveyor.

Table 161.—Comparativs labor requirements to high-pile and break out high-piled boxes to and from various stacking heights by manual methods in appls packing and storags houses

Workers	9-high stacks			10-high stacks			11-high stacks			12-high stacks		
	Labor per 1,000 boxes	Labor per: 333 boxes handled	Elapsed time	Labor per 1,000 boxes	Labor per: 400 boxes handled	Elapsed tims	Labor per 1,000 boxss	Labor per: 455 boxes handled	Elapsed time	Labor per 1,000 boxes	Labor per: 500 boxes handled	Elapsed time
Number	Man-hours	Man-hours	Hours	Man-hours	Man-hours	Hours	Man-hours	Man-hours	Hours	Man-hours	Man-hours	Hours
High-piling: 1/												
2	4.92	1.64	0.82	5.12	2.05	1.02	5.12	2.33	1.16	5.66	2.83	1.41
4	4.92	1.64	.41	5.12	2.05	..51	5.12	2.33	.57	5.66	2.83	.70
Breaking out boxes: 1/												
2	4.20	1.40	.70	4.38	1.75	.88	4.38	2.00	1.00	4.83	2.42	1.21
4	4.20	1.40	.35	4.38	1.75	.44	4.38	2.00	.50	4.83	2.42	.60

1/ These times include the fatigue allowance noted in tabulation on pages .

Table 162.—Comparative labor requirements per operation to high-pile and break out high-piled stacks of boxes of apples by use of one- and two-stack portable mechanical lifts 1/

Operation	11-high stacks: 1 stack—5 boxes	11-high stacks: 2 stacks—10 boxes	12-high stacks: 1 stack—6 boxes	12-high stacks: 2 stacks—12 boxes
	Man-minutes	Man-minutes	Man-minutes	Man-minutes
High-piling				
Pick up	0.047	0.130	0.047	0.130
Elevate	.159	.330	.191	.396
Release	.230	.464	.230	.464
Lower	.127	.145	.152	.174
Total	0.563	1.069	0.620	1.164
Breaking out				
Elevate	0.144	0.185	0.173	0.222
Pick up	.205	.272	.205	.272
Lower	.065	.071	.078	.085
Release	.048	.042	.048	.042
Total	0.462	0.570	0.504	0.621

1/ Portable mechanical lifts are available in capacities of one stack and two stacks. One worker using a one- or two-stack portable mechanical lift can high-pile or break out boxes of apples.

Table 163.--Comparative labor requirements to high-pile and break out high-piled boxes to and from various stacking heights by use of a portable mechanical lift in apple packing and storage houses 1/

Type of portable mechanical lift	9-high stacks			10-high stacks			11-high stacks			12-high stacks		
	Labor per 1,000 boxes	Labor per 333 boxes 2/	Elapsed time	Labor per 1,000 boxes	Labor per 400 boxes 2/	Elapsed time	Labor per 1,000 boxes	Labor per 455 boxes 2/	Elapsed time	Labor per 1,000 boxes	Labor per 500 boxes 2/	Elapsed time
	Man-hours	Man-hours	Hours	Man-hours	Man-hours	Hours	Man-hours	Man-hours	Hours	Man-hours	Man-hours	Hours
High-piling												
One stack	3.72	1.24	1.24	2.57	1.03	1.03	2.07	0.94	0.94	1.89	0.94	0.94
Two stack	3.21	1.07	1.07	2.44	.98	.98	1.96	.89	.89	1.78	.89	.89
Breaking out												
One stack	3.37	1.12	1.12	2.12	.85	.85	1.69	.77	.77	1.54	.77	.77
Two stack	2.47	.82	.82	1.31	.52	.52	1.04	.47	.47	.93	.47	.47

1/ These times include fatigue allowance. See page 267 of the Appendix.
2/ Labor required for the number of boxes involved in handling 1,000 boxes into and out of storage.

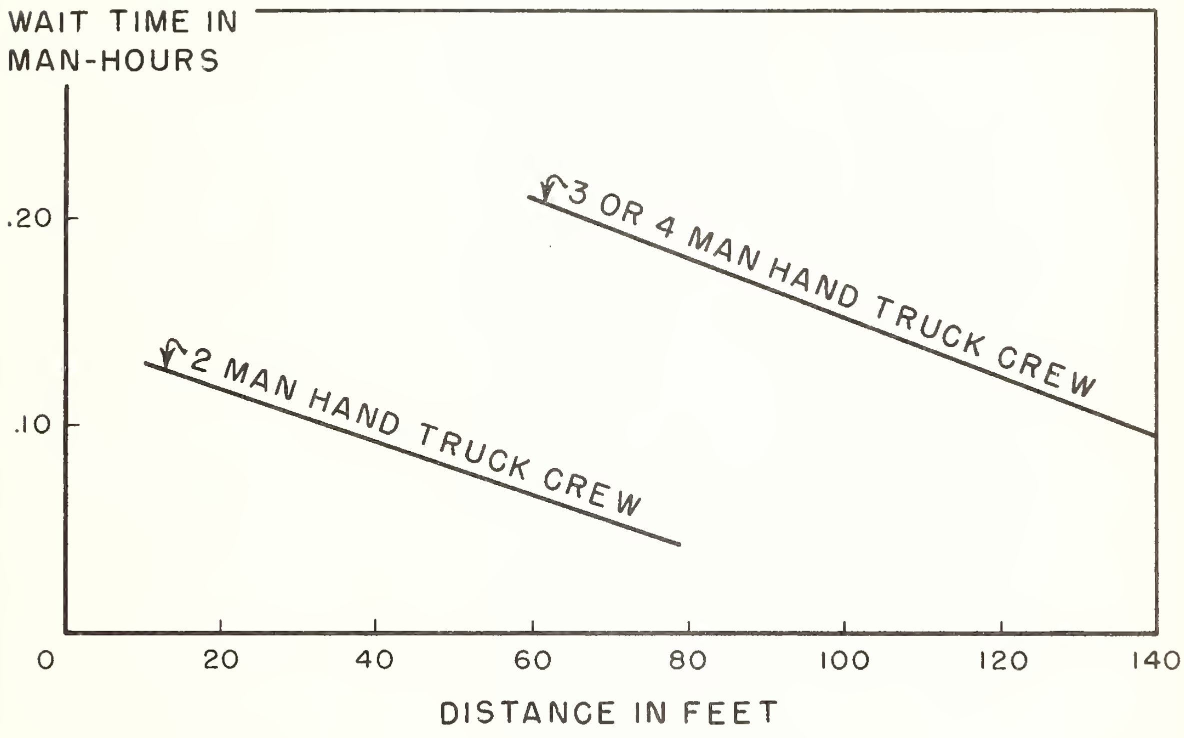

Figure 133.--Additional wait time required per 1,000 boxes because of crew interference when moving boxes in 6-high stacks various distances by use of clamp-type 2-wheel hand trucks and three different crew sizes at apple packing and storage plants. (Note: There was no definite difference in wait time of 3 and 4-man crews.)

Comparative labor requirements per 1,000 packed boxes for performing certain operations in moving boxes of apples out of storage by use of different types and combinations of types of materials-handling equipment, and loading refrigerated railroad cars and refrigerated highway trucks at apple packing and storage plants 1/

Description of operation:	Labor required Man-hours
Hand stack boxes of apples in refrigerated railroad car 2/:	
Hand stack boxes from stacks placed by 2-wheel hand truck in railroad car.	1.43
Push 5-high stacks backward and sideways into position with hand box jack. 3/	1.06
Hand stack boxes from belt conveyor to railroad car.	1.19
Transfer boxes from belt conveyor to roller conveyor in the doorway of the car.	1.04
Hand stack boxes from pallets to railroad car floor.	1.57
Hand stack boxes of apples in refrigerated highway truck 2/:	
Hand stack boxes from belt conveyor to highway truck.	1.25
Hand stack boxes from pallets to highway truck.	1.61
Strip stacked boxes of apples in refrigerated railroad car 4/:	
Nail lath to 2nd, 4th, and 6th tiers of boxes in railroad car. Four pieces of lath needed on 2nd and 4th tiers, and 2 pieces on 6th tier.	.90
Nail lath to 3rd and 6th tiers of boxes in railroad car. Four pieces of lath needed on 3rd tier and 2 pieces on 6th tier.	.61

See footnotes at end of tabulation

Continued -

	Labor required Man-hours
Move pallet dolly and handle empty pallets in refrigerated railroad car 5/:	
Push loaded dolly to position for stacking in railroad car. Remove empty pallet, place pallet beside carrier and return dolly to doorway.	
30-box	0.42
40-box	.33
Move pallet dolly and handle empty pallets in highway truck 5/:	
Push loaded dolly in position for stacking in highway truck. Remove empty pallet, place pallets beside carrier and return dolly to doorway.	
30-box	.49
40-box	.41
Fill in doorway of railroad car with brace or boxes 6/:	
Build 2 x 4 inch brace in doorway of car. Nail two 2 x 4 inch gates together and place against boxes in car doorway. Hand jack gates apart to remove slack and nail 2 by 4 inch braces between gates.	.83
Stack 70 boxes in doorway of car. Take up slack in car, stack boxes and place dunnage to make load tight.	.50
Two-wheel hand truck releases unit load inside refrigerated railroad car or highway truck 7/:	
Two-wheel hand truck operator releases 6-high stacks of boxes in front of carloader.	.50
Two-wheel hand truck operator releases 5-high stacks of boxes in position for worker to hand jack stacks.	.78

See footnotes at end of tabulation

Continued -

	Labor required Man-hours
Fork-lift truck releases unit load inside refrigerated railroad car 8/:	
Fork-lift truck operator releases unit load on dolly. Fork-lift truck is on ground level. Double release needed to place pallet in position.	
30-box pallet	0.18
40-box pallet	.15
Fork-lift truck operator releases unit load on roller conveyor that extends out car door about 3 feet. Fork-lift truck is on about the same level as the railroad car floor rack.	
30-box pallet	.07
40-box pallet	.06
Manifest refrigerated railroad car or highway truck load 9/:	
Manifest load by counting and tallying every box in load.	.45
Manifest load by counting and tallying stacks of unit loads.	.10
Set up preparatory to loading a refrigerated railroad car:	
Set up railroad car for 2-wheel hand trucks. Open car door, place bridgeplate and get hand trucks.	.04
Set up railroad car for belt conveyor. Open car door and place roller conveyor extensions.	.16
Set up railroad car for fork-lift truck and pallets. Open car door and place roller dolly in car.	.18
Clean up preparatory to shipping a refrigerated railroad car:	

See footnotes at end of tabulation

Continued -

	Labor required Man-hours
Clean up railroad car when loaded by 2-wheel hand trucks. Remove bridgeplate, shut door and return hand trucks.	0.03
Clean up railroad car when loaded by belt conveyor. Remove roller conveyor and shut door of car.	.05
Clean up railroad car when loaded by fork-lift truck and pallet dolly. Remove pallet dolly and shut car door.	.07

1/ Only those comparative times are included in this tabulation that reflect a different condition due to carloading (i. e., hand truck release is included, but pick up and transport are on later tabulations).

2/ Stacking boxes from either a belt conveyor, a pallet, or a stack of boxes placed by hand trucks. Begins when the carloader reaches for the box. Includes transferring the box and stacking the box for transit. Ends when the worker reaches for another box.

3/ Work done by worker hand jacking 5-high stacks of boxes into position for transit. Begins when the hand truck operator releases load in position. Includes jacking the boxes backward and sideways into position. Ends when the stack of boxes is in position.

4/ Work done in placing lath across the top of the boxes begins when the carloader goes for lath, nails, and hammer. Includes nailing 4 pieces of lath on the designated tiers, 3 or 4 nails to a lath. Ends when the worker returns the hammer to the center of the car.

5/ Work done by carloaders in handling pallets loaded and empty inside the car or highway truck. Begins when carloader pushes dolly under pallet load. Includes steadying the load while the fork-lift truck releases on the dolly, pushing the dolly to the stacking point, removing the empty pallets and pushing the dolly to the doorway of the car or highway truck. Ends when the empty dolly is near the center of the car or at the end of the highway truck.

6/ Work done by carloading crew in filling the center of the car with a brace or packed boxes. Begins when the regular stacking is done. Includes building a brace in the doorway, or squeezing back the load and stacking boxes in the doorway. Ends when the clean up operation begins.

7/ Work done by hand truck operator in releasing boxes inside railroad car. Begins when the hand trucks pass doorway of the car going into the car. Includes all of transportation, maneuvering, and releasing inside the railroad car. Ends when the hand truck passes the doorway of the car going out of the car.

Continued -

8/ Work done by fork-lift truck operator in releasing unit load on dolly. Begins when the fork-lift truck operator moves the unit load past the doorway of the car. Includes releasing the unit load on the floor of the car, moving the fork-lift truck back about 1 foot, picking up the load, moving forward, and releasing unit load on dolly. Ends when the fork-lift truck has completely withdrawn the forks.

9/ Work done by worker counting and tallying the carload of apples by size, grade, and variety. Begins when the workers reach for the tally sheets. Includes counting the boxes by size, grade, and variety. Ends when all the boxes in the carload have been tallied.

Comparative labor requirements per 1,000 boxes to perform various operations by use of clamp-type 2-wheel hand trucks at apple packing and storage plants

Pick up stack with clamp-type 2-wheel hand truck 1/

	Labor required	
	6-high stacks Man-hours	5-high stacks Man-hours
Pick up stack of boxes in crowded area where surrounding stacks of boxes make maneuvering necessary, or where there is not adequate space between stacks for clamps to enter conveniently, e. g., in a storage room or on a road truck bed.	0.39	0.47
Pick up stack of boxes in relatively crowded area where boxes were originally placed in position by hand truck or stacked with adequate spacing between stacks for clamps to enter, e. g., on a road truck bed, by belt, in an elevator or in cold room.	.29	.35
Pick up stack of boxes in an open area with sufficient room for easy maneuver, e. g., on floor chain conveyor or at open segregation area.	.23	.28

Transport load to stacking point and return 2/

Distance Feet	Labor required 4/ 6-high stacks Man-hours	5-high stacks Man-hours
10	0.28	0.34
15	.37	.44
20	.45	.54
25	.54	.65
30	.62	.75
40	.80	.95
50	.97	1.16
60	1.14	1.36
70	1.31	1.57
80	1.48	1.77
90	1.65	1.98
100	1.82	2.18
125	2.25	2.70
150	2.68	3.21
175	3.10	3.72
200	3.53	4.24
225	3.96	4.75
250	4.39	5.26

(For additional transportation distances see footnote 4 below.)

Release stack with clamp-type 2-wheel hand truck at storage points 3/

	Labor required	
	6-high stacks Man-hours	5-high stacks Man-hours
Release stack of boxes in crowded area where surrounding stacks of boxes make maneuvering necessary, e. g., stacks placed in storage position.	0.35	0.42
Release stack of boxes in relatively crowded area, e. g., in an elevator or on a road truck bed.	.29	.35
Release stack of boxes in open with sufficient room for easy maneuver, e. g., by a belt or roller conveyor, by the washer and dumper, or on a floor chain conveyor.	.24	.29

1/ Work performed by the clamp-type 2-wheel hand truck operator in picking up a load with the hand truck. Begins when operator starts to position truck for the pick up or when the clamps pass the front of the load, and ends when the hand truck begins forward motion.

2/ Work performed by the clamp-type 2-wheel hand truck in transporting a unit load from the pick up area to the storage point and returning empty.

3/ Work performed by the clamp-type 2-wheel hand truck operator in releasing a load with hand truck. Begins when forward motion ends or when positioning commences, and ends when the hand truck begins forward motion.

4/ Clamp-type 2-wheel hand truck transport time for 6-high stacks: $t = 0.0171d + 0.11$

Clamp-type 2-wheel hand truck transport time for 5-high stacks: $t = 0.02052d + 0.132$

(Where d = one way distance in feet and t = time in man-hours per 1,000 boxes—includes transport empty and transport loaded.)

Comparative labor requirements per 1,000 boxes to perform various operations by use of industrial clamp trucks at apple packing and storage plants

Pick up load with industrial clamp truck 1/

	Labor required: 24-box load 4/ Man-hours	Labor required: 20-box load 5/ Man-hours
Pick up unit load from bed of road truck or level surface in relatively open area. Hydraulic stabilizer used to permit industrial truck to go onto road truck bed.	0.11	0.13
Pick up unit load from floor level surface or receiving apron in relatively crowded area, 7/ e.g., beside belt conveyor, unit load made up by hand truck.	.16	.19
Pick up unit load in cold storage. Open area except for numerous posts and ducts.		
First tier	.12	.14
Second tier	.32	.38
Average first and second tiers	.22	.26
Pick up unit load in cold storage. Very crowded area—numerous posts and ducts.		
First tier	.28	.34
Second tier	.86	1.03
Average first and second tiers	.57	.68

Transport load to stacking point and return 2/

Distance Feet	Labor required 6/: 24-box load 4/ Man-hours	Labor required 6/: 20-box load 5/ Man-hours
5	0.24	0.29
10	.26	.31
20	.29	.35
30	.32	.38
40	.35	.42
50	.38	.46
60	.42	.50
70	.45	.54
80	.48	.57
90	.51	.61
100	.54	.65
150	.70	.84
200	.86	1.03
300	1.18	1.41
400	1.49	1.79

(For additional transportation distances see footnote 6 below.)

Release load with industrial clamp truck 3/

	Labor required: 24-box load 4/ Man-hours	Labor required: 20-box load 5/ Man-hours
Release unit load by belt conveyor in open area with little maneuvering necessary.	0.07	0.08
Stack unit load in cold storage. Open area, numerous posts.		
First tier	.10	.12
Second tier	.40	.48
Average first and second tiers	.25	.30
Stack unit load in cold storage. Crowded area, numerous posts and ducts.		
First tier	.20	.24
Second tier	.58	.70
Average first and second tiers	.39	.47
Release unit load behind dumper on flat surface in crowded area. Some maneuvering necessary.	.13	.16
Release unit load in bank near dumper for hand trucker to take to dumper. Very crowded area and much maneuvering necessary.	.19	.23

1/ Work performed by the industrial truck operator in picking up a load with the industrial truck. Begins when operator starts to position truck for the pick up or when the clamps pass the front of the load, includes raising the load, and ends when load has cleared its original position.

2/ Work performed by the industrial truck operator in transporting the unit load with the industrial truck from the pick up position to the release point and returning empty.

3/ Work performed by the industrial truck operator in releasing or stacking a load with an industrial truck. Begins when operator starts to position load for release or when load starts to pass over the area where it will be stacked, includes setting load down, and ends when the clamps have cleared front of load.

4/ Twenty-four boxes of loose fruit stacked 6 boxes high.

5/ Twenty boxes of packed fruit stacked 5 boxes high.

6/ Industrial clamp truck transport time for 24-box load: $t = 0.0032d + 0.22$

Industrial clamp truck transport time for 20-box load: $t = 0.0038d + 0.27$

(Where d = one way distance in feet and t = time in man-hours per 1,000 boxes—includes transport empty and transport loaded.)

7/ Apron considered to be an area of smooth surface at ground level.

Note: Truck that carries 24 boxes of loose fruit does not have the capacity to double-tier more than 20 boxes of packed fruit.

Comparative labor requirements per 1,000 boxes to perform various operations by use of industrial clamp trucks at apple packing and storage plants

Pick up load with industrial clamp truck 1/

	Labor required 36-box load 4/ Man-hours	Labor required 30-box load 5/ Man-hours
Pick up unit load from bed of orchard trailer.	0.12	0.14
Pick up unit load in cold storage. Room has few posts and ducts.		
First tier	.07	.08
Second tier	.13	.16
Average first and second tiers	.10	.12
Pick up unit load in an open area or at segregation point. (Fruit at second tier level.)	.10	.12

Transport load to stacking point and return 2/

Distance Feet	Labor required 6/ 36-box load 4/ Man-hours	Labor required 6/ 30-box load 5/ Man-hours
5	0.17	0.21
10	.18	.23
20	.21	.26
30	.23	.29
40	.26	.32
50	.28	.35
60	.30	.37
70	.33	.40
80	.35	.43
90	.38	.46
100	.40	.49
150	.52	.64
200	.64	.78
300	.88	1.07
400	1.12	1.36

(For additional transportation distances see footnote 6 below.)

Release load with industrial clamp truck 3/

	Labor required 36-box load 4/ Man-hours	Labor required 30-box load 5/ Man-hours
Stack unit load in cold storage. Few posts and ducts.		
First tier	0.08	0.10
Second tier	.14	.16
Average first and second tiers	.11	.13
Release unit load onto roller conveyor bank going to dumper.	.12	.14

1/ Work performed by the industrial truck operator in picking up a load with the industrial truck. Begins when operator starts to position truck for the pick up or when the clamps pass the front of the load, includes raising the load, and ends when load has cleared its original position.

2/ Work performed by the industrial truck operator in transporting the unit load with the industrial truck from the pick up position to the release point and returning empty.

3/ Work performed by the industrial truck operator in releasing a load with industrial truck. Begins when operator starts to position load for release or when load starts to pass over the area where it will be stacked, includes setting load down, and ends when the clamps have cleared front of load.

4/ Thirty-six boxes of loose fruit stacked 6 boxes high.

5/ Thirty boxes of packed fruit stacked 5 boxes high.

6/ Industrial clamp truck transport time for 36-box load: $t = 0.0024d + 0.16$

Industrial clamp truck transport time for 30-box load: $t = 0.0029d + 0.20$

(Where d = one-way distance in feet and t = time in man-hours per 1,000 boxes—includes transport empty and transport loaded.)

Comparative labor requirements per 1,000 boxes to perform various operations by use of electric industrial fork-lift trucks at apple packing and storage plants

Pick up load with fork lift truck 1/

	Labor required 36-box load 4/ Man-hours	Labor required 30-box load 5/ Man-hours
Pick up loaded pallet from bed of truck.	0.10	0.12
Pick up loaded pallet from bed of truck. (Double pick up time.) 7/	.16	.19
Pick up loaded pallet from floor level surface or receiving apron. 8/	.06	.07
Pick up loaded pallet from cold storage room stack.		
First tier	.06	.07
Second tier	.11	.13
Third tier	.19	.23
Average	.12	.14

Transport load to stacking point and return 2/

Distance Feet	Labor required 6/ 36-box load 4/ Man-hours	Labor required 6/ 30-box load 5/ Man-hours
5	-	-
10	-	-
15	-	-
20	-	-
25	0.23	0.28
30	.24	.29
40	.26	.31
50	.28	.34
60	.30	.37
70	.32	.39
80	.35	.42
90	.37	.44
100	.39	.47
125	.45	.54
150	.50	.60
175	.56	.67
200	.61	.73
225	.67	.80
250	.72	.86
275	.78	.93
300	.83	.99

(For additional transportation distances see footnote 6 below.)

Release load with fork-lift truck at storage points 3/

	Labor required 36-box load 4/ Man-hours	Labor required 30-box load 5/ Man-hours
Release loaded pallet on floor level surface or receiving apron.	0.04	0.05
Stack loaded pallet in cold room.		
First tier	.06	.08
Second tier	.11	.13
Third tier	.21	.26
Average	.13	.16
Release loaded pallet on floor at dumper. (Release on roller conveyor includes pushing pallets forward.)	.07	.08

1/ Work performed by fork-lift truck operator. Begins in positioning the forks in the pallet, consists of raising the load, and ends when pallet has cleared original position.

2/ Work performed by fork-lift truck operator in transporting a pallet load from the pick up position to storage point and returning empty.

3/ Work performed by fork-lift truck operator. Begins in positioning the load for stacking, consists of setting load down, and ends when the forks are withdrawn from pallet.

4/ Thirty-six boxes of loose fruit stacked 6 boxes high on 40- by 36-inch pallet.

5/ Thirty boxes of packed fruit stacked 5 boxes high on 40- by 36-inch pallet.

6/ Electric truck transport time for 36-box load: $t = 0.0022d + 0.17$ from $d = 31$ to $d = 300$

Electric truck transport time for 30-box load: $t = 0.0026d + 0.21$

(Where d = one-way distance in feet and t = time in man-hours per 1,000 boxes and includes transport empty and transport loaded.)

7/ Pallets are about 8 inches from edge of truck bed, required pick up and pull to edge of truck, then a second pick up.

8/ Apron considered to be an area of smooth surface at ground level.

Comparative labor requirements per 1,000 boxes to perform various operations by use of gasoline and electric industrial fork-lift trucks and 40-box loads on 40- by 48-inch pallets at apple packing and storage plants

Pick up load with fork-lift truck 1/

	Labor required Man-hours
Pick up loaded pallet from bed of truck.	
Gasoline truck	0.09
Pick up loaded pallet from floor level or receiving apron. 5/	
Electric truck	.055
Pick up loaded pallet from cold storage room stack. (Average of 1st, 2nd, and 3rd tiers.)	
Electric truck	
First tier	.055
Second tier	.105
Third tier	.185
Average	.115

Transport load to stacking point and return 2/

Distance Feet	Labor required 4/ Man-hours
5	-
10	-
20	-
30	0.18
40	.19
50	.21
60	.22
70	.23
80	.24
90	.26
100	.27
125	.30
150	.34
200	.40
250	.47
300	.53

(For additional transportation distances see footnote 4 below.)

Release load with fork-lift at storage points 3/

	Labor required Man-hours
Release loaded pallet on floor level surface or receiving apron. 5/	
Electric truck	0.05
Gasoline truck	.035
Stack loaded pallet in cold room. (Average of 1st, 2nd, and 3rd tiers.)	
Electric truck	
First tier	.05
Second tier	.09
Third tier	.16
Average	.10
Gasoline truck	
First tier	.04
Second tier	.07
Third tier	.12
Average	.075
Release loaded pallet on floor at dumper. (Reflects difficult maneuvering and crowded area.)	
Electric truck	.075

1/ Work performed by fork-lift operator. Begins in positioning the forks in the pallet, consists of raising the load, and ends when pallet has cleared original position.

2/ Work performed by fork-lift truck operator in transporting a pallet load from the pick up position to storage point and returning empty. Data shown are for a gasoline powered industrial fork-lift truck. For short distances there is very little difference between electric and gasoline trucks. Because no data were obtained for larger distances a curve for electric truck transport time could not be developed for 40-box pallet loads.

3/ Work performed by fork-lift operator. Begins in positioning the load for stacking, consists of setting load down, and ends when the forks are withdrawn from pallet.

4/ Gasoline truck transport time: $t = 0.0013d + 0.14$ from $d = 31$ to $d = 300$
(Where d = one-way travel distance in feet and t = time in man-hours per 1,000 boxes—includes transport empty and transport loaded.)

5/ Apron considered to be an area of smooth surface at ground level.

Comparative labor requirements per 1,000 boxes to perform various operations by use of electric fork-lift trucks and 40- by 48-inch pallets at apple packing and storage plants

Pick up load with fork-lift truck 1/

	Labor required: 48-box load 4/ Man-hours	Labor required: 40-box load 5/ Man-hours
Pick up loaded pallet from bed of truck.	0.07	0.08
Pick up loaded pallet from floor level surface or receiving apron. 7/	.05	.06
Pick up loaded pallet from cold storage room stack.		
First tier	.05	.05
Second tier	.07	.08
Third tier	.14	.17
Average	.09	.10

Transport load to stacking point and return 2/

Distance Feet	Labor required 6/: 48-box load 4/ Man-hours	Labor required 6/: 40-box load 5/ Man-hours
5	0.04	0.05
10	.07	.08
20	.13	.15
30	.18	.23
40	.20	.24
50	.22	.26
60	.23	.28
70	.25	.30
80	.26	.32
90	.28	.34
100	.29	.36
125	.33	.40
150	.37	.45
200	.45	.54
250	.53	.64
300	.61	.73
350	.68	.82
400	.76	.91
450	.84	1.01
500	.92	1.10

(For additional transportation distances see footnote 6 below.)

Release load with fork-lift truck at storage points 3/

	Labor required: 48-box load 4/ Man-hours	Labor required: 40-box load 5/ Man-hours
Release loaded pallet on floor level surface or receiving apron.	0.04	0.04
Stack loaded pallet in cold storage room.		
First tier	.04	.05
Second tier	.08	.10
Third tier	.15	.18
Average	.09	.11
Release loaded pallet on floor at dumper. (Includes work of setting pallet on floor and pushing it into position so that stacks 6 high may be hand trucked away.)	.10	.11
Release loaded pallet on 4-wheel dolly at dumper.	.11	.13

1/ Work performed by fork-lift truck operator. Begins in positioning the forks in the pallet, consists of raising the load, and ends when pallet has cleared original position.

2/ Work performed by fork-lift truck operator in transporting a pallet load from the pick up position to storage point and returning empty.

3/ Work performed by fork-lift truck operator. Begins in positioning the load for stacking, consists of setting load down, and ends when the forks are withdrawn from pallet.

4/ Loose fruit handled in unit loads 6 boxes high.

5/ Packed fruit handled in unit loads 5 boxes high.

6/ Electric truck transport time for 48-box load: $t = 0.0056d + 0.013$ for d from 0 to 31 feet; $t = 0.00155d + 0.14$ for d above 31 feet
Electric truck transport time for 40-box load: $t = 0.0067d + 0.016$ for d from 0 to 31 feet; $t = 0.00186d + 0.17$ for d above 31 feet
(Where d = one-way distance in feet and t = time in man-hours per 1,000 boxes—includes transport empty and transport loaded.)

7/ Apron considered to be an area of smooth surface at ground level.

Comparative labor requirements per 1,000 boxes to perform various operations by use of gasoline powered fork-lift trucks and 40- by 48-inch pallets at apple packing and storage plants

Pick up load with fork-lift truck 1/

	Labor required 48-box load 4/ Man-hours	Labor required 40-box load 5/ Man-hours
Pick up loaded pallet from bed of truck.	0.07	0.08
Pick up loaded pallet from floor level surface or receiving apron. 7/	.04	.05
Pick up loaded pallet from cold storage room stack.		
First tier	.05	.05
Second tier	.07	.08
Third tier	.14	.17
Average	.09	.10

Transport load to stacking point and return 2/

Distance Feet	Labor required 6/ 48-box load 4/ Man-hours	Labor required 6/ 40-box load 5/ Man-hours
5	-	-
10	-	-
20	-	-
30	0.17	0.20
40	.18	.21
50	.19	.22
60	.[illegible]	.24
70	.21	.25
80	.22	.26
90	.23	.27
100	.24	.29
125	.26	.32
150	.29	.35
200	.34	.41
250	.39	.47
300	.44	.53

(For additional transportation distances see footnote 6 below.)

Release load with fork lift at storage points 3/

	Labor required 48-box load 4/ Man-hours	Labor required 40-box load 5/ Man-hours
Release loaded pallet on floor level surface or receiving apron.	0.04	0.04
Stacking loaded pallet in cold storage room.		
First tier	.04	.04
Second tier	.06	.07
Third tier	.08	.10
Average	.06	.07
Release loaded pallet on floor at dumper. Includes work of setting pallet on floor and pushing it into position so that stacks 6 high may be hand trucked away.	.10	.11
Release loaded pallet on 4-wheel dolly at dumper.	.11	.13

1/ Work performed by fork-lift truck operator. Begins in positioning the forks in the pallet, consists of raising the load, and ends when pallet has cleared original position.

2/ Work performed by fork-lift truck operator in transporting a pallet load from the pick up position to storage point and returning empty.

3/ Work performed by fork-lift truck operator. Begins in positioning the load for stacking, consists of setting load down, and ends when the forks are withdrawn from pallet.

4/ Loose fruit handled in unit loads 6 boxes high.

5/ Packed fruit handled in unit loads 5 boxes high.

6/ Gasoline truck transport time 48-box load: $t = 0.00103d + 0.135$ for d from 31 feet to 300 feet
Gasoline truck transport time 40-box load: $t = 0.00124d + 0.162$ for d from 31 feet to 300 feet
(Where d = one-way distance and t = time in man-hours per 1,000 boxes--includes transport empty and transport loaded.)

7/ Apron considered to be on area of smooth surface at ground level.

Comparative labor requirements per 1,000 boxes to perform various operations by use of electric powered low-lift motorized pallet transporters and 40- by 48-inch pallets at apple packing and storage houses

Pick up load with transporter 1/

	Labor required 48-box load Man-hours	Labor required 40-box load Man-hours
Pick up a load from a floor level surface.	0.11	0.12

Transport load to stacking point and return 2/

Distance Feet	Labor required 4/ 48-box load Man-hours	Labor required 4/ 40-box load Man-hours
10	-	-
20	-	-
30	-	-
40	0.27	0.32
50	.28	.34
60	.30	.36
70	.31	.38
80	.33	.40
90	.34	.41
100	.35	.42
150	.42	.50
200	.50	.60
250	.57	.68

(For additional transportation distances see footnote 4 below.)

Release load with transporter 3/

	Labor required 48-box load Man-hours	Labor required 40-box load Man-hours
Release load on a floor level surface with some maneuvering.	0.12	0.14

1/ Work performed by transporter operator. Begins in positioning the truck, consists of loading the transporter, and ends when the pallet load has cleared its original position.

2/ Work performed by transporter operator in transporting a pallet load from the pick up position to the storage position and returning empty.

3/ Work performed by transporter operator. Begins in positioning the load for stacking, consists of setting load down, and ends when the transporter is withdrawn from the pallet.

4/ Electric transporter transport time for 48-box load: $t = 0.00141d + 0.213$
Electric transporter transport time for 40-box load: $t = 0.00169d + 0.256$

(Where d = one-way distance in feet and t = time in man-hours per 1,000 boxes—includes transport empty and transport loaded.)

Comparative labor requirements per 1,000 boxes to load and unload elevators of various capacities by use of hand trucks, industrial clamp trucks, and fork-lift trucks, and comparative operating times for the various elevators at apple packing and storage plants

Pick up load	Labor required Man-hours	Elevators: Type	Capacity 4/ Boxes	Operating distance between floors 5/ Feet	Speed of operation 6/ Feet per minute	Release load	Labor required Man-hours
Hand-clamp truck 1/ Pick up 6-high stacks of boxes in elevator. Stack with adequate space for hand truck clamps to enter. 180° turn required in this pick up.	0.29	Cable	72	13	34.0	Hand-clamp truck 7/ Release 6-high stacks of boxes on an elevator surface. Relatively open area. 180° turn required by hand truck operator.	0.29
		Cable	138	11	32.4		
		Cable	162	16	26.7		
24-box industrial clamp truck 2/ Pick up unit load from an elevator surface.	.15	Hydraulic	162	16	27.1	24-box industrial clamp truck 8/ Release unit load on an elevator surface.	.08
40-box fork-lift truck 3/ Pick up unit load from an elevator surface.	.06	Cable	80	20	58.8	40-box fork-lift truck 9/ Release unit load on an elevator surface.	.05

1/ Work performed by the hand-clamp truck operator in picking up a load with the hand truck. Begins when forward motion ends or when positioning commences, and ends when the hand truck begins forward motion.

2/ Work performed by the industrial clamp truck operator in picking up a load with industrial clamp truck. Begins when operator starts to position truck for the pick up or when the clamps pass the front of the load, includes raising the load, and ends when load has cleared its original position.

3/ Work performed by the fork-lift truck operator in picking up a load with the fork-lift truck. Begins in positioning the forks in the pallet, consists of raising the load, and ends when pallet has cleared original position.

4/ These are not necessarily rated capacities but represent maximum amount of fruit that can be transported at one time.

5/ Operating distance between floors. This footage represents the distance between floor levels and not the entire distance that the elevator is capable of moving through at one time. The total run of some elevators in the industry is 32 to 40 feet, depending on the number of floors in the plant.

6/ Speed of operation. All of the elevators studied were of the dead man type; therefore, an elevator operator was needed in all cases. The time element required for the elevator to move from one floor to the next began when the operator pushed the button and ended when the button was released. All elevators were of the constant speed variety.

7/ Work performed by the hand-clamp truck operator in releasing the load with the hand-clamp truck.

8/ Work performed by the industrial clamp truck operator in releasing the load with the industrial clamp truck.

9/ Work performed by the fork-lift truck operator in releasing the load with the fork-lift truck.

Note: An additional 0.017 man-hours per each elevator cycle must be included for time required to open and close elevator doors and raise and lower gates.

How to Use Elemental Data to Build Synthetic Standard Time Values for Combinations of Equipment

Time-study techniques were used which permitted the development of standard time values for each of the various materials-handling operations. Standard time values for appropriate operations can be regrouped or synthesized for a cycle of operations which includes similar operations from several other cycles. To illustrate, a standard time for the pickup operation by use of a hand truck was established and noted separately from the release operation. Standard times for transportation operations also were kept separately. Therefore, the total time required to handle boxes of apples with hand trucks through a given cycle of operations can be calculated regardless of transportation distance. This calculation is made by taking the pickup time plus the release time and adding to it a standard time for the appropriate transportation distance.

When one type of equipment is to be combined with another type for the purpose of exploring the relative efficiency of the combination, the standard time for the group of operations can be built synthetically by using the time required of the one type of equipment and adding the times of the other type. Thus, if hand trucks are used with fork-lift trucks the time requirements for pickup, releasing and transportation with the hand truck for a specified distance may be added to the pickup, transportation, and release time of the industrial fork-lift truck. The time values for all operations by use of all types of equipment studied in the industry are found in the standard data, pages 267 to 290.

In combining various types of equipment, an important factor to be considered is whether or not the one type of equipment can handle boxes in the same elapsed time as another type. The equipment requiring the longest elapsed time tends to set the pace for the entire operation. Equipment that handles fruit more rapidly when combined with the slower equipment stands by idle part of the time. This wait time must be added to the elapsed time for performing the operation.

In a number of instances plant operators using the data will find that when various types of equipment are combined the wait time with one type of equipment may be rather large. If the wait time is great enough (as in a machine paced cycle or operation) it may be possible and desirable to arrange the work so the operator of the equipment being paced can intermittently perform other work, thus reducing idle time.

In the course of the studies every practical combination of equipment now being used in the industry has been explored and developed in this report, making it rarely necessary to show synthetic times for combinations of equipment not already covered in the report. For this reason, some of the actual combinations of equipment observed and studied will be used as examples, illustrating the ways in which labor requirements of various operations were combined to arrive at the total labor required to perform a specific materials-handling operation. These are developed in the tables which follow.

Table 164.--Labor required for a 3-man crew to unload and move 1,000 unpacked boxes of apples into storage from a road truck by use of belt conveyors and clamp-type 2-wheel hand trucks 1/

Operation	Workers	Productive labor	Fatigue allowance 2/	Wait time	Total labor
	Number	Man-hours	Man-hours	Man-hours	Man-hours
Set up and clean up	3	3/ 0.16	0.0	7/ 0.32	0.48
Place boxes on belt conveyor (conveyor moves boxes 50 feet)	1	4/ 1.09	.22	8/ .47	1.78
Transfer boxes from belt conveyor to 6-high stacks	1	5/ 1.13	.23	9/ .42	1.78
Pick up 6-high stacks by use of clamp-type 2-wheel hand trucks	1	6/ .29	.03	.0	.32
Transport 6-high stacks 50 feet by 2-wheel hand trucks	1	6/ .97	.10	.0	1.07
Release 6-high stacks from 2-wheel hand truck	1	6/ .35	.04	.0	.39
Total man-hours	-	3.99	0.62	1.21	5.82
Elapsed time -- hours					10/1.94

1/ In body of report this is table 9, page 45. Labor requirements shown do not include piling boxes above 6-high stack. This size crew can receive 13 road truckloads of 288 boxes each per 8-hour day.

2/ Page 267 of Appendix.

3/ Page 268 of Appendix.

4/ Page 273 of Appendix.

5/ Page 274 of Appendix.

6/ Page 282 of Appendix.

7/ Page 268 of Appendix. 0.28 of the 0.32 man-hour is set up and clean up for the two men inside the warehouse. 0.04 is the time taken for the boxes to reach the stacking off point. (50/80 divided by 60 times 1,000/288)--50 feet of belt conveyor traveling at 80 feet a minute divided by 60 gives hours and assuming 288 boxes per truckload gives man-hours per 1,000 boxes.

8/ This is obtained by subtracting (1.09 + 0.22) from 1.78. The 1.78 is the governing time set by the hand trucker.

9/ This is obtained by subtracting (1.13 + 0.23) from 1.78.

10/ This is obtained by adding (1.78 + 0.16). The 1.78 is the hand trucking time and 0.16 is the set up and clean up time.

Table 165.--Comparative labor and equipment costs of a common method for unloading from road trucks and moving into storage 1,000 unpacked boxes of apples by use of belt conveyors and clamp-type 2-wheel hand truck when a 3-man crew is employed 1/

Method	Elapsed time	Labor and equipment required			Labor and equipment costs			
		Equipment time	Wait time	Total labor	Equipment	Labor	Total costs: Current wages	Total costs: Assumed wages
	Hours	Machine-hrs.	Man-hrs.	Man-hrs.	Dollars	Dollars	Dollars	Dollars
One worker places boxes on, one worker takes boxes off conveyor, and one worker hand trucks	2/ 1.94	3/ 5.82	2/ 1.21	2/ 5.82	4/ 1.74	5/ 6.69	6/ 8.43	7/ 9.89

1/ Taken from table 13, page 48 in body of report. In hand trucking operation, boxes of fruit are handled in 6-high stacks. Costs shown do not include piling boxes above 6-high stacks. Transportation distance 100 feet, 50 feet by use of belt conveyor and 50 feet by use of hand truck.

2/ Taken from table 9.

3/ Clamp-type 2-wheel hand truck, 100-foot belt conveyor and 15-foot roller conveyor 1.94 machine hours each, total 5.82 machine-hours.

4/ The machine-hours are multiplied by the machine costs as found in table 2.

5/ The "current" wage rate of $1.15 per hour times the man-hours of labor.

6/ Equipment cost plus the labor cost at current wage rates of $1.15 per hour.

7/ Equipment cost plus the labor costs at a wage rate of $1.40 per hour.

Table 166.—Labor required for a 3-man crew to unload and move 1,000 unpacked boxes of applee into storage from a road truck by use of a single elevator and clamp-type 2-wheel hand trucks when fruit ie moved directly to elevator to storage 1/

Operation	Workers	Productive labor	Fatigue allowance 2/	Wait time	Total labor
	Number	Man-hours	Man-hours	Man-hours	Man-hours
Set up and clean up	3	3/ 0.12	0.0	4/ 0.06	0.18
Pick up 6-high stacks off the road truck bed by 2-wheel hand truck	3	5/ .39	.04	.0	.53
Traneport 6-high stacke 30 feet to elevator by 2-wheel hand truck	3	5/ .62	.06	6/ .27	.95
Release 6-high stacks on elevator by 2-wheel hand truck	3	7/ .29	.03	.0	.32
Elevator cycle	3	8/ .20	.0	9/ .40	.60
Pick up 6-high stacks off the elevator by 2-wheel hand truck	3	7/ .29	.03	.0	.32
Traneport 6-high stacks 70 feet from elevator to storage point by 2-wheel hand truck	3	5/ 1.31	.13	6/ .07	1.51
Release 6-high stacke at storage point by 2-wheel hand truck	3	5/ .35	.04	.0	.39
Total man-houre		3.57	0.33	0.80	4.70
Elapeed time—houre					10/ 1.57

1/ In body of report this is table 28, page 68. Elevator load is 168 boxes. Labor requirements shown do not include piling boxes above 6-high stacks. Transportation dietance standardized at 100 feet does not include vertical transportation distance of the elevator cycle.

2/ Page 267 of the Appendix.

3/ Pages 267 and 268 of the Appendix.

4/ The elapsed time for the eet up is 0.06 because the productive time for the work is 0.12 and only two can perform the work at the same time. Therefore, one man etands by while the other two men work.

5/ Page 282 of the Appendix.

6/ Page 277 of the Appendix (fig. 133).

7/ Page 290 of the Appendix.

8/ Thie is the amount of time required for an operator to move the elevator from one floor to another and return. It ie determined by the following: $(1{,}000/162 \times 14/267 \times 1/60 \times 2) + (0.017/162 \times 1{,}000) = 0.20$. 162 boxes per load, 14 is the footage between floors, 26.7 is the feet per minute travel of the elevator, 60 is used to convert time to hours, 2 is used because the elevator has to go up and down, 0.017 is time given to open and cloee the elevator doors per elevator trip.

9/ Two workers wait 0.20 hours during the elevator cycle.

10/ Thie ie the total labor in man-hours divided by 3.

Table 167.—Comparative labor and equipment costs for unloading from road trucks and moving into storage 1,000 unpacked boxes of apples by use of one elevator and clamp-type 2-wheel hand trucke into etorage from road trucks 1/

Method	Workers	Elapsed time	Labor and equipment required: Equipment time	Wait time	Total labor	Labor and equipment coste: Equipment	Labor	Total cost: Current wagee	Assumed wagee
	No.	Hours	Machine-hrs.	Man-hrs.	Man-hrs.	Dollars	Dollars	Dollars	Dollars
One elevator									
Three men hand truck stacks from road truck onto elevator. Elevator taken to off-loading floor where the 3 men hand truck stacks to storage position	3	2/1.57	3/ 6.28	2/ 0.80	2/ 4.70	4/ 5.15	5/ 5.41	6/ 10.56	7/ 11.73

1/ Taken from table 32, page 73 in body of report. Boxes of fruit are handled in unit loads consisting of 6-high stacks. Costs shown do not include piling boxes above 6-high stacke. Horizontal distance standardized at 100 feet; vertical distance not included.

2/ Taken from table 28.

3/ Equipment time is made up of 3 x 1.57 for the clamp-type 2-wheel hand trucke and 1.57 for the 8,000-pound capacity elevator.

4/ The machine hours are multiplied by the machine cost shown in table 2.

5/ The "current" wage rate of $1.15 per hour times the man-hours of labor.

6/ Equipment cost plus the labor cost at current wage rate of $1.15 per hour.

7/ Equipment cost plus the labor cost at a wage rate of $1.40 per hour.

Table 168.—Labor required for a 2-man crew to unload and move 1,000 unpacked boxes of apples into storage from orchard trailer by use of pallets and fork-lift truck when boxes are received unpalletized 1/

Operation	Workers	Productive labor	Fatigue allowance 2/	Wait time 3/	Total labor
	Number	Man-hours	Man-hours	Man-hours	Man-hours
Set up and clean up	1	4/ 0.24	0.0	0.0	0.24
Transfer boxes from orchard trailer to 48-box pallets	1	5/ 1.49	.30	.0	1.79
Pick up a 48-box pallet load by a fork truck	1	6/ .05	.0	.0	.05
Transport pallet load 100 feet by a fork-lift truck	1	6/ .29	.02	.0	.31
Release pallet load in cold storage room (average 1st, 2nd, and 3rd tier—18-boxes high)	1	6/ .09	.0	.0	.09
Total man-hours		2.16	0.32	0.0	2.48
Elapsed time—hours					7/ 2.03

1/ In body of report this is table 51, page 105.
2/ Page 267 of the Appendix.
3/ Some wait time may occur for the fork-lift truck operator during the receiving cycle of operations.
4/ Page 271 of the Appendix.
5/ Page 272 of the Appendix.
6/ Page 287 of the Appendix.
7/ The elapsed time is labor of the worker hand stacking the boxes from the trailer bed to pallets including set up and clean up.

Table 169.—Comparative labor and equipment costs of unloading and moving 1,000 unpacked boxes of apples into storage from orchard trailers by use of pallets and fork-lift trucks when boxes are being received unpalletized 1/

Method	Elapsed time	Labor and equipment required: Equipment time	Labor and equipment required: Wait time	Labor and equipment required: Total labor	Labor and equipment costs required: Equipment	Labor and equipment costs required: Labor	Total cost: Current wages	Total cost: Assumed wages
	Hours	Machine-hrs.	Man-hrs.	Man-hrs.	Dollars	Dollars	Dollars	Dollars
Orchard trailer								
One man stacks boxes on pallets, 1 fork-lift truck operator transports and stacks unit loads	2/ 2.03	3/ 0.90	2/ 0.0	2/ 2.48	4/ 1.94	5/ 2.93	6/ 4.87	7/ 5.49

1/ Taken from table 54, page 109 in body of report. The handling is done in 48-box pallet loads which are tiered 3 pallets, or 18-boxes high.
2/ Taken from table 51.
3/ Equipment time is made up of 0.45 hours for 20.8 pallets (48-box), 0.45 hours for 4,000-pound capacity electric fork-lift truck.
4/ The machine hours are multiplied by the machine costs as found in table 2.
5/ The "current" wage rate of $1.15 per hour unskilled labor and $1.30 per hour skilled labor (fork-lift truck operator) times the labor hours required.
6/ Equipment cost plus the labor costs at current wage rates of $1.15 per hour and $1.30 per hour.
7/ Equipment cost plus the labor costs at wage rates of $1.40 and $1.55 per hour.

Table 170.--Labor required for a 3-man crew to move 1,000 unpacked boxes of apples from storage to the packing line by use of clamp-type 2-wheel hand trucks and belt conveyor 1/

Operation	Workers	Productive labor	Fatigue allowance 2/	Wait time	Total labor
	Number	Man-hours	Man-hours	Man-hours	Man-hours
Pick up 6-high stacks at storage position by hand truck	2	3/ 0.29	0.03	0.0	0.32
Transport stacks 35 feet to temporary bank	2	3/ .71	.07	4/ .10	.88
Release stacks at bank	2	3/ .29	.03	.0	.32
Pick up 6-high stacks from bank by hand truck	1	3/ .29	.03	.0	.32
Transport stack 15 feet to belt	1	3/ .37	.04	.0	.41
Release stack at belt conveyor	1	3/ .24	.02	.0	.26
Place boxes from single row stack on belt conveyor	1	5/ .90	.18	6/ 1.26	2.34
Total man-hours		3.09	0.40	1.36	4.85

1/ In body of report this is table 80, page
2/ Page 267 in the Appendix.
3/ Page 282 in the Appendix.
4/ Page 277 in the Appendix (fig. 133).
5/ Page 273 in the Appendix.
6/ This figure is obtained by adding the time for the worker to hand truck stacks from the bank to the belt (0.32 + 0.41 + 0.26) plus the time to place the boxes on the belt conveyor (1.08) and subtracting this amount from the number of hours required to supply 1,000 boxes to a line dumping at assumed rate of 300 boxes per hour (3.33 man-hours per 1,000 boxes).

Table 171.--Comparative labor and equipment costs of one specified method of moving 1,000 unpacked boxes of apples from storage to the packing line by use of clamp-type 2-wheel hand trucks and belt conveyors 1/

Method	Labor and equipment required: Equipment time	Wait time	Total labor	Labor and equipment costs: Equipment	Labor	Total cost: Current wages	Assumed wages
	Machine-hrs.	Man-hrs.	Man-hrs.	Dollars	Dollars	Dollars	Dollars
Two hand truckers move stacks 35 feet from storage to build up a day's supply in bank near the belt, then move to another job, 1 worker places boxes on belt to dumper and hand trucks stacks 15 feet to belt.	2/ 8.18	3/ 1.36	3/ 4.85	4/ 3.98	5/ 5.58	6/ 9.56	7/ 10.77

1/ Taken from table 82, page 168 in body of report. Costs do not include breaking out boxes above 6-high stacks in storage room.
2/ Equipment time is made up of 3.33 machine-hours for the 140-foot belt conveyor and 4.85 machine-hours for clamp-type 2-wheel hand trucks.
3/ Taken from table 80.
4/ Machine hours are multiplied by equipment costs shown in table 2.
5/ The "current" wage rate of $1.15 per hour times man-hours of labor.
6/ Equipment cost plus labor cost at current wage rate of $1.15 per hour.
7/ Equipment cost plus labor cost at a wage rate of $1.40 per hour.

Table 172.--Labor required for a 3-man crew to move 1,000 packed boxes of apples from the packing line to storage and pile 10-boxes high by use of clamp-type 2-wheel hand trucks, belt conveyor, and gravity roller conveyor 1/

Operation	Workers	Productive labor	Fatigue allowance 2/	Wait time	Total labor
	Number	Man-hours	Man-hours	Man-hours	Man-hours
One worker segregates boxes at roller conveyor and builds 6-high stacks	1	3/ 2.19	0.44	4/ 2.13	5/ 4.76
Pick up 6-high stacks of boxes in segregation area by 2-wheel hand truck	2	6/ .23	.02	7/ 5.51	5.76
Transport 60 feet by 2-wheel hand truck	2	6/ 1.14	.11	8/ .07	1.32
Release stacks in storage with 2-wheel hand truck	2	6/ .35	.04	.0	.39
Manually high-pile boxes in 10-high stacks	2	9/ 1.64	.41	.0	2.05
Total man-hours		5.55	1.02	7.71	10/14.28

1/ In body of report, this is table 115, page 206.
2/ Page 267 of the Appendix.
3/ Page 274 of the Appendix.
4/ This figure is obtained by subtracting the productive labor to segregate plus the fatigue allowance from the total hours per 1,000 boxes (4.76 = 1,000/210) required for packed boxes to come from the packing line at an assumed rate of 210 per hour. 4.76 minus (0.44 + 2.19).
5/ Assuming a shrinkage factor of 70 percent and a dumping rate of 300 boxes per hour the number of packed boxes per hour is 210. (1,000 divided by 210 gives 4.76.)
6/ Page 282 of the Appendix.
7/ This figure is obtained by adding the productive labor, wait time, and the fatigue allowance of the two workers who hand truck and high-pile the packed boxes and subtracting this total from two times the number of hours per 1,000 boxes required for packed boxes to come from the packing line at an assumed rate of 210 per hour.
8/ Page 277 of the Appendix (fig. 133).
9/ Page 276 of the Appendix.
10/ Total man-hours is (3 x 4.76 =) 14.28.

Table 173.--Comparative labor and equipment costs for moving 1,000 packed boxes of apples from the packing line to storage by use of belt conveyor, clamp-type 2-wheel hand trucks, and gravity conveyor section 1/

Method	Labor and equipment required			Labor and equipment costs			
						Total cost	
	Equipment time	Wait time	Total labor	Equipment	Labor	Current wages	Assumed wages
	Machine-hrs.	Man-hrs.	Man-hrs.	Dollars	Dollars	Dollars	Dollars
Three-man crew--1 worker segregates, 2 workers hand truck 60 feet and manually high-pile 10 boxes high	2/ 19.04	3/ 7.71	3/ 14.28	4/ 4.37	5/ 16.42	6/ 20.79	7/ 24.36

1/ Taken from table 117, page 208, in body of report.
2/ Equipment time is made up of 4.76 machine-hours for the 100-foot belt conveyor plus 2 x 4.76 machine-hours for the clamp-type 2-wheel hand trucks, plus 4.76 machine-hours for the 15-foot gravity roller conveyor.
3/ Taken from table 115.
4/ The machine-hours are multiplied by equipment cost as shown in table 2.
5/ The "current" wage rate of $1.15 per hour times the labor hours required.
6/ Equipment cost plus labor cost at current wage rate of $1.15 per hour.
7/ Equipment cost plus labor cost at wage rate of $1.40 per hour.

Table 174.—Labor required for a 6-man crew to move 1,000 packed boxes of apples out of storage and load a railroad car by use of clamp-type 2-wheel hand trucks, belt conveyor, and gravity roller conveyor when the load is braced and stripped 1/

Operation	Workers	Productive labor	Fatigue allowance 2/	Wait time	Total labor
	Number	Man-hours	Man-hours	Man-hours	Man-hours
Set up and clean up	6	3/ 0.21	0.0	4/ 0.37	0.58
Pick up 6-high stacks in storage by 2-wheel hand truck	2	5/ .29	.03	.0	.32
Transport 50 feet to belt conveyor	2	5/ .97	.10	6/ .08	1.15
Release 6-high stacks beside belt conveyor in double rows	2	5/ .29	.03	.0	.32
Place boxes on belt conveyor	1	7/ 1.05	.21	8/ .17	1.43
Transfer boxes from belt conveyor to gravity roller conveyor	1	9/ 1.04	.10	10/ .29	1.43
Stack boxes in the railroad car	1	9/ 1.19	.24	.0	1.43
Strip every second tier of boxes stacked in the railroad car	1	9/ .90	.09	11/ .44	1.43
Brace doorway of railroad car	1	12/ .83	.08	.0	.91
Total man-hours		6.77	0.88	1.35	9.00
Elapsed time—hours					13/ 2.44

1/ In body of report, this is table 135.
2/ Page 267 of the Appendix.
3/ Pages 280 and 281 of the Appendix.
4/ During the clean up time of 0.16, which is done by 2 workers in an elapsed time of 0.08, 4 workers wait giving a wait time of 0.32 man-hour. During the clean up of 0.05 2 hand truckers are assumed to have left and the clean up is done by 2 workers in an elapsed time of 0.025. Therefore, 2 workers wait for a total of 0.05 man-hour, adding time 0.05 and the 0.32 gives a total of 0.37 man-hour wait time.
5/ Page 282 of the Appendix.
6/ Page 277 of the Appendix (fig. 133).
7/ Page 274 of the Appendix.
8/ This is obtained by subtracting the productive labor (1.05) + the fatigue allowance (0.21) from the total labor required to stack boxes in the railroad car (1.43).
9/ Page 278 of the Appendix.
10/ This is obtained by subtracting the productive labor (1.04) + the fatigue allowance (0.10) from the total labor required to stack boxes in the railroad car (1.43).
11/ This is obtained by subtracting the productive labor (0.90) + the fatigue allowance (0.09) from the total labor required to stack boxes in the railroad car (1.43).
12/ Page 279 of the Appendix.
13/ This is obtained by adding the elapsed time for the set up and clean up (0.10) + the total labor required to stack boxes in the railroad car (1.43) + the total labor required to brace the doorway of the railroad car (0.91).

Table 175.—Comparative labor and equipment costs for moving 1,000 packed boxes of apples out of storage and loading a railroad car by use of clamp-type 2-wheel hand trucks, belt conveyor, and roller conveyor when the load is braced and stripped 1/

Method	Elapsed time	Labor and equipment required			Labor and equipment costs			
		Equipment time	Wait time	Total labor	Equipment	Labor	Total cost: Current wages	Total cost: Assumed wages
	Hours	Machine-hrs.	Man-hrs.	Man-hrs.	Dollars	Dollars	Dollars	Dollars
Two workers hand truck 50 feet to belt conveyor, 1 worker places on, 1 worker transfers boxes from and 1 worker stacks boxes off the belt conveyor, 1 worker strips load and braces doorway	2/ 2.44	3/ 4.65	2/ 1.35	2/ 9.00	4/ 1.29	5/ 10.35	6/ 11.64	7/ 13.89

1/ Taken from table 137, page 235 in body of report.
2/ Taken from table 135.
3/ Equipment time is made up of 1.43 machine-hours for the 100-foot belt conveyor, 1.43 machine-hours for the 15-foot gravity roller conveyor and 1.79 machine-hours for the clamp-type 2-wheel hand trucks.
4/ Machine hours multiplied by equipment costs as shown in table 2.
5/ The "current" wage rate $1.15 an hour times the labor hours required.
6/ Equipment cost plus the labor cost at current wage rate of $1.15 an hour.
7/ Equipment cost plus labor cost at a wage rate of $1.40 an hour.

Comparisons of Labor Required to Handle Packed Cartons and Packed Standard Boxes

Time studies show that the labor required to handle cartons of apples does not differ greatly from that required to handle standard boxes. By comparing the various handling operations, it is possible to show that the differences are not statistically significant. Comparisons of the labor required to pick up, transport, and release loads are presented in table 176.

For each of the three operations involved in handling cartons, all the elements are identical to the operations in handling standard boxes. Because of this there are no great differences in the labor required to handle cartons and standard boxes. Table 176 shows that the average time to handle standard boxes falls within the range of the average time required to handle cartons plus or minus two standard errors. Therefore, it is reasonable to conclude that there is no significant difference between the labor required to handle cartons and standard boxes.

Table 176.--Comparative labor requirements to pick up, transport, and release 1,000 packed cartons of apples and 1,000 packed standard boxes of apples by use of clamp-type 2-wheel hand trucks

Operation	Cartons		Standard boxes
	Average	Range 1/	Average
	Man-hours	Man-hours	Man-hours
Pick up	0.31	0.28 to 0.34	0.29
Transport 105 feet 2/	1.91		1.91
Release	.31	.28 to .34	.29

1/ The range is equal to the average plus and minus two standard errors of the mean.

2/ At this distance the two times were identical so there is no cause to make a statistical test. A more adequate comparison, if the data were available, would be to compare the times over a wide range of distances or to compare the regression equations for transporting both types of containers. Because the weights of the containers are approximately equal and they are handled in the same manner, there is no reason to suspect that differences would exist.

Pallets and Fork-lift Truck

Studies made at two plants using fork-lift trucks and pallets indicate that there is no significant difference in the labor required to handle unit loads of cartons of apples and standard boxes of apples on pallets. Since fewer packed cartons than standard boxes are placed on pallets to make up a pallet load, the man-hours per 1,000 boxes are correspondingly higher for cartons. Packed cartons are seldom tiered in cold storage. As a consequence comparisons of labor requirements to handle cartons and boxes can be made only on the basis of first tier pick ups and releases. The times per unit load for pick up, transport, and release are the same for cartons as for standard boxes.

The average time for a first tier pick up per unit load of cartons was 0.13 minute per unit load with a standard error of 0.0039 minute. This compares with a first tier pick up time of 0.134 minute per unit load for standard boxes. Because the difference is less than one standard error it can be concluded that there is no significant difference between the two.

The average time for individual unit load releases was 0.10 minute, with a standard error of 0.0059 minute. The comparative time for releases of standard boxes was 0.106 minute. This small variation indicates that no significant difference exists.

The transportation time per unit load logically should be very close for both types of containers. Difference in weight and stability of the unit loads is not great enough to affect the speed of the fork-lift truck. Thus, the times established for standard boxes being applicable to cartons, it is only necessary to adjust the times in proportion to the number of cartons per unit load. In table 177 comparisons for handling boxes and cartons are made on the basis of man-hours per 1,000 containers. This was done to make these data comparable with other data in this report.

Table 177.--Comparative labor requirements to pick up, transport, and release 1,000 packed cartons of apples and 1,000 packed standard boxes of apples by use of pallets and fork-lift trucks

Operation	Cartons 1/		Standard boxes
	Average	Range 2/	Average
	Man-hours	Man-hours	Man-hours
Pick up	0.045	0.041 to 0.049	0.046
Transport 45 feet 3/	.205		.210
Release	.035	.031 to .039	.037

1/ An equal number of boxes per unit load was assumed for two types of cartons in order to make the comparisons.

2/ The range is equal to the average plus and minus two standard errors of the mean.

3/ At this distance, the labor requirements for cartons and boxes were so close there was no cause to test the significance of the difference. A more adequate comparison, if the data were available, would be to compare the times over a wide range of distances or to compare the regression equations for transporting both types of containers.

Belt Conveyor

In four different apple packing and storage plants, seven time studies, averaging 606 cartons per study, were made of workers placing fiberboard cartons on a moving belt conveyor. Studies also were made in three plants of the same operation when standard boxes were being handled. The size of the sample was relatively large and the labor required per 1,000 cartons was so close to that for standard boxes that no test was made of the difference (table 178).

Table 178.—Comparative labor requirements for placing cartons and standard boxes on a belt conveyor

Containers	Plants	Studies	Average containers per study	Total labor
	Number	Number	Number	Man-hours
Cartons	4	7	606	0.93
Standard boxes	3	3	336	.97

The elements of the operation of placing cartons on a belt conveyor are identical to those of placing standard boxes on a belt conveyor. Since the weights of the two packed containers are approximately equal, there should be no significant difference in the labor required to handle the two types of containers.

Comparison of Handling Operations for Industrial Lift Trucks of Various Capacities

In comparing the operating efficiencies of various sizes of industrial lift trucks it was found that the efficiencies were related to the size of the unit loads that could be handled. In ten plants in which data were gathered, the industrial lift trucks, regardless of size, travelled at approximately the same rate of speed. It is not possible for the industrial trucks to travel at their maximum rate of speed in most of the plants because of the possibility of boxes tipping off the load in turns, sudden slowdowns or stops. Safety precautions also tend to restrict the speed of the trucks in the plants, mainly because of narrow aisles. In figure 134, regression lines are shown for the various sizes and types of trucks. For the range of distance that is most frequently travelled—100 to 300 feet—three of the lines are very close together. The fourth line differs considerably from the others because it is based on data taken on two gasoline powered fork-lift trucks which were operated without governors and the speed of travel in the plant was relatively unrestricted by turns and narrow aisles.

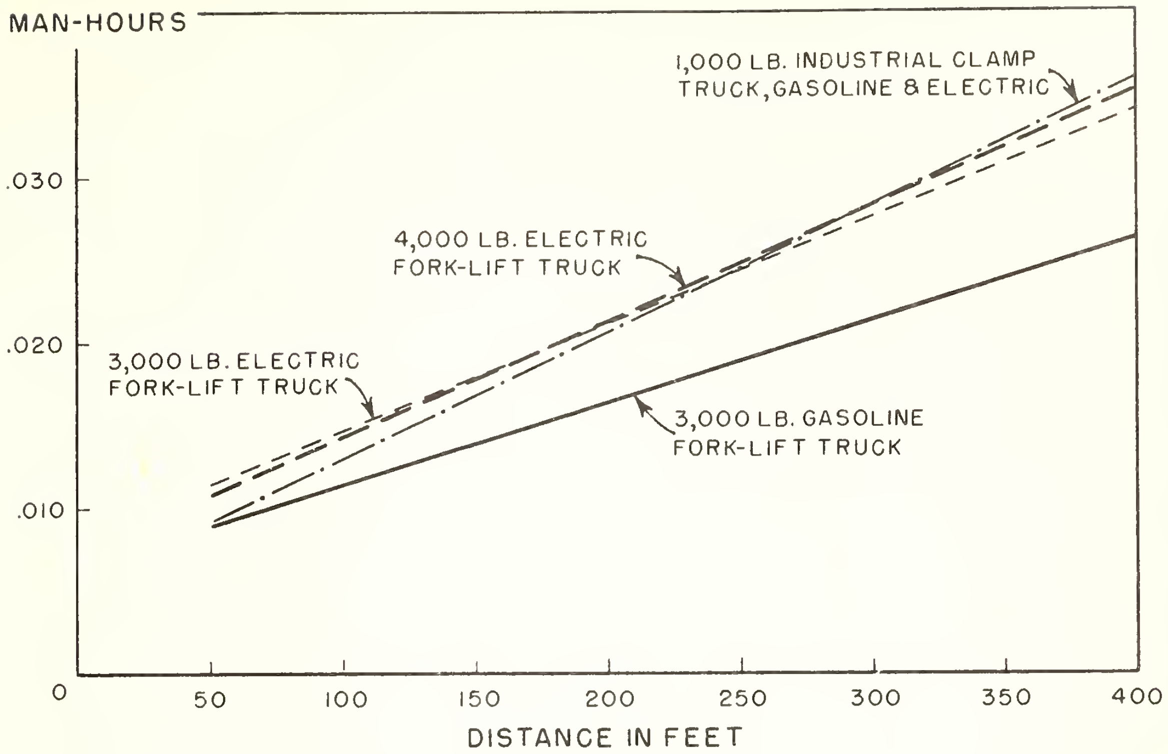

Figure 134.--Comparative labor requirements per unit load to transport boxes of apples and return empty by use of pallets and industrial fork-lift trucks of various capacities.

Data on pick up and release by various sized industrial fork-lift trucks are shown in table 179. Very little difference among the trucks in man-hours per unit load occurs in any of the operations because all the elements in either pick up or release are the same for all sizes of trucks. Data for industrial clamp-type lift trucks are not included in the table. Industrial clamp trucks are frequently used in plants that have been converted and consequently conditions are different than in plants that were built for industrial equipment.

The elevating speed per unit load of the trucks seems to be fairly uniform, possibly because the heavier unit loads offset the greater power capacities of the larger trucks. From these data it can be concluded that the relative efficiencies of the industrial lift trucks are dependent upon the number of boxes that can be handled at one time as a unit load. Man-hours per 1,000 boxes rather than the man-hours per unit load are a measure of the operating efficiencies of industrial lift trucks.

Table 179.--Comparative labor requirements for pick up and release per unit load and per 1,000 boxes by use of industrial fork-lift trucks of various capacities

Capacity of truck	Unit load			1,000 boxes		
	Road truck bed	Floor level	1st, 2nd, 3rd, tier	Road truck bed	Floor level	1st, 2nd, 3rd, tier
	Man-hours	Man-hours	Man-hours	Man-hours	Man-hours	Man-hours
Pick up						
36-box	0.0036	0.0022	0.0043	0.10	0.060	0.12
40-box	.0036	.0022	.0046	.09	.055	.115
48-box	.0034	.0022	.0043	.07	.045	.09
Release 1/						
36-box	-	0.0014	0.0045	-	0.04	0.13
40-box	-	.0020	.0040	-	.05	.10
48-box	-	.0019	.0043	-	.04	.09

1/ Releases not made onto road truck beds.

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