Mechanization of Handling

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HANDLING products into, within, and out of the series of facilities through which they must move, to provide the volumes at the places and times and in the forms required, costs more than any other part of marketing.

The cost would be much higher if we had been content with the methods and equipment of 50 years ago.

Then the marketing system for many staple food items had been fairly well developed. People bought flour, coffee, sugar, canned foods, and such items at retail stores that were supplied by wholesalers. For many perishable food items it was a rather primitive system. It was relatively short, too, because consumers bought produce in season largely from local farmers.

Lack of package and other standardization in those days was no problem: Perishable food was handled only once or twice before it reached the consumer. Labor was plentiful, cheap, willing to work as long as there was a job to be done, and ready to quit when the job was completed. There was no incentive therefore to mechanized handling operations beyond the two-wheeled handtruck or the wheelbarrow. Packages usually were handled one at a time. Unit-load handling was unknown.

Over the years many changes have occurred. The more efficient marketing firms began handling larger and larger amounts of farm and food products as both population and farm output increased. Hourly earnings of labor doubled and trebled. It was not economical any more to have men do work that machines could do better. The larger firms then could afford to invest in machines if they could use them in the kinds of facilities they occupied. Some left their old buildings because mechanized handling was impractical in them.

Let us consider now the progress made by some types of marketing agencies in mechanizing their operations and some of the possible steps ahead.

COMMERCIAL FRUIT storage and packinghouses of the period around 1910, when some operations began shifting from farm to off-farm points along railroad lines, used about the same methods of handling, sorting, sizing, and packing that were used in farmhouses.

Boxes of field-run fruit were dumped by hand on a workbench, where a worker sorted it into grades, sized it, and packed one box of each grade-size. Fruit was moved to and away from the workbenches either by hand or two-wheeled handtrucks. It took a lot of work and there was very little uniformity among boxes packed out by different workers.

When the Department of Agriculture undertook a research program in 1951 to increase operational efficiency in fruit storage and packinghouses, most houses in the Pacific Northwest were using two-wheeled handtrucks and belt conveyor lines for handling fruit in the mostly multistory facilities. Where possible, the unit-load principle of handling by handtrucks was in use, even though these loads were relatively small.

Besides the manual dumping station and equipment for washing and drying fruit, apple packing lines usually consisted of a belt conveyor or spiral-roll sorting table, two or three sections of weight-type sizing equipment (one section for each grade of fruit), and rotating tubs for accumulating fruit. From these tubs most of the sorted and sized fruit was manually wrapped and place-packed in standard wood boxes.

With 3 different grades and 12 to 16 different sizes of each grade, there were indications that some operations had been overmechanized.

The major emphasis in research and developmental work has been put on the development of improved methods and equipment for handling fruit into, within, and out of storage and packing rooms and for packing fruit.

In the many new, specially designed packinghouses, 48-box pallet loads of unpacked fruit now are picked up by industrial lift trucks from the beds of road trucks or from the apron of the storage house and transported to storage rooms, where they usually are tiered in 3-high (18 boxes) stacks. Fruit is withdrawn from storage and moved to the packing line by the same method. The unit load remains intact until the fruit is dumped.

At the opposite end of the line, packed fruit is graded and sized and put into 40-box pallet loads. It is returned to storage by the lift truck. The unit load remains intact until it is again withdrawn from storage and set in the door of a refrigerator car, or on the tailgate of a motortruck, for shipment.

In these houses, when pallet loads are built in the orchard, one worker and a 1-ton forklift truck can handle as much fruit as five or six workers can handle by two-wheeled handtrucks and belt conveyors.

Many of the older multistory apple houses still in use have adopted 12- and 24-box clamp-type lift trucks for the one-floor jobs of high piling, breaking out high-piled boxes, and transporting to or from the belt conveyor lines.

Another development since 1955 was made possible by the adoption of industrial lift trucks. It is the shift to pallet boxes (variously referred to as bulk boxes, bulk bins, and tote boxes) for handling and storing apples as a replacement for the standard wood box, that also is used as a shipping container. It was estimated that half of the 1959 crop in Michigan, the Pacific Northwest, and the Appalachian section was handled and stored in pallet boxes.

The first cost and the maintenance costs of properly designed pallet boxes are less than field crates of standard-box size. Up to 30 percent more fruit can be placed in storage in some plants in properly designed pallet boxes than in standard boxes. Fruit in pallet boxes having 8 to 10 percent open space in their sides and bottom cools faster than in standard boxes; thus 7 to 10 days are added to its storage life. Handling costs in pallet boxes are 10 to 15 percent lower than the costs in standard boxes in 48-box pallet loads. Pallet boxes reduce bruising during initial handling, but after the fruit has been in storage for more than 5 months more bruises may show up than when it is in standard boxes.

Other highlights of the mechanization of apple packing lines are the mechanical box dumper; the float-roll sorting table; an automatic box filler for loose-packing standard boxes; a semiautomatic packer of tray-pack cartons; and a pallet box filler.

Dimension-type sizing equipment, developed primarily for lemons, has been modified greatly. New commercial models have been brought out. Weight-type sizing equipment also has been improved. In both, emphasis has been given to fewer separations by size (usually six to eight) and on group sizing instead of exact sizing. For both types of sizers, rotating tubs are being replaced wholly or partly by improved return-flow belt conveyor tables, on which fruit accumulates and which provide packing stations.

A mechanical box dumper replaces one worker per packing line, and provides a more uniform flow of fruit to other work stations in the line.

On a new float-roll sorting table, developed by men of the Department of Agriculture, fruit rides forward on rotating rolls. The rotating and forward speeds of the rolls can be varied as required for inspection of incoming lots. Lanes also are provided on the surface of the table. One lane is assigned to each worker to eliminate reinspection of the same fruit by several workers. Cull chutes at the side of the table reduce the reach in disposing of this fruit.

The float-roll table increases labor productivity about 17 percent, compared with the reverse roll table, and about 80 percent, compared with the old belt conveyor table. Both improved tables are used widely.

Before improvements were made in equipment for sizing by weight, apple packing lines, which sorted to three grades of fruit and had three double sections of this equipment arranged end to end, stretched out almost 200 feet and required extensive floor space. Fruit of the same grade-size class was accumulated in as many as five different tubs. Shifting packers from tub to tub meant a substantial amount of unproductive time. Moreover, in these lines the sizing operation set the pace for all other line operations, so that there was much idle time. An improved weight-type sizer and a new dimension-type sizer have come into general use, and these problems noted largely have been alleviated.

Improved return-flow conveyor tables have two belts remaining parallel but running in opposite directions. The tables are equipped with movable powered shunts, which transfer fruit from belt to belt, maintain size separations, and circulate the accumulated fruit in front of the packers, who place-pack the fruit in standard boxes. Effort and fatigue are reduced. More important is that heads for bagging, semiautomatic tray packers, automatic standard box fillers, and pallet box fillers can be hooked up with the return-flow belt tables, which automatically feed the other machines. These packing and filling devices could not be hooked up with rotating tubs.

Another is the semiautomatic packer of tray-pack cartons. Although trays for all varieties and sizes of fruit were not yet available in 1960, this packing device has come into widespread use—almost overnight. This device and one worker can pack about five times as much fruit in tray-pack cartons as she can pack by hand in the same type of container—an increase in labor productivity of 500 percent.

The box filling device for automatically loose packing standard boxes of fruit has come into widespread use in apple and peach packinghouses. It was developed primarily as a means of accumulating in standard boxes some grades and sizes of apples for their return to storage unpacked when no orders for them were on hand. It is used for packing lower grades of apples and all grades of peaches for the market. Boxes of apples packed by this method usually are faced by hand. The only labor required for accumulating loose fruit by this method is that needed to supply empty boxes.

I should point out that few operators of apple packinghouses had adopted all the equipment and devices I have described. In houses that have gone most of the way, reductions of 50 percent in the size of the labor force previously employed are not uncommon. Some operators reported they employed only one-third the labor required by the older and more conventional methods and equipment.

Although I have centered my discussion around apple storage and packinghouses, similar facilities for other fruits and for vegetables also have made rapid strides in mechanizing operations.

Of special interest is the shift to volume-fill shaker-packing devices in California citrus fruit packinghouses and to count-fill shaker-packers in Florida houses. To settle the fruit, both devices vibrate, or shake, the container as it is being filled to either a predetermined weight or number.

The adoption of these automatic packing devices also made central sizing necessary with the abandonment of the single belt-and-roll sizers. On this type of sizer, fruit is moved forward in single file on a narrow belt conveyor line and rides against a parallel, tapered, rotating roll that spins each fruit. At the point where the distances between the belt and the roll approximates the diameter of the fruit, the fruit falls through to a bin. With the count-fill devices, the need for more accurate sizing also is indicated. As the use of these automatic packers is limited to fiberboard containers, houses in Florida are faced with a problem of precooling fruit before it is packed for shipment. They formerly depended on cooling in transit. Relatively heavy expenditures for hydrocoolers or other precooling equipment is a part of the mechanization program.

Earlier commercial egg grading and packing plants consisted mainly of one or more candling booths plus space for temporarily holding eggs and packing materials. Cases of eggs were brought up to and moved away from candling booths by hand or by two-wheeled handtrucks.

At assembly points, graded eggs usually were repacked in the same cases for shipment to terminal markets. Wholesalers there recandled and cartoned eggs for stores. At both locations, candling booths were the same dark-curtained enclosures having a candling light and workbench. Eggs were lifted, positioned, and held, one at a time, before the candling light for inspection and then packed in cartons or cases.

Candling and cartoning work stations later were connected by powered conveyor lines for moving in ungraded eggs and empty cartons and moving out empty cases and packed cartons. About eight different commercial models of integrated cartoning and candling lines were developed from them. In addition to the cartoning and candling stations, all these lines include a carton makeup machine, carton closing equipment, and a table for packing cartoned eggs in cases. These integrated lines brought greater specialization and productivity of labor.

Still later improvements include the installation of weight-type sizing equipment, tabulating or memory systems for maintaining grade-out records of individual lots, egg transfer devices and conveyor lines for more efficient presentation of ungraded eggs to the candlers, and chutes for supplying empty cartons. Lights for candling and the arrangement of candling and cartoning workbenches or stations also have been improved to effect economics in motions.

Even with these improvements, however, it became increasingly apparent that grading eggs by inspecting each individual egg before a candling light and cartoning them by hand stood in the way of attaining a high degree of labor efficiency. Some questioned the accuracy of grading all qualities of eggs and the need to grade eggs from controlled-production flocks by full candling.

As a first step in meeting the need for improved methods for grading eggs and for the detection of bloodspots in eggs, scientists and engineers in the Department of Agriculture undertook to develop a spectrophotometric method for detecting blood in eggs. This method involved a comparison of the intensity of light transmitted through an egg at two narrow bands of the spectrum. A commercial model of the electronic bloodspot detector, which had light filters for white-shell eggs only, was ready for testing in 1957.

As the bloodspot detector could not be integrated and tested in a conventional egg grading and packing line, a new, experimental line was designed and constructed in a plant that handled white eggs sized previously on the farm. Geared to the detector's 20 case-per-hour scanning capacity, the experimental line provided for flash candling and cartoning by hand.

Studies of both the experimental and conventional lines in this plant showed that when full candling of high-quality eggs (80 to 100 percent Grade A) was replaced by flash candling and electronic bloodspot detection, a saving of 3 cents a case, on the basis of 1957 wage rates, could be realized. For eggs of lower quality, costs were increased. Breakout tests showed the electronic device to be far more accurate than human candlers in detecting bloodspots.

It became evident that the elimination of the handling that full candling required would not effect a substantial net saving as long as manual cartoning, performed in the same series of motions, was continued. Moreover, it was believed that automatic or semiautomatic cartoning would require less costly and more exact sizing than was done on the farm.

Further work led to modifications of the experimental line so as to incorporate automatic sizing (by weight) and automatic cartoning of eggs. Twenty commercial models of the prototype line were in operation in commercial plants in 1959, and there was a large backlog of orders for the line. It was estimated that the new lines in larger plants could effect an average saving in labor costs of 20 cents a case and increase productivity of labor 100 percent. (Equipment costs were expected to be higher than for conventional lines, and the net savings would be smaller than this figure.)

Even greater mechanization of commercial egg plants will come when we can solve problems of inline cleaning, electronic detection of blood in brown eggs, and automatic removal from the line of eggs having unsound shells.

When poultry processing began moving to commercial plants, birds were killed and dressed for individual orders. Coops of live birds were handled by manual methods. Processing equipment consisted of a scalding barrel, a defeathering and eviscerating table, and an offal drum. High inputs of labor and the maintenance of sanitary standards were problems.

Limited mechanization and specialization of labor were introduced in commercial plants when retail food stores began ordering a dozen or more birds from processors, but commercial plants attained their present scale and mechanization of operations only when the industry became aware of the possible economies in processing poultry in the producing sections.

Today's highly mechanized plants, some of which have a capacity of 5 thousand broilers an hour, usually are designed around overhead, monorail conveyor lines, on which birds, as they are killed, are suspended from shackles for scalding, defeathering, and eviscerating. Eviscerating lines move into weight-type sizing mechanisms, from which sized birds fall into chill tanks.

Many of the already highly mechanized processing plants that went under Federal inspection in 1958 soon found that they needed even greater mechanization of some operations. Plants having production capacities of 2 thousand to 5 thousand birds an hour per line needed to install additional eviscerating lines to provide the number of inspection stations needed to maintain production or of modifying existing lines. They also were faced with increased labor costs because of the lack of mechanical methods of transferring birds from the defeathering line onto two or more eviscerating lines. Labor costs for this one operation, on the basis of 1959 wage rates, are about 10 thousand dollars a year in the larger plants.

Engineers of the Department of Agriculture and the Georgia Agricultural Experiment Station initiated research in 1958 on an experimental overhead conveyor line that provides for the automatic transfer of materials from a powered main line onto power-free branch lines. This line offers promise for meeting the need for a mechanized transfer method at a reasonable cost.

Equipment for the inline chilling of poultry, as a replacement for the conventional slush-ice chill tanks, is the next big step in the mechanization of processing plants. Commercial models of inline chilling equipment were installed in a few plants in 1959 and were undergoing the usual period of testing, changing, and improving. The matter of excess water absorption was a problem that remained to be solved.

Greater mechanization of packing

operations is another development. It includes a hydraulic tank tipper, which eliminates the manual transfer of birds from chill tanks to the packing table, and an integrated packing line, which replaces the slatted-top conventional packing table. It was designed to save labor. It has a hopper for receiving birds and a packing apron. It saved more than 5 thousand dollars annually in plants that ice-packed 250 thousand boxes. More than 75 plants had installed the tipper and packing equipment in 1958.

FLUID MILK PLANTS of the early 1900's were no marvels of mechanization as they were in 1960. Back in the days when commercial bottling and distribution plants began supplanting milk depots, mechanical refrigeration, power-driven machines, and mechanically operated bottle filling and capping machines were unknown.

Over the years, dairy plants have had many innovations in mechanization—some new and some borrowed from other industries.

Nearly all types of dairy plants since 1950 have shifted to receiving milk in bulk. Thus cumbersome and costly methods of receiving in cans are ended. Cleaning-in-place methods are improvements on methods in which equipment is torn down, cleaned, and reassembled each day.

Automation has been growing in dairy plants since about 1950. Because of the high degree of mechanization attained in nearly all types of dairy plants in 50 years, it was only natural that the industry's interest would turn toward bringing mechanical operations under automatic control.

Paul H. Tracy, former professor of dairy technology in the University of Illinois, in 1958 studied the impact of automation on dairy plants. He concluded that because of obsolescence many firms would have to scrap their facilities and equipment if they were to make their processing fully automatic. He pointed out that engineers of dairy plants have not kept pace with the needs for electronic controls and other equipment to achieve the desired degree of automation in the fewer and larger plants that will come with full automation.

It may be appropriate to raise here the question as to whether other food handling industries may not also eventually face the same dilemma as a result of advancing technology—or can mechanization in other food industries be aimed more accurately at the ultimate target?

IN LIVESTOCK slaughter plants, the adoption or development of new methods and equipment has not been impressive since about 1910, when overhead, monorail conveyor lines were substituted for tables to provide work stations for skinning or dehairing and related operations and for moving carcasses.

The rearrangement of equipment and work stations in slaughter plants since that time to provide improved layouts, however, has been significant.

To gain greater efficiency through a better flow of product and improved arrangements of work stations, a number of the older multistory plants in national meatpacking centers have been abandoned, usually in favor of smaller, one-story plants at interior points.

In livestock auction markets and terminal stockyards, yarding operations always have involved relatively long drives of each lot of animals to commission firm or sellers' pens and from the pens to buyers' pens following their sale. A lot may consist of one animal or a carload. In terminal stockyards, the pen assigned to a specific lot may be as much as half a mile from the receiving docks. To pen each lot, workers on foot traditionally drive the animals through alleys to the assigned pen, opening both alley and pen gates, to reach it. The workers return on foot, through the same alleys or over catwalks, and repeat the operation.

The mechanization of livestock market operations until 1959 had been limited to the installation of office machines and to hydraulic gates at strategic points in the yards of a few markets. Then the San Antonio Terminal Stockyards began using mechanical cowboys. This device is a modified three-wheeled, battery-powered golf cart, or carrier. One rider uses it for driving cattle in yarding operations. Four of these carts and four drivers can replace six yardworkers who operate on foot—an increase of 50 percent in productivity. An electronic or automatic device for opening and closing pen gates to achieve even greater productivity is needed. It should have wide acceptance with or without the use of the mechanical cowboy.

MANY COTTON warehousemen can remember when they yelled at workers, "lift that bale!" In most cotton warehouses, until labor costs began rising in the 1930's, bales of cotton were stacked and broken out of stacks by hand. Hand hooks were the only concession to mechanization. Bales were transported into, within, and out of warehouses by two-wheeled handtrucks. In a few warehouses, where separated storage compartments increased distances, the cotton was transported on trailers pulled by farm tractors. Open storage yards in the West frequently used road trucks for inplant transportation. In both instances, bales were loaded and unloaded by hand.

The cotton warehouse industry now has almost completely mechanized its handling methods.

The mechanization has centered around the industrial truck. Clamp attachments, instead of forks, are used for transporting and stacking bales. Hook or boom attachments are used for breaking out bales from storage stacks. Electronic scales, mounted on boom attachments, also have come into extensive use in western warehouses.

One worker and a 3-bale lift truck can handle as many bales of cotton as 9 or 10 workers can handle by manual-handtruck methods. But warehousemen, particularly in the West, have started to shift to 9-, 12-, and 16-bale clamp-type industrial trucks for the inplant transportation of bales. In a warehouse in the Texas Plains, one 9-bale truck does the work of 26 handtruckers or 5 workers and 5 tractor-trailer trains.

In the face of increasing wage rates, the cotton warehouse industry is one of the few marketing agencies that have been in a position to reduce charges. Effective June 1, 1959, warehouses in New Mexico and in the South Bend and Plains areas of Texas reduced storage and insurance tariffs 15 percent. Receiving and shipping tariffs were reduced 45 and 50 percent, respectively.

OPERATORS of grain elevators traditionally have turned grain from one storage bin to another (by conveyors and elevator legs) for the purpose of cooling the grain, equalizing moisture, drawing samples, and fumigating for insects.

Turning thus is the movement of grain through air. As the surface of the grain on a moving conveyor is exposed to the air for only a short time, however, repeated turnings may be necessary to cool warm grain satisfactorily.

Turning grain is a relatively expensive operation, which costs one-fourth to three-fourths of a cent for labor and equipment to turn a bushel once. Grain is turned an average of four times each year in some sections. Furthermore, turning means a loss of storage revenues, because empty storage space must be maintained in which to turn grain. In one small sorghum grain storage in southern Texas, for example, 20 percent of the total space was used to receive turned grain; the loss in storage revenues was more than 4 thousand dollars a year. Turning also causes considerable breakage and shrinkage of grain.

Grain aeration—the movement of air through stored grain—was used first in small bins of the type used on farms, in flat storages, and in ships of the reserve fleets, none of which had equipment for turning grain. Such successful use attracted considerable attention among operators of elevators and other commercial storages.

A number of attempts were made to design efficient and economical systems for upright- and large-flat types of commercial storages. Many were not successful because they ignored sound engineering principles of air movement or were not operated within proper limits.

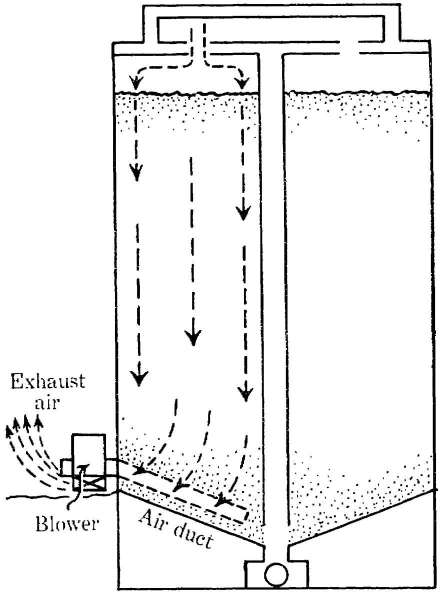
Engineers in the Department of Agriculture began research in 1954 in cooperation with the engineers of the experiment stations of Georgia, Indiana, Iowa, Michigan, and Texas to develop suitable equipment, methods, and operating procedures for the aeration of grain and dry beans in commercial facilities.

The widespread adoption of their first results prompted the Grain Elevator and Processing Superintendents Association at its 1956 annual meeting to predict that within 5 years 90 percent of the commercial grain storages in the country would be equipped with mechanical aeration systems.

Preliminary data place annual costs of aerating grain at about one-fourth to 1 cent a bushel and annual savings by substituting aeration for turning at one-half cent or more a bushel. If 90 percent of the industry adopted aeration, annual savings should approximate at least 15.7 million dollars.

Increased storage revenues of about 1 million dollars a year also might be realized from existing storages through better utilization of space. Costs of fumigating grain against insect damage also should be less.

MECHANICAL AERATION OF GRAIN STORED IN COMMERCIAL STORAGES



Aeration is practical in deep tanks as well as in shallow bins for preventing heating, molding, and caking of the stored grain. For less than 1 cent per bushel for power, recommended amounts of air can be moved through grain stored in tanks up to 150 feet high.

PUBLIC REFRIGERATED warehouses, sometimes thought of as part of the intransit bridge between shipping points and terminal points in the food marketing system, receive, store, and ship millions of tons of perishable products each year. Handling of materials may account for 75 percent of the physical operations in the warehouses.

More consideration once was given to the costs of land for warehouse sites and to refrigerating the structures than to handling costs. All public refrigerated warehouses were multistory buildings, in which elevators generally provided means for handling between floors. Two- and four-wheeled handtrucks and manual stacking methods were in general use.

Designed and financed by the Federal Government as a war measure, the first single-floor public refrigerated warehouse was constructed during the Second World War. In it, industrial forklift trucks and pallets were used for handling products in unit loads. Handling costs averaged about 35 percent less than in multistory warehouses.

Since the construction of the prototype one-story warehouse, few new multistory warehouses have been constructed—nearly all new ones largely have followed the one-floor design.

At the terminal end of the marketing system, most wholesalers of some 60 years ago were small, independent dealers. Produce dealers usually operated in established market areas, where the facilities available were designed for other purposes. Wholesalers of dry groceries tended to locate outside the market areas in their own buildings. In both, handling was either purely manual or by handtrucks. Attempts to improve these methods usually were limited to the installation of a few sections of gravity-type conveyors to bridge the differences in heights between railroad car or motortruck floors and warehouse floors. Independent service wholesalers and chainstore warehouses since about 1940 have led the way in the adoption of mechanized handling methods. With the exception of beef carcasses and some other irregular shaped items that do not lend themselves to unit load handling, the use of pallets and skids has come into fairly widespread use. In receiving, unit loads are built as the products are unloaded from railroad cars or motortrucks and moved by skid jacks, pallet transporters, or industrial lift trucks to storage areas. Because of the instability of some types of packages, which limits stacking height of unit loads, pallet racks are coming into general use in wholesalers' warehouses.

With the growth of service wholesaling, methods of assembling products from storage areas and loading delivery trucks also have become more highly mechanized.

In some warehouses, entire unit loads are withdrawn from storage and are brought to the shipping area. In others, orders are totaled to determine the exact amounts of each specific item needed for all orders and only that amount is withdrawn from storage. Portable belt conveyor lines, which extend from the assembly area in the warehouse to the loading face in the truck, can accomplish the last of the shipping operations.

But improved technology in these warehouses has not been limited to greater use of lift trucks and other mechanized handling equipment. Recording and transcribing equipment is employed in at least two ways in addition to usual office methods—for receiving orders from salesmen and to replace checkers who call out items in individual orders as they are loaded.

An obstacle to the more general adoption of mechanized handling by all types of wholesalers is outmoded buildings. Savings in labor of up to 50 percent in facilities of modern design, in which mechanized equipment can be used efficiently, make a convincing argument for abandoning obsolete structures or putting them to other uses.

Retail food stores at the turn of the century were purveyors of food that served also as social institutions, extended credit to their customers, and made deliveries. Clerks waited on each customer and bagged and weighed individual orders. Prepackaged items largely were unknown.

When self-service retail food stores eliminated the need for clerks to wait on customers, some experts felt that these stores had no further possibilities to effect savings or to increase labor productivity.

Research in the Department of Agriculture has pointed the way to many additional improvements in operation of retail stores.

Progress in meat departments, for example, began with the shifting of butchers and other workers to a special room designed and equipped for cutting, grinding, and packaging meats and meat products for self-service displays. Except for special cuts of meat, butchers were relieved of responsibilities for direct contacts with customers.

The establishment of meat rooms has permitted the complete mechanization of many operations that formerly required high labor inputs. As an illustration, new equipment now automatically grinds, packages, and prices hamburger as an integrated operation. This equipment plus numerous other mechanical innovations that have come since about 1950 have sharply increased the productivity of workers in meat departments. Beginning with average sales of roughly 25 dollars per man-hour of labor employed about 1950, a number of stores that have moved and mechanized their meat departments reported that 1959 sales per man-hour of labor had increased to 44 dollars. Although increases in meat prices during the 9-year period account for part of the difference, increased labor productivity accounts for the major part.

With the increase in the number of prepackaged items, produce departments in many supermarkets also have been assigned a backroom, where selected products can be trimmed, packaged, and placed on specially designed trays for handling and display.

Thus the shelf life of produce is increased, and waste is minimized. Sales per man-hour of labor also have increased—from about 21 dollars in 1950 by conventional methods to 29 dollars in 1959 by the new methods.

In some stores where improved methods and equipment have made the greatest inroads, sales for the store as a whole have risen from 25,400 dollars annually per worker employed in 1948 to 41,200 dollars in 1958.

ALTHOUGH the effects of the mechanization I have cited have been many and varied, none has had a greater impact than the reductions made possible in the unit costs of handling products as the volumes handled in a single establishment increased.

True, these reductions in unit costs have not been enough to bring about reductions in total costs. But this would be too much to expect when it is recognized that total costs now cover the handling of substantially larger volumes of products and the performance of additional services plus inflation.

Possible economies of scale on the part of marketing firms actually is another way of pointing up possibilities of achieving unit cost savings as volumes handled warrant the adoption of improved technology and of determining, for example, when two industrial lift trucks or another packing line should be installed.

Fixed, or ownership, costs of such equipment should of course be considered in terms of fractional utilization, influenced by seasonal operation and related factors. Possible savings in unit costs, however, usually have been so great, and the expectations of further increases in volumes so well founded, that the degree or extent of utilization of the second or third units of equipment usually has been of relatively minor importance to most of the larger marketing firms.

Just as the mechanization of farms has encouraged a shift to larger units, so has mechanization in the agricultural marketing system encouraged business—and for like reasons.

Despite continued increases in the total annual volume of agricultural products moving through the marketing system and the demand for more and more services, smaller marketing firms have found it increasingly difficult to maintain a share of this business because of the competition provided by larger, more highly mechanized firms.

As a consequence, many of the smaller firms, whose respective volumes of business did not justify heavy capital outlays for equipment, now have sought other enterprises. And with this decline in the number of smaller marketing firms, larger firms usually have taken over both the volumes vacated plus those stemming from increased consumer demand. Moreover, many of the larger firms now are in position to seek out and pay for the consulting and research services needed to increase their competitive advantage among firms of their same relative scale of operations. In this respect, smaller firms also are at a distinct disadvantage.

Farm economists and engineers have pointed out that if the shift on farms from horse-drawn and horse-powered equipment to mechanically powered equipment had not taken place during the first half of the 20th century, our present levels of farm production could not have been attained. But largely because of these multipliers of human effort on the farm, in 1960 only 12 percent of the total population could produce more foods, fibers, and other agricultural products than were in demand by the total population.

The situation has not been so favorable in the agricultural marketing system. The number of workers employed by marketing firms has continued to increase from 2 to 3 percent each year. Thanks to the progress made in increasing worker productivity, this increase is relatively small in proportion to the increased volume of products moving through the marketing system each year and the increase in services rendered in the preparation of oven-ready or table-ready products. If the productivity of marketing labor had not been increased above the levels prevailing around 1910, it is doubtful whether sufficient work stations could be provided in our present facilities for the labor that would be required to move the 1960 volume of products.

But lack of space for workers is not a primary consideration of marketing firms, which have been investing about 850 million dollars each year in new and improved marketing and off-farm storage facilities. Although the replacement of facilities destroyed by fires, hurricanes, and other disasters accounts for part of this amount, a substantial part of this investment stems from the impact of mechanization. Multistory facilities in congested downtown areas, which were designed for a bygone age, are giving way to new structures specifically designed for the operations to be performed and the methods to be employed. Transportation facilities also have been similarly affected by improved methods and equipment and, in some instances, have pointed up the need for greater mechanization. Notable among these shifts are the use of tank trucks for hauling milk, which have replaced expensive labor and equipment in the plant for receiving and handling milk in cans.

Greater mechanization of handling operations also has been directly responsible for reducing the spoilage and waste of perishable items by minimizing the number of times products are handled during the course of their journey from farms to consumers and by providing gentler handling.

In fact, the stimulus for many improved methods now in use has been quality maintenance rather than savings in labor and other costs.

In conclusion, I should point out that the benefits from the mechanization on farms would have been largely dissipated in the marketing of farm and food products if corresponding improvements had not been made in the marketing system.

Railroads, Trucks, and Ships

John C. Winter

MAY 10 of 1869 was a big day in Promontory, Utah. Amid speechmaking and jollification, a golden spike was driven to mark the coming together of two lines of railroad track, one from the East and one from the West. The Pacific Railroad had been completed. A route was open between the Atlantic and the Pacific.

The oxcart, the mule team, the sailboat, the canaler, and the steamboat had all held worthy places in the Nation's early development. But the development and expansion of the railroads, in which the ceremony at Promontory was an incident, were primarily responsible for the settle-