COMPUTERIZED CHECKOUT SYSTEMS FOR RETAIL FOOD STORES

MANAGEMENT INFORMATION BULLETIN NO. 3

A Cooperative Report by the Bureau of Business Research, School of Business, Indiana State University, and the Transportation and Facilities Research Division, Agricultural Research Service, United States Department of Agriculture.

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COMPUTERIZED CHECKOUT SYSTEMS FOR RETAIL FOOD STORES

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April 1971

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FORWARD

This study was conducted under a Cooperative Agreement between the U.S. Department of Agriculture and Indiana State University. The costs presented in the study were determined by synthesizing data developed in a laboratory test with operational standards provided by industry cooperators or documented by previous studies. Additional research needs to be done to verify the estimated savings under normal store operating conditions.

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COMPUTERIZED CHECKOUT SYSTEMS FOR RETAIL FOOD STORES

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SUMMARY

A preliminary study of a computerized checkout system resulted in reduced operating costs of five and a half percent, with slight variations, depending upon the customer checkout procedure used. The estimated savings were approximately 1.2 to 1.5 percent of sales which is substantially more than the net earnings after taxes of .92 percent as reported by food chains for 1969. If this savings were applicable to all retail food stores in the United States, the savings would approximate $1.2 billion annually.

The savings estimates were based on a laboratory evaluation of an optical scanning, computerized checkout system and an assumed representative supermarket with annual sales of $4 million. The potential savings figures do not include estimates for the presumed additional economic benefits that will result from having current, accurate product and management information.

The total computerized checkout system is assumed to encompass the activities of ordering, inventory control, pricing, checkstand operations, sales analysis, management control, labor scheduling, advertising, promotion and customer relations. All employees and management at the store, warehouse and headquarters levels will find their work methods influenced by a computerized system. It encompasses much more than the process of checking out the customer's order.

The key to the system's effectiveness is the ability to optically scan code marked or tagged merchandise.

This report is based on an evaluation of a computerized checkout system that contained an electro-optical scanner as one of its key components. Each product item in the store was assigned an eight digit identification code represented by a pattern placed on the individual packages. When the items were checked out, the scanner "read" the pattern and transmitted the code to the computer. The computer matched the number with the product information and relayed it to the register. While this was going on, one unit of the item was deducted from book inventory. The price was displayed on a display unit and a sales tape was simultaneously printed for the customer along with a brief six letter description of the item. Other product information was also printed out for the customer.

A laboratory evaluation only was conducted on this system. Results were compared with checkout standards that had been developed by industry cooperators utilizing conventional checkout equipment. Two basic checkstand conditions were simulated to facilitate the comparison of scanning with conventional productivity. In the first condition, the shopper unloaded the shopping cart onto a conveyor belt and the checker processed the order, including bagging the groceries. In the second, using a split checkstand, the checker unloaded the shopping cart, processed the order and bagged the items.

In the simulated situation in which the split checkstand was used, optical scanning improved checkstand throughput 18 percent. A 19

percent improvement in productivity was realized when the shopper unloaded the cart. For a store with a $4 million annual sales volume, the 18 percent increase in productivity represents a cost savings of $16,200 or a 1.9 percent reduction in operating costs. The 19 percent increase in productivity would result in a savings of $17,424 annually or 2.1 percent reduction in operating costs. An individual grocery item can be scanned and recorded 52 percent faster than it can be rung-up using conventional cash registers and techniques.

Checkout errors were reduced by an estimated $14,200 or 57 percent using optical scanning. This represents a reduction in operating costs of 1.7 percent annually. In addition, it is estimated that the length of time necessary to train checkers could be reduced by 33 percent.

Once universal product codes are placed on the grocery items by manufacturers, the need for price marking and repricing can be eliminated. Potential savings could amount to an estimated $10,200 or 1.2 percent of operating costs by facilitating a reduction in time spent taking inventory and ordering.

For the first time, the retailer can have instantaneous current product movement data which can be used for such specific studies as (1) shelf space allocation, (2) department profitability, (3) labor scheduling, (4) consigned goods identification, (5) shrinkage, (6) advertising and promotion, (7) pricing decisions, (8) new item evaluation, (9) out of stocks, (10) selecting product mix, and (11) other statistical data. Management will have a wealth of product movement information by individual product, department, store, and chain for each day, week, month, and year. Effective use of this information will result in substantial savings and reduced operating costs.

The results of the evaluation suggest that, aside from potential information benefits, a retail store with a $4 million annual sales volume could potentially realize a total annual savings of approximately $45,000 by using an optical scanning computerized checkout system. The potential savings are substantial enough to justify the establishment of test installations, recognizing that the full potential of computerized checkout systems will not be realized for a few years.

The cost savings presented in this study were determined by synthesizing data developed in a laboratory test with operational standards that were provided by industry cooperators or documented in the literature. Additional research needs to be done to verify the estimated savings under normal store operating conditions. The introduction of a computerized checkout system into an existing store environment could point up contingency situations that have not been visualized.

Research should be undertaken to develop cost-benefit estimates for the many types of management information reports that could be generated from data provided by the system. Consideration should be given to the frequency with which reports should be generated as well as the nature and number of reports to be developed.

There is an immediate need for research to be conducted to determine the best means for printing and applying product identification code labels on merchandise. Until these codes are printed on the containers at the point of manufacture or processing, it will be necessary to apply them at the retail store or at the warehouse.

Many operations at the store, the warehouse, and at headquarters will be affected by the introduction of the computerized checkout system. Cost-benefit studies should be undertaken to determine the most effective procedures to be followed to achieve an economical operation without sacrificing customer satisfaction.

While some questions remain to be answered, most can be resolved by evaluating the system under normal operating conditions in retail stores. Once a test installation has been established, research should be undertaken to determine (1) customer, checker, and management acceptance of all aspects of the system, (2) the best methods for handling perishable items to effectively utilize optical scanning, and (3) the optimum design for a checkstand that will appropriately incorporate the bagging function.

INTRODUCTION

In 1969, average sales per chain store reached a new high of over two million dollars, yet net earnings after taxes declined to their lowest point in a ten year period, .92 percent of sales. While sales have been increasing, gross margins have shown a continuous decline to 21.3 percent of sales, the lowest point in a decade. Payroll expense continues to be the most significant expense item at 10.5 percent of sales; equivalent to one-half of gross margin. Average payroll expenses increased 72 percent while average chain store sales increased 65.6 percent since 1961. (1) The rise in retail food prices has provided the impetus for consumer complaints. These complaints have created considerable pressure for the retailer to stop passing on price increases and to provide additional shopping information.

The retail food industry finds declining margins subjected to external consumer pressures and internal economic pressures. Management continually seeks to improve operating methods and reduce operating costs in order to survive these countervailing pressures. Reductions in operating costs will benefit the consumer if they are reflected in lower prices, or reduced price-increase rates, or in more consumer services at the same price.

The industry is striving to meet the challenges of more services, such as fast food, unit pricing and code dating. While the number of items carried in new stores approaches 10,000, management is seeking to utilize electronic data processing for control of space allocation, purchasing, delivery scheduling, and other new ways. The Food Industry is attempting to develop a universal product identification code which will control product movement from the manufacturer to the consumer. This control can become a reality with the development and utilization of a computerized checkout system.

The computerized checkout system appears to offer retailers the possibility of reducing operating costs. In this report, the computerized checkout system is referred to in the broad sense and is assumed to encompass the activities of ordering, inventory control, price marking, sales analysis, management control, labor scheduling, checkstand operation, advertising and promotion; all of which influence product turnover, gross profit and return on investment. The key to the system's effectiveness, though, is the ability to optically scan code-marked merchandise.

The computerized checkout system will affect the job performance of nearly all employees and decision-makers regardless of level or location. The computerized checkout system will encompass much more than just the process of checking out customers.

The development of a computerized checkout system utilizing improved optical scanning raises questions which need to be examined and resolved. What will be the economic feasibility of adapting computerized checkout systems to retail food firms? What will be the potential impact of scanning devices as components in the system? What changes in store operations such as inventory control and reordering, price marking and repricing will result? What effects will this system have on personnel, computer backup equipment needs, management information and customer acceptance of the store?

The study was designed to develop, through use of actual equipment in an in-store simulation, a preliminary evaluation of the feasibility of a computerized checkout system. The basic objectives of this study were to determine:

1. The potential economic impact of the computerized checkout system on over all store operations. The "impact" was determined by means of a cost-benefit analysis.

2. The optical scanning checkout station performance in comparison with present conventional checkouts. "Performance" included accuracy, efficiency, and productivity, before and after new work methods and procedures were developed.

The Project's....

Scope and Methodology

A cost-benefit analysis was made of store operations affected by computerization of the checkout function. To facilitate the analysis, a profile of an assumed representative store was developed. This store was assumed to have an annual sales volume of four million dollars.

A store of this size was selected because a store of this high volume has a more immediate need for the efficiencies inherent in the computerized checkout system. Therefore, it was assumed that stores of this size will more likely be among the first to implement a computerized checkout system.

Of particular significance, and providing the basis for this report, was the laboratory evaluation of an optical scanning checkout station. It was compared with checkout standards developed by industry cooperators utilizing conventional checkout equipment.

The Engineering Evaluation

A functional engineering evaluation was made of the optical scanning checkout station's performance and efficiency. The evaluation concentrated on station performance and the ability to meet the performance criteria of an actual retail food store computerized operation. In addition it was determined how efficiently the system functioned. The performance rate of the scanner checkout station was determined by micromotion study and compared with standards for conventional checkout stations of man-hours per 100 orders.

An inexperienced checkout operator was trained and familiarized with the use of the electronic scanning equipment. This person was able to develop proficiency in using the scanner within several minutes after starting. During this early trial period, the total elapsed-time to process an order was recorded. After about two hours of practice, the overall order processing time had stabilized at approximately 30 percent less than the initial timings.

The total checking operation was broken down into detailed work-elements performed by each hand and machine. A 16mm movie camera equipped with a wide-angle lens and constant-speed drive motor was used to photograph each activity. The camera was driven at a rate of 1,000 frames per minute. By counting the number of frames associated with each activity it was possible to determine the time values for each element. The number of activities filmed were equivilent to thirty separate orders. A sufficient number of frame counts were analyzed of the critical or control elements to insure an accuracy of plus-or-minus 5 percent.

The time values in minutes obtained from an analysis of the film were defined as basic times for purposes of this report. A personal and fatigue allowance of 15 percent was applied to the sum of the basic time values of regular work elements. Standard time is defined as basic time plus the personal and fatigue allowance.

System Performance

The performance of the computerized checkout system was evaluated over a three month period. The equivalent of 1,500 orders consisting of 38 grocery items were processed. Characteristics such as the ease of changing the register tape, precision required of hand motions to center the scanner on the identification label, ease of executing the procedures required to change the computer program and ease of recalling data were each evaluated.

A Profile Of....

Today's Checkout Systems

The checkout operation plays a vital role in todays' self service retail food store. For many shoppers the checkstand is the only location where they come in personal contact with a representative of the store management. The ability of the checker to be courteous, friendly, accurate, and able to process the order quickly makes an impression on the shopper which may strongly influence her image of the total store.

Few other store departments offer as much opportunity to reduce operating costs as does the front end. It represents one of the major sources of operational expenses; nearly 40 percent of the man-hours needed to operate a store. (2) Maintaining security, checker accuracy, and productivity are three major management problems. In addition, labor scheduling problems compound the job of managing the front-end to achieve maximum efficiency and customer satisfaction.

Productivity

Checker productivity varies widely depending on the proficiency of the checkers and baggers, the type of equipment and training provided, the level of customer traffic, and the method of operation. To illustrate the relationship of productivity and method of operation, standard time values were developed from data supplied by industry cooperators and USDA researchers.

Standard orders processed per man-hour ranged from 40.8 for stations with customer unloading to 30.7 for stations with checker unloading (Table 1), costing slightly less than 10 and 13 cents per order respectively. The data indicates that the conventional checkout operation with customer unloading was the most efficient of the two conventional operations studied. Adding additional labor at the checkstand speeds order processing but also adds to the cost of processing the orders. The added cost would more than offset gains.

TABLE 1 - Comparative Productivity of Conventional Checkout Operation; Customer Unloading vs. Checker Unloading the Cart.

Handling Method	Std. Orders Per Man-Hour	Store Cost Per Order
	(Number) 1/	(Cents) 2/
Customer Unloading	40.8	9.80
Checker Unloading	30.7	13.03

1/ Source: See Appendix Tables 3 and 5.

2/ Assumed wage rate of $4.00 per hour including employee fringe benefits.

Costs of Operating

Positive cost-control is a function of the firm's ability to control front end payroll costs, labor scheduling, checkout errors and customer-service policies. Close and continued monitoring of existing management practices and policies is required.

Labor

It was found by Harwell (3) that payroll costs of the checkout operation amounted to twenty percent of the total store payroll or about 2.1 percent of sales. Sanford (4) estimated that labor costs for the checkout operation averaged about 1.65 percent of sales. One food chain (5) estimated that, for an average $4 million store, the checkout operation required 18 full-time equivalent employees. This represented approximately 4 full-time employees and 28 part-time employees.

Training Employees

Part of the labor cost involves the training of personnel. Harwell (6) reported that a training program of 16 hours was typical. One industry cooperator (7) reported a total commitment of 92 hours per checker trainee. Appendix Table 1 contains the cooperator's breakdown of time spent in training checkers.

Error Costs

One chain reported that a study of checker accuracy revealed three types of errors — underrings, over-rings, and overlooked items (on the bottom of the cart) — which contributed to an annual net loss due to errors of $2,400 per store. (8) Another chain reported that if losses from these sources were eliminated, its net profit before taxes would have increased an additional 1.07 percent of sales. (9) Other estimates vary from a low of 0.2 percent of sales to more than 1.4 percent with an average of about 0.7 percent. (10)

The Learning Systems Development Corporation (11) estimates that 12 types of losses can be incurred at a checkout lane (Table 2). For a supermarket with a $4 million annual sales volume, checkout lane error losses could amount to $25,000 or 0.625 percent of gross annual sales.

Harwell reported check lane errors equalled 0.70 percent of sales, or $28,000 annually for a $4 million store. (12)

Cash Control

One of the basic purposes of the checkout function is cash control. Cash control consists of a detailed accounting of the amount of money that is processed at each checkstand by individual clerks by period worked. It is axiomatic that if the number of people handling cash can be reduced, the chances for errors in handling and theft can be reduced.

TABLE 2 -- A Distribution of Estimated Checkout Lane Losses, By Type of Loss, With Estimated Influence on Gross Store Sales, for a Store With A $4 Million Annual Sales Volume.

Type of Loss	Percent Of Total Checkout Losses	Estimated Percent of Store Sales Involved 1/	Dollar Amount For A $4 Million Store
	(Percent)	(Percent)	(Dollars)
1. Checker Misinterpretation of Price Mark	4	0.025	$ 1,000
2. Failure to Ring Items Left In Bottom of Carts	36	0.225	$ 9,000
3. Improper Handling of Coupons	4	0.025	$ 1,000
4. Improper Calculation of Multiple Prices	4	0.025	$ 1,000
5. Making Change	2.2	0.0137	$ 548
6. Items Missed or Overlooked	28	0.175	$ 7,000
7. Improper Calculation of Sales Tax	2	0.0125	$ 500
8. Poor Skill in Handling Registers	2	0.0125	$ 500
9. Failure to Note Price Changes	1.8	0.01125	$ 450
10. Loss of Customers Through Lack of Courtesy	6	0.0375	$ 1,500
11. Poor Bag Handling	6	0.0375	$ 1,500
12. Improper Handling of Trading Stamps	4	0.025	$ 1,000
TOTAL	100	.625	$25,000

1/ For use in multiplication, decimal must be moved 2 places to the left, i.e., 0.025 percent = 0.00025.

Source: Learning Systems Development Corporation, Cincinnati, Ohio

Elements of A....

Scanner Checkout Station

During the past three years, much has been written about the development of computerized checkouts. To date much of what has been written has consisted of speculation and anticipation about how these checkouts will operate. At the present time, few models are being field tested under actual store operating conditions. Most models tested have been primarily of the type where the operator manually enters a product identification code into the machine via a keyboard.

Several firms are experimenting with systems in which an optical character recognition device "reads" the product code directly off of the item package. At the time of this report, no manufacturers have released information on their system's performance and efficiency.

A system was made available to the U.S. Department of Agriculture for evaluation. This system operates using a principle of optical pattern recognition. The results of a laboratory evaluation conducted cooperatively by the U.S. Department of Agriculture and Indiana State University provided the basis for this report.

Optical Scanning Compared With Other Techniques

It was not possible to compare precisely comparable systems. It is, therefore, desirable to briefly consider the rationale behind the alternative checkout techniques that were compared. Two very important characteristics present in all systems presently being considered are the possibilities for automatic and instant inventory control, and the possibility for automatic ordering. To facilitate these accomplishments, most systems have required the use of item identification codes.

A major difference in the computerized systems being developed is the method for entering the product identification code. Three techniques have been mentioned most frequently for performing this operation; manual keyboard entry, optical character recognition, and optical pattern recognition. The latter two involve the use of mounted or hand held scanning devices. The major features of each of these are:

1. Manual keyboard entry - This feature is one similar to the conventional checkout system in use today. A checker manually depresses keys to register price, department and tax. Computerized checkout systems utilize manual keyboard entry as an emergency input device and will require the registering of more product identification code digits than that associated with the standard checking procedure. It is anticipated that these codes will consist of seven or more digits. It is difficult to see how the manual entry approach will reduce errors associated with present checkout methods. Manual entry relies on the human checker for performing all the checkout operations.

2. Optical character recognition - This feature utilizes a scanning device to "read" man readable characters electro-optically. This eliminates the need for the manual entry of product identification code digits. The technology facilitating the use of this technique is not fully developed. The practicality of systems employing optical character recognition is limited on two counts: (a) The characters must be of a particular type font and (b) the cost of recognition is approximately twenty times that of optical pattern recognition.

3. Optical pattern recognition - This feature involves the transformation of each item's product identification code into a unique pattern which can be "read" by an electro-optical scanner. Scanning devices that can decode simple patterns cost about five percent of what optical character recognition units cost. While a pattern is not man-readable, it is possible to have the code in readable form adjacent to the pattern. The lower cost and the elimination of the human factor involved in entering the product identification codes manually are advantageous characteristics of this feature.

Each of the above features yields benefits to the retailer when universal product identification codes are placed on items by the manufacturer and utilized by the system. Presently, identification codes must be placed on items in the backroom of the retail store or at the chain warehouse.

The Charecogn System

Charecogn Systems, Inc. of Natick, Massachusetts was reportedly the first firm to develop a working experimental model of an improved computerized checkout system, utilizing an optical pattern recognition device, and at the same time making the device available for public evaluation. This system was delivered to Hyatts-, ville, Maryland where it was given a laboratory evaluation from June 23 to October 9, 1970 for engineering proficiency and economic efficiency.

This section of the report describes the various components of that system.

The Charecogn System consisted of a series of product identification code labels, an optical pattern recognition scanner, a registering device, a mini-computer, a high-speed printer, teletype machine, and computer program tapes. Each grocery item used in the evaluation was assigned a unique product identification code number; with different numbers being assigned to different sizes of the same brand of product. It was assumed during the evaluation that a universal product code will eventually be adopted requiring the manufacturer or processor to incorporate his product's proper identification code on the package or container. At present, this code must be applied by the retailer or wholesaler utilizing a printed gummed label or an inked stick stamp. Price and other product information associated with each of the identification code numbers was stored in the computer.

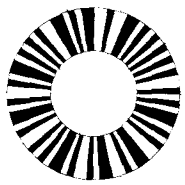
It was assumed that, as a substitute for item price marking, price information would be placed on shelf strips or cards in the aisles. Thus, each item would not need to be price marked and periodic price changes could be made in the computer and on the shelf. The electronic checkout system was programmed to maintain a continuous item by item inventory. As an item was sold at the check stand it was automatically subtracted from book inventory. Inventory and sales data was retrieved via the teletype printer.

Information associated with the identification code stored in the computer consisted of a six character item description, the price per standard measure, identification of the department in which the item was sold, and inventory data.

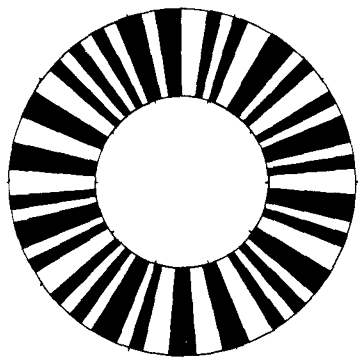
Basically, the system operated as follows: The scanner "read" the product identification code on the package, sent the code number to the computer which retrieved the product information and relayed it to the register. The price was shown on a nixie tube display unit and simultaneously printed the shopper's tape including the price per standard measure.

Product Identification Code

The product identification code consisted of eight digits plus a check digit. To facilitate efficient scanner recognition the code was transformed by Charecogn Systems, Inc. into a circle configuration one inch in diameter. This pattern consisted of a circular array of radial black and white elements of varying thicknesses (Figure 1). The pattern can reportedly be adjusted to accurately identify 100 million different items. The pattern which can be printed using common printers ink, can be applied to an item using pressure sensitive labels, or a rubber stick stamp.



1432 5133 8



2354 6139 7

Figure 1 - Charecogn Identification Code Labels.

Optical Pattern Recognition Scanner

The scanner device was designed to be hand held (Figure 2). It is 7.75 inches long, 1.5 inches in diameter, weighing about 10.5 ounces. A tapered optical end permits tag location with relative ease. The operator holds the scanner in one hand while positioning the item to be scanned with the other hand. When placed over an identification code pattern, the scanner, utilizing its own light source, differentiates among the patterns of reflected light intensity bouncing off the label. The focal range of the scanner device used in the test was approximately three-eighths of an inch. In actual operation, the operator often chose to touch the scanner to the label.

Figure 2 - Optical Scanner Tested

Computer

The computer utilized during the test was a mini-computer with 8K core storage capacity. The "computing" consisted primarily of addition and subtraction. The ability to enter storage and retrieve the proper price information quickly was of prime importance. The mini-computer used in this test could have handled the computing operations for 60 registers. It is anticipated that a smaller model would be satisfactory for a single supermarket. However, additional disc core storage will be needed to take care of the approximate 10,000 items in a large supermarket, and to perform additional functions required by management.

The computer program was loaded into the computer utilizing a Mod 33 teletype and a high-speed reader. Program revisions such as the addition of new items to the inventory, price changes, and date changes were made via the teletype. The test situation simulated program revisions made at the store, although the system could theoretically receive program changes from a central headquarters location.

Printer

The printer in the register was an alphanumeric printer with a capacity for printing thirty characters per row on the sales tape. The printing mechanism was located on the right-hand side of the register under the register housing. The tape output of this printer was more acceptable by the customer because it contained more information than is presently received. The tape (Figure 3) contained dual pricing information (unit price plus price per standard measure), a six character description of the item purchased, total sales, number of stamps to be received, amount sales tax due, the date, and a brief store message. In addition, the tape indicated with an asterisk which items were multiple-priced. It also indicated the amount of credit received for promotional discount coupons.

Teletype

A teletype was utilized in the system. It was used to punch program tapes for a high-speed reader or for direct access to the computer to make minor program changes. In the test model, it was used to print out total sales data, total inventory, date changes and price changes (Figure 4).

Program Tape

The computer program was fed into the computer via a paper tape and high-speed reader. The system accepted program revisions in the same manner as if they had been received via magnetic tape or punch cards.

.11	JELLO	.04/OZ
.11	JELLO	.04/OZ
.11	JELLO	.04/OZ
.30	SHRWHT	.03/OZ
.21	NBLETS	.02/OZ
.26	MXCORN	.02/OZ
.31	ACCENT	.31/OZ
.29	ALFOIL	.01/SFT
.24*	SPAGH	.24/LB
.23*	SPAGH	.24[illegible]
.14	TOMPST	[illegible]
.34*	CHOCHP	[illegible]FOZ
.34*	CHOC[illegible]	.01/OZ
.11	[illegible]	.03/OZ
.17	[illegible]SP	.04/OZ
[illegible]	SYRUP	.03/FOZ
[illegible]	JELLO	.04/OZ
.11	JELLO	.04/OZ
.11	JELLO	.04/OZ
.33	FRITOS	.07/OZ
.25	ALFOIL	.01/SFT
.41	PROD 19	.05/OZ
.30*	GINALE	.01/FOZ
.30*	GINALE	.01/FOZ
.29*	GINALE	.01/FOZ
.10	CREDIT	.00/CNT
.10	CREDIT	.00/CNT
		8.02 SUM
		.04 TAX

SAMPLE TAPE

8.06 TOTAL 80 STAMPS
AUG 19 1970

THANK YOU
CHARECOGN USDA ARS TFRD

Figure 3 - Example of the Tape Output Developed for the Shopper.

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PS

DAILY SALES	DAILY TAX	DAILY STAMPS
$ 307.38	$ 1.76	3043

PI

	ITEM	DEPT	PROD	---------QUANTITY-----------		
				ORIG	SOLD	ON-HAND
1	92354162	GROC	ALFOIL	500	39	461
2	47271726	GROC	ALFOIL	525	27	498
3	54620946	BTYA	TTHPST	100	55	45
4	32032549	BTYA	TTHPST	120	0	120
5	32940367	GROC	TOMSUP	421	33	388
6	46739369	GROC	TOMSUP	400	27	373
7	15367517	GROC	PROD19	759	43	716
8	91472467	GROC	CKRSP	743	30	713

Figure 4 - Typical Sales and Inventory Reports That Were Obtained on the Mod 33 Teletype.

RESEARCH FINDINGS

A Discussion of The....

Research Findings

The results of an evaluation of a laboratory tested optical scanning checkout station are presented in this "findings" section. The findings are divided into two sections. The first includes a discussion of the efficiency of the optical scanning station as compared with checkout standards of conventional checkout equipment as developed by industry cooperators and the USDA. The second subsection includes a discussion of the operational performance of the optical scanning checkout equipment.

Station Efficiency

The production standards used in the comparative analysis are applicable only to the optical scanning checkout station and a comparable, conventional checkout station. Variations in state tax laws, weight and shape of the product, the store's product mix, and the design of checkstands limit the use of the time values in a direct evaluation of any one particular retail food store operation.

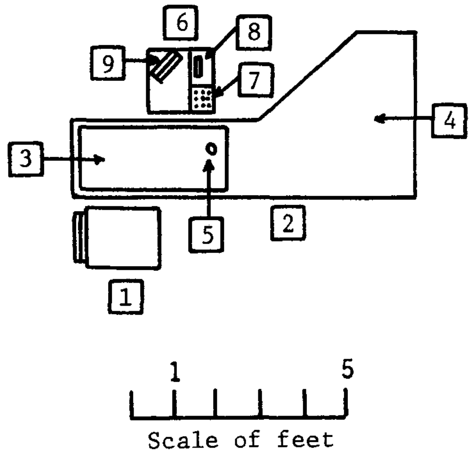
A detailed description of the work elements observed in this study is presented in Appendix Table 7. Appendix Tables 3, 4, 5, and 6 display the production standards for the optical scanning checkout station and the conventional checkout station for both customer unloading and checker unloading situations. "Orders" as referred to subsequently averaged 13.3 items. This order size corresponds to order sizes as determined by the 7th Dupont consumer buying habits study. (13) Data supplied by a cooperator indicated that 70 percent of the items in an average order were grocery items; or 9.3 grocery items per order.

Customer Unloading

One checkstand configuration required that the customer unload the shopping cart and place the items on the conveyor (Figure 5). The location of each unit including the register and scanner are designated. The configuration of the conventional checkout station is the same with two exceptions:

(1) The optical scanner was eliminated.
(2) The scanner register was replaced with a conventional cash register.

The register and cash register were placed in relatively the same location in both station configurations.



Equipment Schedule

Number	Item
1	Shopping Cart
2	Checkstand
3	Conveyor Belt
4	Bagging Station
5	Suspended Optical Scanner
6	Register
7	Keyboard
8	Printer
9	Nixie Display Tube

Figure 5 - Checkstand Layout for Customer Unloading.

The optical scanner station was 19 percent more efficient than the conventional system when the customer unloaded the shopping cart (Table 3). This efficiency was gained by (1) reducing the overall time required to register the price, (2) by eliminating the ringing up of subtotals for tax and totals, (3) eliminating the need to call for prices of unmarked items and (4) the elimination of the need to sort multiple priced and mix and match items. If the number of items had been increased to over 13.3 items per order, efficiency would have increased correspondingly for the optical scanner station compared to the conventional station. A comparison of the time to "scan items and place aside" (optical scanner, .019 minutes per occurrence) with "ring-up order" (conventional checkout, .029 minutes per occurrence) demonstrates that an individual grocery item was registered 52 percent faster using the optical scanner.

TABLE 3 - Production Standards for Optical Scanner and Conventional Checkout Station; Customer Unloaded the Shopping Cart.

Station	Time Per 100 Orders 1/	Orders Per Man-Hour 2/
	(Minutes)	(Number)
Conventional	147.05	40.8
Optical Scanner	123.14	48.7

Source: Appendix Tables 3 and 4.

1/ Based on 13.3 grocer items per order.

2/ Based on a one man crew.

Appendix Figure 7 illustrates the normal times for right and left-hand motions of the checker utilizing the optical scanner, when the customer unloaded the shopping cart.

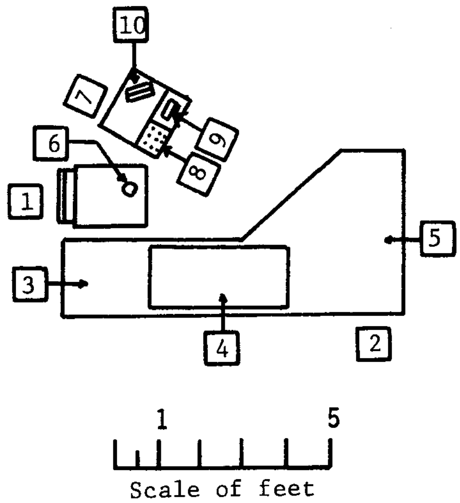
Checker Unloading

The checkstand configuration used by checkers to perform all of the necessary checkout activities, including the unloading of the shopping cart, is presented in Figure 6. The configuration for the conventional checkout station was identical with that of the optical scanner with two exceptions:

(1) The optical scanner was eliminated.
(2) The scanner register was replaced with a conventional cash register.

The register and cash register were placed in relatively the same location in both station configurations.

The optical scanning checkout station was approximately 18 percent more efficient than the conventional station when the checker unloaded the shopping cart (Table 4). This efficiency was gained by (1) reducing the time required to register the price, (2) by eliminating the need to ring-up subtotals for tax, total cash and, (3) by eliminating the need to call for prices of unmarked items and (4) by eliminating the need to sort multiple-priced or mix and match items.



Number	Item
1	Shopping Cart
2	Checkstand
3	Surge Storage for Multi-Priced Items (Conventional System)
4	Conveyor
5	Bagging Station
6	Suspended Optical Scanner
7	Register
8	Keyboard
9	Printer
10	Nixie Display Tube

Figure 6 - Checkstand Layout For Checker Unloading

TABLE 4 - Production Standards for Optical Scanner and Conventional Checkout Station; Checker Unloaded the Shopping Cart.

Station	Time Per 100 Orders 1/	Orders Per Man-Hour 2/
	(Minutes)	(Number)
Conventional	195.57	30.7
Optical Scanning	165.97	36.2

Source: Appendix Tables 5 and 6.

1/ Based on 13.3 grocer items per order.

2/ Based on a one man crew.

Appendix Figure 8 illustrates the normal time values for right and left hand motions when the checker unloaded the cart and simultaneously scanned the items.

Additional Observations on Efficiency

Although the previous section presented production standards for orders averaging 13.3 grocery items and processed through different checkout configurations, times were also obtained for processing orders which contained 38 grocery items. A detailed description of the 38 grocery items and the associated identification codes appear in Appendix Table 2. An eight-digit product identification code was arbitrarily assigned to each item in order to demonstrate the capability of the scanner. The total cycle time required to process the 38 grocery items was approximately eight-tenths of a minute. "Cycle time" began when the checker cleared the register and grasped the first item until she depressed the register total key, after having read the last item, and released the scanner.

The "scan" element was accomplished in less than 1.2 seconds per item. The "scan" element was accomplished simultaneously with the movement of the left hand which put aside the item.

Operational Performance

There were several important observations made during the processing of the approximately 1,500 grocery orders during the laboratory test. These observations are discussed as they related to a particular component of the system.

Scanner

The scanner was simple to operate and in a short time an inexperienced person was able to use it proficiently. The scanner operator started by clearing the register and grasping the scanner with the right hand. Then the item was picked up and scanned using the left hand. The scanner was positioned over the code pattern with the right hand. Upon hearing the beep sound (indicating the code had been "read") the item was placed aside with the left hand. Then the next item was picked up. Upon scanning the last item the scanner was released and the total key was depressed.

The scanner successfully read labels which were photographically reproduced and items marked with a common type stick stamp. The capability of the scanner to read copies of labels indicates that coupons obtained from magazines or newspapers could be scanned and accepted by the system. Preprinted gummed labels were read properly 100 percent of the time without error. Labels were accurately read on curved surfaces of containers that were 1 3/4 inches in diameter or larger. It did not matter whether the curved surface was convex or concave. The optical scanner successfully read labels defaced by any color inks and crayons except black.

A code pattern applied by a stick stamp instead of the price was read accurately by the scanner. Further development of reliable adjustable stick stamps will reduce labeling costs and eliminate the possibility of label removal or label switching by customers. A fast drying scuff-resistant ink is necessary for this labeling procedure. The code either registered properly or did not register at all. There were no errors in price registration.

There are products whose size, shape or weight will not initially permit the placement of an identification label on the product in such a manner so that it can be read by the scanner. Provisions will have to be made to manually enter the product identification code number into the system so that the inventory and sales data of the item can be included.

The register keyboard will have to provide for a subtract key for use in both the manual entry and scanning modes of operation. This feature will enable customers to be credited with returns and over-buys.

Many of today's retail food store stamp dispensers are manually activated. The customer's tape dispensed by the Charecogn system indicated the number of stamps to be dispensed. Consideration will inevitably be given to the development of an automatic stamp dispenser activated by closing the cash drawer, the depression of the clear button or by some other automatic means.

Computer

The mini-computer used in the laboratory test performed flawlessly. During the test, the mini-computer was programmed with several simple programs and accommodated all the storage capacity needed. Repeated power failures during one phase of the test period did not affect the programs nor inventory data storage capabilities.

High-Speed Paper Tape Reader and Teletype

The computer program was loaded via tape processed through a high speed tape reader. Minor revisions and corrections to the original programs were loaded via paper tape punched through capabilities of the teletype. Instructions for date and price changes were made from the teletype. The use of the teletype to directly load the program or establish the master file was time consuming and inefficient. It was recommended that the entire program be punched on paper or magnetic tape for use on a high-speed reader. Punched cards could have been used for date and price changes. A card for each year, month, and item could have been made. A data or price change could have been accomplished by reading the appropriate card, and placing the new date or price into the program from a 0 through 9 digit keyboard. These changes could have been made from either a central headquarter location or at the store.

The teletype was also utilized to print a sales and inventory summary. The teletype was not suited for this application as it was too slow. An intermediate speed printer should have been used to reproduce the complete inventory for physical count purposes. A high speed printer should be considered for developing inventory exception reports and for use in reordering. A sales summary report should be provided for each register in the store for purposes of cash control and work scheduling.

System Failure

Serious consideration will have to be given to the fact that eventually various system components will fail and under extreme circumstances will effectively shut down the total system. Solutions to this problem include the provision of a complete back-up system but this doubles the equipment cost.

Equipment failures that could "close the store" (as distinguished from the failure of a single checkout station) would be such things as a down central data processor, down mass data storage devices (disc units), and down electronic interfaces between or among units. Carefully choosing the processor and disc units for reliability would permit one to attain a mean time between failure (MTBF) of 2,500 to 5,000 hours for the processor and 2,500 to 3,500 hours for the disc. Since the interfaces between these are made with integrated circuits, similar reliability can be predicted for these. In spite of the fact that these MTBF's represent one to two years of operating time between failures, one cannot ignore the statistical probability that a failure could occur at 7:30 PM on a Thursday night during the first month of operation.

The failure of a scanner or the register device would not likely "close the store." These failures would close one checkstand rather than the store. Technological developments permit the replacement of components with spare parts maintained at the store. Store personnel could have the checkstand operating again in less than fifteen minutes. The hand-held scanner, evaluated in this report, could be replaced with an interchangeable plug-in spare. At the present time, failure of other components of the register would have required closing the checkstand and making a service call as is customary with conventional cash registers.

Power Failure

Power failure resulted in the loss of the accumulated total of the items being processed at the time of the power loss. Sales and inventory data for items which had been scanned and registered prior to the power loss were retained. The addition of a subtract key to the register keyboard, as previously mentioned, would enable the checker to subtract the items scanned prior to the power failure and permit the order to be reprocessed as soon as power was restored. This would have eliminated double counting of both sales and inventory.

The system required an auxiliary power supply such as a small power plant, standby generator or rechargeable storage batteries. The latter should have sufficient power to run the checkstands for an hour. The purpose of the auxiliary equipment would be to provide economical power to enable customers in the store at the time of the failure to be checked out. It is not presumed that the backup power system would be designed to carry the entire store. The power requirements to run the checkout are minimal compared with the needs of refrigeration and air conditioning equipment. It is also presumed that the supermarket already has an adequate emergency lighting system.

Due to increased probabilities of power failure in some parts of the country, and the increased power required by more and more frozen food equipment, supermarkets will have to give serious consideration to auxiliary power sources.

Impact of the Computerized Checkout System On Retail Store Operations

This section of the report presents the discussion of the impact of the computerized checkout system on overall store operations. Where possible, the impact was assessed in terms of a cost-benefit analysis.

The computerized checkout system permits sales data to become computer input data. This input data can be manipulated, both independently and in combination with other data in computer memory, to generate information output for use in the management decision making process. The types and format of the information generated will vary with the capabilities of the hardware and software equipment in the system.

Some will argue that some of the data generated for management information purposes should not be discussed as a part of this evaluation. The analysis approach assumes the development of a computerized checkout system. The potential savings resulting from using data that are developed as a by-product of the computerized checkstand should not be overlooked merely because the same data are presently being obtained through other means. Management could end up with two data gathering processes in the store both capable of generating the same information. The computerized checkout system can gather data more efficiently whereas other approaches would probably require an additional time allocation and involve less accuracy.

Prior to a discussion of the potential savings that will be possible with the computerized checkout system, consideration will be given to the general types of supporting equipment and procedures needed to make it viable. Full appreciation of the nature of the system can be gained only after considering the additional procedures and components needed to make it work.

Following this discussion, the report focuses on the potential impact of the system on checkstand productivity, checker training, checker error reduction, price marking and repricing, inventory control and reordering, and other management and merchandising activities.

System Supporting Procedures and Equipment

The nature and extent of supporting procedures and equipment required by the computerized checkout system is a function of management's expectations of the system. Where management wants activities performed and how much management is willing to spend will also influence procedures and equipment requirements. System compatability with existing equipment used by the firm is another constraint. Given the diversity of management talents, interests and the variety of equipment available, the possible alternative equipment configurations are virtually limitless.

No attempt was made to determine costs of the supporting equipment. Attention was focused on approaches that can be taken to establish the system, determine basic in-store equipment needs, and establish the information to be used. The latter was discussed under the section on management information. Where should data processing be done? Alternative approaches include the use of (1) on-line central computer facilities, (2) an in-store facility, or (3) a combination of on-line and in-store facilities.

In alternative one above, all of the checkstands and input and receiving terminals for a group of stores are connected on-line via data transmission devices and telephone lines with a central computer. The computer could be located at the warehouse or at a central processing point located so that it minimizes the cost of leased lines for the stores served. This computer could be connected to data storage and processing equipment capable of producing inventory control data, sales analysis, pertinent store operating data, and other management information reports deemed necessary by management.

The second alternative (in-store facilities) could involve two different setups. First, a simple checkstand containing a scanner capable of reading product identification codes and registering prices could be setup. It would perform the same functions as a conventional cash register but have the advantages of increased speed and accuracy associated with scanning. Lacking the supporting data processing equipment, it would not be possible to generate information reports.

On the other hand, each store could become its own data processing headquarters. Depending upon equipment capabilities, the store management could enter input and retrieve output. This alternative approach should be considered for high volume isolated store units. Costs of customizing the system for individual stores need not be prohibitive. Careful planning including a thorough cost-benefit analysis is essential before deciding on this alternative.

Alternative three utilizes a combination of the first two. A small computer could be provided at the store to log and accumulate transaction data. This would include product movement data by item, store operations data by departments, and checkstands, etc. At a later time, probably at night when the store is not operating, the accumulated data could be transmitted to a central processing unit. Depending upon the equipment available, the data could be transmitted over telephone lines to a central processor or it could be stored on tape to be transported by a delivery truck.

The central processor would update the store inventory, automatically reorder selected items and generate specific analyses and reports. Using this alternative, operating and product movement data could be kept separate, facilitating automatic reordering and the development of special merchandizing and performance profitability reports of direct value to each store.

The supporting equipment or procedures needed for the optical scanning checkstand at the retail store include (1) a management information station, (2) a customer price verification device, and (3) a code label printer and verifyer.

The Manager's Information Station (MIS)

The Manager's Information Station (MIS) is an input-output device connected on-line with the central processing unit. The complexity of the MIS will be determined by the sophistication of the system, and the kind of information needed. The store manager will need cash control information by checkstand and by checker, departmental operating performance data, and selected product movement data.

The MIS should consist of several pieces of equipment. First, it should include a keyboard for manual input containing various special function keys which can be lock protected. The functions initialized should be pre-programmed and range from simple totals on sales, tax, and stamps to more complex profitability reports. An alternative to lock protected keys could be coded key words which facilitate access to specific types of data.

Second, the MIS should include an electric typewriter or computer line printer. The printer must be able to print both the input from the keyboard and the output from the computer.

A cathode ray tube is an optional output device. This is a visual display device capable of presenting data in standard report form.

A data set could link the MIS via phone lines to the computer center of the warehouse and central headquarters. In this situation, the MIS would probably be used as a teletype, although in some situations, processing would be essential.

Customer Price Verification Procedures

It is assumed that the computerized checkout system will eliminate the need for item price marking. Provisions will have to be made to facilitate easy customer acceptance and confidence in shelf pricing rather than individual item pricing. Customer confidence could be developed by (1) providing display cards, similar to shelf talkers, with accurate price information for all items in a product category, (2) making provisions for pricing each item as well as coding the item especially during the initial period, and (3) providing customer product information scanners at various strategic aisle locations throughout the store. Pending development of price-marking equipment that will apply code and price simultaneously, price marking and code marking will approximately double the costs of marking. The length of time the dual marking is required will determine the costs of this approach. Customer acceptance of no price marking needs to be measured.

The aisle scanners would be on-line to the computer and would direct-reference the file containing product price information. When a shopper places the product up to the scanner, the code would be registered and product information would appear on a digital display or cathode ray tube. The display could have sufficient capacity to display three or four related information items at the same time. This easy access to information would build confidence in the technique and provide accurate price information for the shopper.

There is no published information to support the customer acceptance of these alternatives. In some parts of the country, certain product categories do not have price marked on the item and the shopper has already learned to rely on shelf strip pricing. Whether this situation will be acceptable for all product categories to all customers remains to be determined.

Code Label Printer and Verifier

Before a universal product code is adopted and before codes are printed and applied by the manufacturer, they will have to be applied at the store or warehouse level. Codes could be applied with self-inking stick or band type stamps or with preprinted gummed labels. Depending on the specifications for the code, it will be necessary to have newly designed equipment for reproducing code patterns or digits. The code will probably take the form of either man readable digits or scanner readable patterns. The number of digits, and the potential number of stamps required, plus the particular type font required for scanning tends to rule out the traditional individual inked stick stamp as a code applicator. An adjustable stick or band stamp which will produce the code accurately and consistently, may possibly be an alternative solution to this problem.

Another alternative would be a machine that can produce preprinted gummed labels on demand. The required item code and the number of labels would be fed into the machine, and the appropriate quantity of preprinted labels would be rapidly dispensed, ready to apply to the items. In order to minimize the chances of error and to provide a measure of label security it is necessary that neither the store nor warehouse have an inventory of printed code labels. This places an added burden on the speed and accuracy of the label printer.

It is anticipated that such a label printer may cost approximately $2,500. Labels will probably cost something less than 50 cents a thousand. Now that optical scanning in the retail store is a practicality, more emphasis will have to be placed on developing low cost label printing devices.

To check on the accuracy of the label printing device, an employee product information scanner (EPIS) will have to be provided to facilitate employee verification of the code. After registering the code using the EPIS, the computer would verify the appropriate stock item number, product identification number, price, and size. This information would appear on a visual display which the employee can use to verify the label. This helps to assure proper product identification. The verifying display unit could differ from the aisle scanners in that more stock information could be presented.

Checkstand Productivity

The potential impact on checkstand productivity is of concern to the retailer contemplating the adoption of a computerized checkout system. An effective measure of this productivity is the change in orders processed per man-hour.

Productivity was increased almost 18 percent (Appendix Tables 5 and 6) when a checker unloaded the shopping cart at a split checkstand and used the scanner in place of the conventional cash register. Optical scanning improved productivity approximately 19 percent (Appendix Tables 3 and 4), over the conventional cash register, when the shopper unloaded the cart onto a conveyor belt.

Harwell stated that the payroll costs for the checkout operation amounted to twenty percent of the total store payroll or 2.1 percent of sales. In the $4 million store this would amount to approximately $84,000 annually. Industry cooperators estimated that the checkout operation required six man-hours per $1,000 checked out. In this situation our hypothetical store would require 24,000 man-hours (6 x 4,000). At an average wage rate of $4.00 this would amount to $96,000 annually for the checkout operation. The average of the two equals $90,000. An 18 percent improvement in productivity (split stand, checker unloading) would reduce operating costs by $16,200 or 1.9 percent of operating costs, (.41 percent of sales). A 19 percent improvement in productivity (customer unloading) would reduce operating costs $17,424 or 2.1 percent, (.44 percent of sales).

These potential savings were possible only when 100 percent of the items were successfully scanned. Productivity decreased rapidly as the number of items requiring manual entry increased. Evidence strongly suggests that a commitment to optical scanning will have to be total, involving all supermarket items.

Two other factors that affected productivity were unloading and bagging. Both operations will have to be performed at a productivity equal to or less than 73 seconds per average order of 13.3 units. If this level of productivity is not achieved, a bottleneck will be created which will reduce the total productivity or checkstand throughput.

Training Requirements

The initial and follow-up training of checkers and baggers required several hours. Activities that were eliminated with the advent of the optical scanner included:

(a) Tax computation.
(b) Single price determination given a multiple priced item.
(c) Sorting of multiple priced items.
(d) Setting up and clearing the register.

More emphasis will have to be placed on improving customer relations and building confidence in new checkout procedures and equipment.

The operation of the scanner did not require a level nor type of skill equal to that required for the efficient operation of a cash register. There will be time saved in training due to the fact that trainees will not have to learn and become familiar with as many mechanical register operations.

Two different training programs were analyzed (Table 5) including estimated hours required to train a checker to use an optical scanner. Assuming a trainee wage rate of $2.00 and a trainer wage rate of $5.00, the savings per trainee in Program A would be $42 and for Program B, $75.

The annual savings will depend on the annual turnover of employees trained to work as checkers. The firm which used Program B reported a turnover rate of 87 percent for part-time and 53 percent for full-time employees.

Progressive Grocer implies that a $4 million annual sales store will have approximately 60 employees, 34 full-time and 26 part-time. Assuming that 20 of these employees are trained checkers, and assuming a weighted average turnover of 60 percent, a checker training program could involve 12 persons per year.

The cost of training a new checker ranged from $42 to $75, Programs A and B respectively. If it is assumed that an average cost of $60 per employee is required, optical scanning will save approximately $700 in checker training costs per year.

Error Losses

Dollar losses due to supermarket checker errors are substantial. A store with an annual sales volume of $4 million could sustain error losses of $25,000 annually (Table 6). Other loss estimates ranged from $8,000 to $56,000 annually for a store of $4 million.

The number of checker errors has increased in recent years. The checker's job has become more complex and supermarkets have a high employee turnover rate and face a tight labor market. Increased labor costs have caused more and more part-time employees to be hired. As a result, there are fewer highly qualified checkers.

The estimated error cost reductions accruing to a store implementing optical scanning could be substantial (Table 6). The use of scanning equipment does not guarantee protection against losses associated with items not being rung-up. Since the checker will be facing the order and the customer rather than the register, there is reason to conclude that losses associated with "items not rung-up" will be substantially reduced.

It is estimated that the optical scanning checkstand could reduce checkout losses by about 57 percent (Table 6). This is equivalent to a reduction of 1.7 percent in operating costs or .36 percent of sales.

Price Marking and Repricing

A typical store with a sales volume of $4 million annually would sell approximately 10 million units. An appreciable amount of time would be spent price marking these items. Assuming an average case size of 25.9 units (14), approximately 386,100 cases would be handled annually. Approximately 279 cases per man-hour can be marked (Table 7). At least 1,384 man-

TABLE 5 - The Estimated Number of Man-Hours Required to Train A Checker With A Conventional System and the Estimated Hours Saved by Use of a Scanner Equipped Checkstand.

Training Activity	Program A Hours Required 1/	Program A Estimated Hours Saved	Program B Hours Required 2/	Program B Estimated Hours Saved
Supervised Bundling Instruction	2	None	15	None
Programmed Cash Register Instruction	5	4	13	10
Setting Up Register	1	1		
Employee Responsibilities	1	None		
Qualities of Good Checkers	1	None		
Making Change	1	None		
Handling Stamps	1	None		
Handling Complete Order	1	None		
Clearing Register	1	1		
Handling Complaints	1	None		
Handling Pilferage	1	None		
Independent Practice	---	----	52	10
Total Trainee Hours	16	6	80	20
Total Trainer Hours	16	6	12	7
Total Hours	32	12	92	27
Percent of Hours Saved		37.5%		29%
Dollar Savings				
Trainee @ $2.00 per hour		$12		$40
Trainer @ $5.00 per hour		30		35
		$42		$75

Sources: 1/ Checkout Management, by Edward M. Harwell, Chain Store Publishing Corporation, New York, 1963, p. 71.

2/ Industry Cooperator.

TABLE 6 - Estimated Potential Savings Accruing to a Store, By Type of Saving, As a Result of Reducing Checkout Lane Losses By Implementing Optical Scanning.

	Type of Loss	Percent of Total Checkout Losses 1/	Estimated Percent of Store Sales Involved 1/	Dollar Amount For A $4 Million Store	Dollar Amount Saved For A $4 Million Store With Optical Scanning
		(Percent)	(Percent)	(Dollars)	(Dollars)
1.	Checker Misinterpretation of Price Mark.	4	0.025	1,000	1,000
2.	Failure to Ring Items Left in Bottom of Carts.	36	0.225	9,000	4,500 2/
3.	Improper Handling of Coupons.	4	0.025	1,000	1,000
4.	Improper Calculation of Multiple Prices.	4	0.025	1,000	1,000
5.	Making Change.	2.2	0.0137	548	---
6.	Items Missed or Overlooked.	28	0.175	7,000	3,500 2/
7.	Improper Calculation of Sales Tax.	2	0.0125	500	500
8.	Poor Skill in Handling Registers.	2	0.0125	500	500
9.	Failure to Note Price Changes.	1.8	0.01125	450	450
10.	Loss of Customers Through Lack of Courtesy.	6	0.0375	1,500	750 3/
11.	Poor Bag Handling.	6	0.0375	1,500	---
12.	Improper Handling of Trading Stamps.	4	0.025	1,000	1,000
	TOTAL			$25,000	$14,200

1/ Source Table 2.

2/ Assumed that since the checker now faces the order and the cart instead of the register that 50 percent of the items formerly missed in these categories will be captured.

3/ The scanner by itself will not improve checker courtesy. However, the checker has fewer mental demands and faces the shopper. Assumed 50 percent improvement.

TABLE 7 - Price Marking Times Per Case And In-Store Productivity In Cases Marked Per Man-Hour.

Element Description	Total Time Per Element	Frequency of Occurrence	Weighted Time
	(Minutes)	(Percent)	(Minutes)
Check Price	.138	3.3	.0046
Pickup and Adjust Stamp	.112	65.4	.0732
Mark Price	.128	97.2	.1244
Restamp	.253	5.1	.0129
Total Man-Minutes Per Case			.2151
Standard Number of Cases Per Man-Hour			279

Source: "Comparative Costs of Two Unified Grocery Handling Systems - Mobile Cart and Warehouse Pallet," USDA Unpublished Report.

hours would be required to price mark. This productivity rate does not include time for opening and disposing of cases. At a wage rate of $4.00, price marking would cost $5,536 annually or .7 percent of operating costs, or .15 percent of sales.

In addition to the initial price marking costs, consideration must also be given to the costs of making price changes. Promotions, deals and competition are some of the reasons for price changes. Weekly price changes affect 2 to 5 percent of the items handled. (15)

Price changes could cost a store about $500 annually or .06 percent of store operating costs, (.01 percent of sales). If price marking plus price changes cost a store $6,036, ($5,536 + $500) or .72 percent of operating costs annually, the question is raised as to the impact on costs if the manufacturer applied product identification codes.

It was assumed that approximately 30 percent of the 10 million units handled in the $4 million store were meat and produce units price marked in the store and another 19 percent were vendor delivered and price marked. This leaves 51 percent of the units handled being marked and possibly subject to repricing. In a store with a $4 million annual sales volume, this could amount to price marking approximately 197,000 cases. At a marking productivity rate of 279 cases per man-hour, 706 man-hours would be required. At a wage rate of $4.00 this cost is equivalent to $2,825 annually or .34 percent of operating costs, (.07 percent of sales).

It was assumed that meat and produce items represented 30 percent of the total units sold in a store and account for about half of the units requiring price changes or remarking. Since grocery remarking costs could be eliminated using the computerized checkout system, there could be a reduction in store operating costs of $250 annually.

In the event of central packaging and price marking of meats and produce there could be an additional reduction in price marking and remarking costs. It was assumed that an item identification code indicating the nature of the product and its weight would be applied by an electronic scale printer at the point of packaging. If this were to develop there could be a further reduction in retail price marking costs. This could amount to a cost reduction of $1,660 annually or .20 percent of store operating costs.

Since the remarking of perishable items results from trimming, special customer requests and special sales, it was assumed that there would be no additional remarking savings available using a computerized checkout system.

Since central packaging and price marking of meat and produce is still uncommon for most retail food firms, the potential savings on marking and remarking of these categories was not included in the total estimated savings.

For a store with $4 million in annual sales, the total potential reduction in operating costs due to the elimination of price marking and remarking of grocery items could be $3,075 or 0.37 percent of operating costs.

Code labels will have to be printed and placed on the items at the retail store until such time as a universal product code is adopted and labels are applied by the manufacturer. During this time, price marking labor savings will only result from the elimination of the need to remark items. Since code labeling and price marking are similar in nature, it is anticipated that it will take the same amount of time to place the code on the package as to mark the price. Initial annual savings of $250 could accrue only to the retail store which can eliminate the need to remark grocery items.

A retail chain with its own private label line of grocery items, could apply the product code centrally and save approximately $1,300 in price marking expenses for each store with an annual sales of $4 million. The savings of $250 for remarking plus the $1,300 provides an annual potential savings of $1,550 or .19 percent of operating expenses.

Inventory Control

The computerized checkout system makes possible perpetual inventory control, a long-time goal of the retail industry. A perpetual inventory provides a continuing record of all units on hand. It involves continuous recording of sales data, adjustments for merchandise received at the store and for customer returns, reductions for damaged merchandise losses and theft, and returns to vendors. Periodic product, department, and store inventory analyses can be generated as needed by management. The maintenance of perpetual inventory records by stores facilitates automatic reordering. This is feasible using systems having computers and information storage capacity at the store level. Inventory data can be stored and transmitted, either via tape or wires, to the central ordering point. This also eliminates the necessity of keeping the central data processing unit on line to all stores all of the time.

Based on estimates of an industry cooperator, approximately 20 hours weekly was spent preparing orders for a $4 million store. It took 3 hours to take inventory, 8 hours to make up the order, 6 hours of contingency time and 3 hours handling special order situations. Even though the final orders had to be approved by the manager, compiling the orders was typically performed by several people in the store.

If the computerized checkout system includes automatic ordering and can eliminate 20 hours a week spent on these activities, 1,040 hours per year could be saved per store. At an average wage rate of $4.00 per hour, $4,000 per year could be saved or about .48 percent of operating costs or .1 percent of gross sales.

It should be recognized that the inventory control system is primarily a "book" inventory system. The book inventory may differ from the actual amount of goods on hand in the store or department because of various forms of shortages. Regular physical counts can be taken to determine the extent of any actual shortages and to correct the book figure. Some retailers currently take quarterly unit audits to get accurate counts with which to adjust their computer inventories. A complete store audit requires approximately 100 man-hours and could cost $400. With quarterly audits the cost could be $1,600. Given improved product movement data associated with the computerized checkout system, a 50 percent reduction in audit time is assumed possible. Either the number of audits can be reduced or a shrinkage adjustment factor can be applied and a sampling technique developed to reduce inventory time. If the latter approach were to be used, items subject to the highest theft rate could be audited frequently.

There are other potential savings which can accrue to perpetual inventory control. Savings could accrue to a closer control of inventory required on hand, resulting in an increased number of stock-turns. It is recognized in this analysis that an accurate record of store movement, by itself, is not sufficient to cause an inventory reduction. Minimum case pack size, frequency of delivery and lag time between order and delivery are factors that must be considered and programmed into the system.

The average chain supermarket reported 11 stock-turns in 1968-1969 (16). Although some chains reported 12, the average was the lowest in seven years.

A $4 million store that reports 11 stock-turns per year has an approximate average retail stock inventory of $364,000. As the number of stock-turns increases, the average retail inventory decreases. An increase in stock-turns of only one could mean an inventory reduction of $20,000 to $30,000 for a $4 million store (Table 8). The reduction in inventory could mean reduced taxes, insurance, risk, cost appreciation due to falling prices, storage space, and display space needed. It was assumed in this study that inventory would be reduced by $30,000 annually. Based on Indiana inventory tax regulations, a reduction of $30,000 in inventory could reduce taxes about $1,000 annually. Interest saved on the investment computed at 8 percent would approximate $2,400 annually. Other contingency savings could amount to approximately $2,000 annually.

In summary, for a $4 million store the savings from inventory reduction and ordering efficiencies could approximate $10,200, as follows:

Reduced cost of ordering	$4,000
Reduced cost of physical inventory	800
Inventory tax reduction	1,000
Interest reduction	2,400
Other reductions	2,000
Total	$10,200

This is equivalent to 1.22 percent of operating costs or .26 percent of sales.

Management and Merchandising Information

With optical scanning equipment becoming technically and economically feasible for the food retailer, sales data can automatically become computer input. This data can be manipulated, both independently and in combination with data already in computer memory, to generate information useful to all levels of retail management. The nature and types of information generated will vary considerably with individual firm needs.

Management will have a wealth of product movement data available by product, department, store and chain; for each day, week, month and year. The ability to effectively translate data into information and apply it to problems will go a long way towards determining the successful retailer of the future. It is anticipated that scanning will permit substantial savings through reduced operating costs.

When a computerized checkout system is installed in a retail store, it will be possible to develop reliable cost-benefit information and many specific types of reports. However, due to the lack of information needs, it is not possible at the present time to make reliable estimates of the value of information or the costs of obtaining same.

TABLE 8 - Effect of Increases in Annual Stock Turns On Average Inventory for a Store With An Annual Sales Volume of $4 Million.

Stock Turns	Inventory	Inventory Reduction	Accumulative Inventory Reduction
11	364,000	--	--
12	334,000	30,000	30,000
13	308,000	26,000	56,000
14	286,000	22,000	78,000
15	266,000	20,000	98,000

All of the following types of reports will be possible because for the first time the retailer will have available current product movement data. The data can be used for such specific reports as those involving:

Shelf Space Allocation. Item sales volume could be compared with the amount of shelf space allocated taking into consideration the space required for minimum order quantities. Guides for determining efficient product location within the store could be included.

Department Profitability. The department's contribution to net profits and return-on-investment could be readily determined.

Labor Scheduling. Accurate sales data and customer counts by register, store, time of day and day of week over a period of time would help in labor scheduling. Accurate data will be available on the impact of such influences on sales volume as weather, holidays, and special promotions. Measures of efficiency could be developed.

Consigned Goods Identification. A clear identification of all consigned merchandise sold at the store will improve management control.

Shrinkage. The computer could be programmed to provide department managers, buyers and top management with a means of periodically checking shrinkage rates, by item, for control purposes.

Advertising and Promotion. It will be possible to evaluate the impact of price specials, advertising, and special displays on sales by individual item, department and store.

Pricing Decisions. Information will be available on the impact on sales of changes in prices or changes in pricing policies by item category, product group or department.

New Item Evaluation. It will be possible to monitor sales of new items for quick and accurate indications of sales performance.

Out-of-Stocks. While automatic reordering should reduce out-of-stock conditions, delays in shipment or special promotions may result in out-of-stock conditions. Inventory control procedures should assure an effective inventory level for normal operations.

Selecting Product Mix. Product movement data will help to determine the optimum assortment of merchandise including brand selection, flavors and size of packages to be carried.

Statistical Data. Long term product movement data by store will assist in long range planning efforts. This data will also enable observations of changes in product mix as a reflection of changing consumer tastes or changing neighborhoods. Management could have immediately available information on current operations as related to performance and profitability.

Each level of management should conduct an analysis of the type and format of reports "needed," in order to avoid generating information for information sake. Similarly, consideration needs to be given to the frequency with which reports should be generated, and to whom they should be sent. If proper consideration is given to this in advance, it will greatly simplify the selection of appropriate computer equipment. It may be that since some checkout systems will provide data in computer-readable form, little, if any, peripheral equipment will be required.

Consumer Acceptance

Growing concern about the lack of accurate descriptive information on the label of consumer products has brought about a requirement that specific product information be made available on the label. A notable example is "dual-pricing" in which the unit price and price per standard measure must be clearly displayed. The computerized checkout system makes it possible for this information to be printed on the customer's receipt.

The customer's receipt as designed for the laboratory test was very well received by all of the potential shoppers who saw it. The main reason was that it contained more product information than presently available. The tape contained a six character description of the item, the total amount of the sale, total tax, and the total number of stamps to be received. Multiple-priced items were also identified.

Since the system had not been installed in a retail store at the time of this report, little additional information is available about the customer acceptance.

The customer desires accuracy, speed, information, and confidence in the system. These are important features that tend to either increase or decrease consumer complaints.

Accuracy. The net potential savings possible from reducing inaccurate ring-ups is substantial. There are errors in favor of the customer and there are errors that are not in her favor. The ability to eliminate both of these types of errors will contribute to a favorable image of the store.

Speed. A major benefit of the computerized checkout system is the potential improvement in checkout throughput of as much as 34 percent depending upon the methods used.

Information. This item has already been discussed in terms of the customer's receipt. It would also be possible to provide certain nutrition information in the aisles adjacent to the point of purchase or on the customer's receipt.

Confidence. An intangible benefit may well be the greater confidence developed in food retailing. The checker can be more accurate and consequently more confident in one's ability. Confidence is generated through experiences at the checkstand, and through other experiences the shopper has with data processing systems.

There are questions concerning customer acceptance that still have to be studied. Not the least of these will be the effect of the absence of price information on the package, and the customer reaction to another piece of mechanization. Until such time as a computerized checkout system becomes operational in an actual retail store, it will be impossible to get accurate measures of customer acceptance.

ESTIMATED POTENTIAL SAVINGS WITH AN OPTICAL SCANNING COMPUTERIZED CHECKOUT SYSTEM

The estimated annual dollar savings were $44,375 and $45,599 for the two systems studied (Tables 9 and 10). The difference in savings may be due to one system being more productive than the other or it may reflect lack of comparable data. The computerized checkout system shows a potential for reducing operating costs approximately 5.5 percent. A savings equivalent of 1.2 percent of sales is projected. No provisions have been made to estimate the substantial additional savings that could be achieved as a result of having accurate, current and complete product movement data and other management information.

The potential savings resulted from improved work methods and performances. No attempt has been made to determine the costs of implementing the system. Computerized checkout systems will be customized to meet the information needs and performance specifications of individual firms. Customizing the system can result in substantial variations in implementation and operating costs. Some equipment manufacturers have indicated possible pay-back periods of one or two years based on anticipated cost savings. An accurate cost-benefit analysis will have to be left to the descretion of individual retailers. An indication of the potential savings has been spelled out.

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13. "The Family Shopper: Here's How She Buys," 7th Dupont Consumer Buying Habits Study, 1965.

14. Industry cooperator indicated an average case size of 25.9 units.

15. "Feasibility of Mechanical Price Marking of Groceries at the Central Warehouse," USDA Marketing Research Report No. 872, December 1970, p. 15.

16. The "37th Annual Report of the Grocery Industry," Progressive Grocer, Volume 49, Number 4, New York, New York, April 1970, p. 65.

TABLE 9 - Estimated Potential Savings With An Optical Scanning, Computerized Checkout System for a Store With a $4 Million Sales Volume: 1/ Customer Unloading the Shopping Cart.

	Annual Savings		
Type of Savings	Dollars	Percent of Operating Costs 2/	Percent of Sales
Increased Checkout Productivity	$17,424	2.09	0.44
Reduced Checkout Error	14,200	1.70	0.36
Reduced Checker Training Costs	700	0.08	0.02
Eliminate Price Marking and Repricing	3,075	0.37	0.08
Inventory Reduction and Ordering Efficiencies	10,200	1.22	.26
TOTAL	$45,599	5.46	1.16

TABLE 10 - Estimated Potential Savings With An Optical Scanning Computerized Checkout System for a Store With A $4 Million Sales Volume: 1/ Split Checkstand With Checker Unloading the Cart.

	Annual Savings		
Type of Savings	Dollars	Percent of Operating Costs 2/	Percent of Sales
Increased Checkout Productivity	$16,200	1.94	0.41
Reduced Checkout Error	14,200	1.70	0.36
Reduced Checker Training Costs	700	0.08	0.02
Eliminate Price Marking and Repricing	3,075	0.37	0.08
Inventory Reduction and Ordering Efficiencies	10,200	1.22	0.26
TOTAL	$44,375	5.31	1.13

1/ Excluding the cost of implementing the system.

2/ Operating costs represent 20.87 percent of sales or $834,800. Operating costs differ from gross margin (21.3 percent) due to exclusion of net operating profit, (0.44 percent).

FURTHER RESEARCH

A Word About The....

Need for Additional Research

The development of a computerized checkout system for the retail food store will have a direct impact on many of the existing work methods and procedures. The basis for this report was a laboratory test of the checkout station in which test results were used to estimate the potential impact on other phases of store operations. Since this was only a laboratory test, the system needs to be tested under normal operating conditions in an actual supermarket, where such factors as customer, employee and management acceptance can be evaluated.

Procedures need to be tested to determine the best methods for handling variable weight and bulk perishable items. Tentative procedures have been formulated for handling perishable packaged items with the use of labels, but procedures for handling bulk produce items still need to be worked out.

The development of a checkout system with electronic components will make it possible to completely restructure the front end. Research should be conducted on the total checkstand design to determine the optimum configuration for maximum throughput while maintaining customer and checker satisfaction. Any checkstand modification should consider improved methods for bagging groceries. Additional consideration should be given to remove the cash handling function from the register and possibly having one cashier serving two or more checkstands.

A universal product identification code acceptable to manufacturers and distributors needs to be developed. The universal code must be developed with specifications as to configuration, size, and number of digits. Once an acceptable code is developed, procedures must be implemented for the assignment of codes to various packers and manufacturers for their products. Placing codes on the products by the manufacturer will eliminate the need to code products at the store or warehouse.

Product identification codes will have to be placed on the individual items at the retail store until manufacturers perform this function. Research is needed to modify existing equipment and to develop new equipment for placing scanner readable code labels on individual item units. A research report has been published on mechanical price marking of groceries at the warehouse; however, it did not include a report on a mechanical market that would place labels on grocery products.

Research is needed to determine the extent to which consumers will accept the faster checkout made possible with optical scanning. In addition, consumer confidence needs to be developed in the reliability of shelf pricing, and in an understanding of the relationship between the product code and the shelf price. It will be necessary for the customer to have a means of verifying item price against shelf price. Research needs to be conducted to determine the number and location of verification devices, as well as determining the costs of maintaining them.

Since the computerized checkout system will have an impact on many of the operating procedures and information gathering procedures currently in use in the retail store, many additional questions can be raised. Most of these relate to refinements of the basic system and can be resolved with the implementation of the system in a supermarket. Others can be answered more specifically when retail firms develop their own specific system performance specifications. Once the retailer specifications have been developed, equipment manufacturers will be in a better position to develop systems capable of satisfying these needs, and of porviding specific cost information for special additional features. The basic technology is available and the cost savings potential is substantial. Retailers should give favorable consideration to a test installation.

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APPENDIX

TABLE 1.--Number of Hours to Train an Individual Checker As Estimated by One Industry Cooperator, December 1970.

Training Activity	Training Hours
Supervised Bundling Instruction	15
Programmed Instruction	
---Cash Register	9
Alternate Cash Register	
---Ringing With Trained Checker	4
Ring Alone With Some Supervision	52
Total Training	80
Instructors Time	12
TOTAL	92

TABLE 2 - Product Mix Description

Code Number	Quantity	Item Description
92354162	1	Box - Aluminum foil 12" width 25" length
47271726	1	Box - Reynolds Wrap 12" width 25" length
54620946	1	Box - Macleans toothpaste - Giant size 3.25 oz.
32940367	1	Bottle - Ideal Vinegar 16 fl. oz.
46739369	1	Can - Campbell's Tomato Soup 10 3/4 oz.
15367517	1	Box - Kellogg's Product 19 (dry cereal) 8 oz.
91472467	1	Bag - Acme Coffee 16 oz.
23546139	1	Can - Ideal Vegetable Soup 10 3/4 oz.
21650232	1	Box - Frito's six pack corn chips 4½ oz.
52370050	1	Can - Hi-C fruit drink 46 fl. oz.
46131893	3	Cans - Minute-Maid 6 fl. oz. each frozen concentrate orange juice
82249773	2	Boxes - Black Raspberry jello - 3 oz. each
53743168	3	Boxes - Strawberry jello - 3 oz. each
60131342	1	Box - Lime jello - 3 oz. each
02365320	1	Box - Acme Artic Seal - frozen haddock 16 oz.
86123421	3*	Package - cellophane - FFV Chocolate Chip cookies 12½ oz. each
27564314	2*	Boxes - Ronzoni No. 9 Spaghetti - 16 oz. each
54631971	1	Can - Acme, Ideal Applesauce 16 oz.
58909924	1	Box - Nabisco Shredded Wheat - 10 oz.
44972662	1	Can - Green Giant Nibblets Corn - 12 oz.
13094852	1	Package (plastic) Yellow split peas - 16 oz.
68860435	1	Can - Acme Louella Evaporated Milk 13 fl. oz.
49351585	1	Box - Dutch Fudge Cookies 33 oz.
57568625	1	Can - Beech Nut strained orange-apricot juice (baby food) 4.2 fl. oz.
75953043	1	Can - Progresso tomato paste 6 oz.
51017215	1	Can - Accent seasoning 1 oz.
14325133	3*	Bottles - Rockcreek gingerale - 1 pt. - 12 fl. oz.
49197566	1	Box - Phase III soap - 3.5 oz.

* Indicates multipriced items.

TABLE 3.--Development of Production Standard for Conventional Checkout Station: One Man Operation with Customer Unloading the Shopping Cart.

Description of Element	Time Per Occ.	Frequency Per 100 Orders	Weighted Time
	Minutes	No.	Minutes
Ring-up 1/	.029	1240 2/	35.96
Handle coupons 3/	.160	15	2.40
Sub-total for tax 3/	.027	100	2.70
Look up tax 3/	.036	100	3.60
Ring up tax 1/	.029	100	2.90
Total order 3/	.027	100	2.70
Obtain and position bag 1/	.081	100	8.10
Bag items 1/	.032	1330	42.56
Total regular elements			100.92
Fatigue and personal allowance (15%)			15.14
Handle cash 3/	.240	95	22.80
Handle checks 3/	.276	5	1.38
Customer delay 3/	.170	25	4.25
Call for price 3/	.124	12	1.49
Look up price 3/	.107	10	1.07
Total minutes per 100 order			147.05
Standard in hours per order			.0245
Standard in orders per man-hour			40.8

1/ Data source: The checkout operation in self service retail food stores, AIB No. 31, January 1951.

2/ Data supplied by cooperator shows that 6,160 grocery items were individually priced out of 7,000 items or 88 ring-ups per 100 items, and the remaining 12 items were multiple priced. The following assumptions were made for 100 items rung-up or scanned: 6 items at 2 per price require 3 ring-ups, 6 items at 3 per price require 2 ring-ups; therefore the average ring-up frequency for multiple priced items is 5 ring-ups per 100 items. Average number of items per order = 13.3. Total ring-up frequency per 100 orders = (1,330 X .88 + .05) = 1240.

3/ Data source: Industry cooperator.

TABLE 4.--Development of Production Standard for Optical Scanning Station: One Man Operation with Customer Unloading Shopping Cart.

Description of Element 1/	Time Per Occ.	Frequency Per 100 Orders	Weighted Time
	Minutes	No.	Minutes
Clear register and grasp first item	.033	100	3.30
Aside item (simultaneously scanning)	.019	1330 2/	25.27
Aside coupon (simultaneously scanning)	.022	15 3/	.33
Release scanner and total order	.028	100	2.80
Obtain and position bag 4/	.081	100	8.10
Bag Items 4/	.032	1330 2/	42.56
Total regular elements			82.36
Fatigue and personal allowance (15%)			12.35
Handle cash 3/	.240	95	22.80
Handle checks 3/	.276	5	1.38
Customer delay 3/	.170	25	4.25
Total minutes per 100 orders			123.14
Standard in hours per order			.0205
Standard in orders per man-hour			48.7

1/ Data source for time values shown for the elements was micromotion study using 16mm film. All other time values are from sources footnoted. A more detailed description of the elements for this optical scanning operation is included in Appendix Table 7 and illustrated in Appendix Figure 7. In this scanning operation, the left hand motion controls the elements while right hand elements are performed simultaneously.

2/ Average number of items per order = 13.3 - "The Family Shopper: Here's how she buys," 7th Dupont consumer buying habits study, 1965.

3/ Data source: Industry cooperator.

4/ Data source: The checkout operation in self service retail food stores, AIB No. 31, January 1951.

TABLE 5.--Development of Production Standard for Conventional Checkout Station: One Man Operation with Checkout Unloading the Shopping Cart.

Descriptions of Elements	Time Per Occ.	Frequency Per 100 Orders	Weighted Time
	Minutes	No.	Minutes
Remove items from cart and aside (simultaneously ring-up) 2/	.053	1330 1/	70.49
Handle coupons 2/	.160	15	2.40
Sub-total for tax 2/	.027	100	2.70
Look up tax 2/	.036	100	3.60
Ring-up tax 3/	.027	100	2.70
Total order 2/	.027	100	2.70
Bag items 2/	.044	1330 1/	58.52
Total regular elements			143.11
Fatigue and personal allowance (15%)			21.47
Handle cash 2/	.240	95	22.80
Handle checks 2/	.276	5	1.38
Customer delay 2/	.170	25	4.25
Call for price 2/	.124	12	1.49
Look up price 2/	.107	10	1.07
Total minutes per 100 orders			195.57
Standard in hours per order			.0326
Standard in orders per man-hour			30.7

1/ Average number of items per order = 13.3 - "The Family Shopper: Here's how she buys," 7th Dupont consumer buying habits study, 1965.

2/ Data source: Industry cooperator.

3/ Data source: The checkout operation in self service retail food stores, AIB No. 31, January 1951.

TABLE 6.--Development of Production Standard for Optical Scanning Station: One Man Operation with Checker Unloading the Shopping Cart.

Description of Elements 1/	Time Per Occ.	Frequency Per 100 Orders	Weighted Time
	Minutes	No.	Minutes
Clear register and grasp first item	.033	100	3.30
Remove items from cart & aside (simultaneously scanning)	.047	1330 2/	62.51
Aside coupon (simultaneously scanning)	.022	15 3/	.33
Release scanner & total order	.028	100	2.80
Obtain and position bag 4/	.081	100	8.10
Bag items 4/	.032	1330 2/	42.56
Total regular elements			119.60
Fatigue and personal allowance (15%)			17.94
Handle cash 3/	.240	95	22.80
Handle checks 3/	.276	5	1.38
Customer delay 3/	.170	25	4.25
Total minutes per 100 order			165.97
Standard in hours per order			.0277
Standard in orders per man-hour			36.2

1/ Data source for time values shown for the elements was micromotion study using 16mm film. All other time values are from sources footnoted. A more detailed description of the elements for optical scanning is included in Appendix Table 7 and illustrated in Appendix Figure 8. In this scanning operation, the left hand motion controls the elements while right hand elements are performed simultaneously.

2/ Average number of items per order = 13.3 - "The Family Shopper: Here's how she buys," 7th Dupont consumer buying habits study, 1965.

3/ Data source: Industry cooperator.

4/ Data source: The checkout operation in self service retail food stores, AIB No. 31, January 1951.

TABLE 7 - Detailed Element Description For Optical Scanning Station

1. Clear Register and Grasp First Item

Begins:	When left hand is moved towards register.
Includes:	Forty-five degree body turn, depressing register "clear" key with the index finger of the left hand, and hand motion towards the first grocery item.
Ends:	As first item of the grocery order is grasped.

2. Pick-Up Scanner

Begins:	When right hand is moved toward scanner.
Includes:	Hand motion towards suspended scanner.
Ends:	As scanner is grasped with right hand.

3. Unavoidable Delay

Begins:	When either hand has no activity.
Ends:	As hand motion begins.

4. Aside Item

Begins:	When left hand moves grasped item.
Includes:	Left hand transport of item to bagging section of the check-stand, finger release, and hand return.
Ends:	As next grocery item is grasped.

5. Scan Item

Begins:	When right hand moves scanner towards label.
Includes:	Transport of scanner across label and return.
Ends:	As motion is completed.

6. Aside Coupon

Begins:	When left hand is moved towards customer's hand containing coupon.
Includes:	Left hand grasp of coupon and transport to storage box.
Ends:	As coupon is released over storage box.

7. Scan Coupon

Begins:	When right hand moves scanner towards coupon label.
Includes:	Transport of scanner across coupon label and return.
Ends:	As motion is completed.

8. Release Scanner and Total

   Begins: When right hand is moved towards register.
   Includes: Forty-five degree body turn, release of suspended scanner, and depression of register "total" key with index finger.
   Ends: As right hand index finger is removed from "total" key.

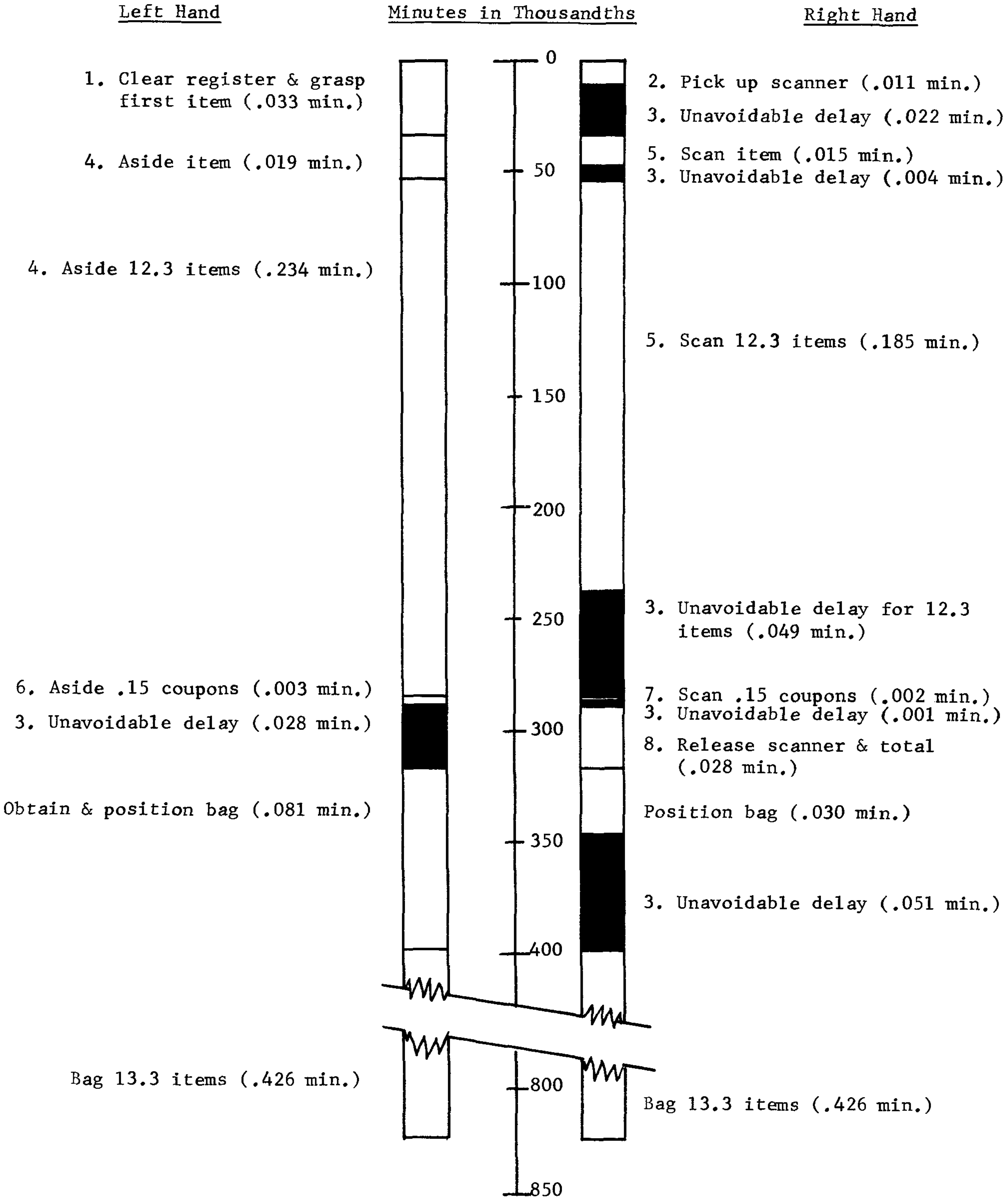
9. Remove Item From Cart and Aside

   Begins: When body bends towards cart.
   Includes: Left hand grasp of item in cart and transport of counter.
   Ends: As fingers release item.

10. Aside Multipriced Items

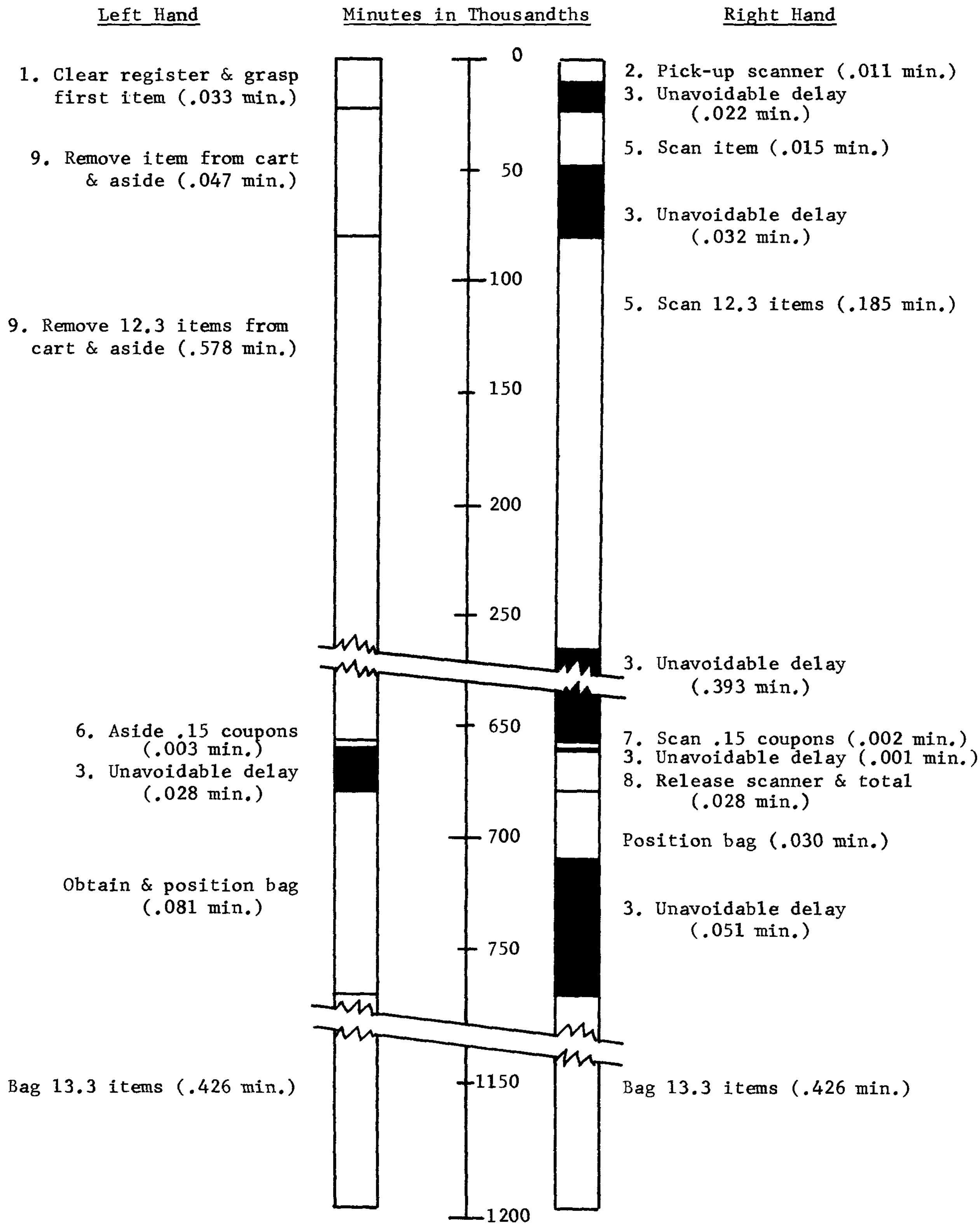
   Begins: When left hand moves towards multiple priced item on check stand.
   Includes: Sliding item to bagging section of stand.
   Ends: As hand leaves item.

Figure 7. -- Normal Time Values For Optical Scanning System: Customer Unloading Shopping Cart.



Total time .824 minutes per order
Time Scale: 1" = .060 Minutes

Figure 8. -- Normal Time Values For Optical Scanning System: Checker Unloading Shopping Cart



Total time 1.20 minutes per order
Time Scale: 1" = .060 Minutes

Simulated In-Store Layout As Used In
The Previously Discussed Analysis