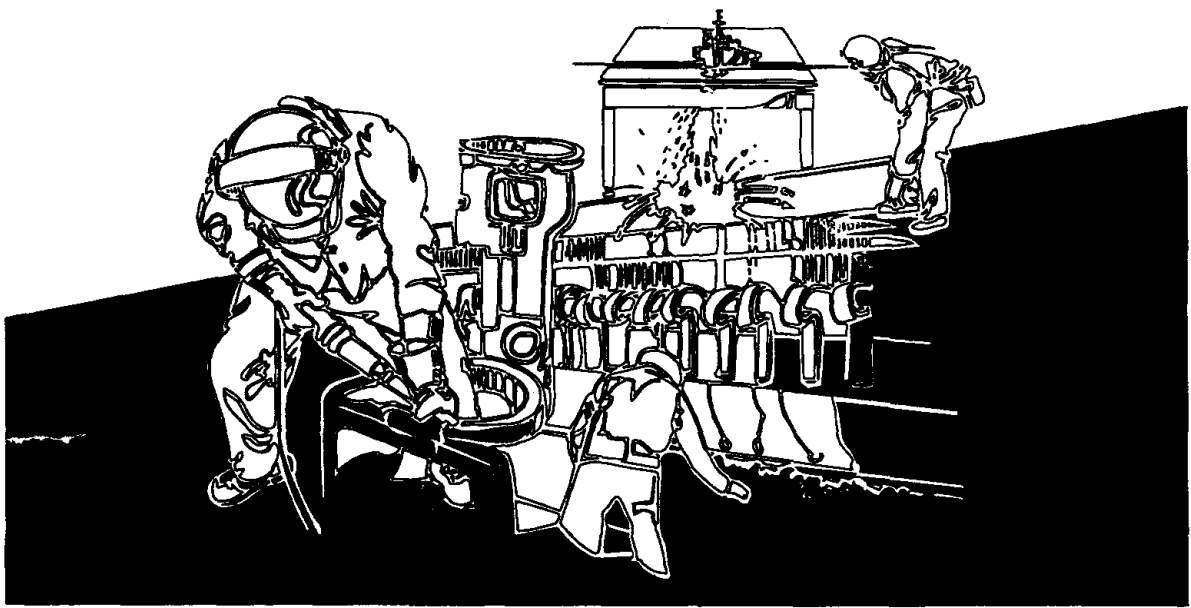


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# NIOSH HEALTH HAZARD EVALUATION REPORT

**HETA 92-294-2301  
SCHNUCK'S NATIONAL &  
DIERBERG'S SUPERMARKETS  
ST. LOUIS, MISSOURI**



**U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES**  
Public Health Service  
Centers for Disease Control and Prevention  
National Institute for Occupational Safety and Health



## PREFACE

The Hazard Evaluations and Technical Assistance Branch of NIOSH conducts field investigations of possible health hazards in the workplace. These investigations are conducted under the authority of Section 20(a)(6) of the Occupational Safety and Health Act of 1970, 29 U.S.C. 669(a)(6) which authorizes the Secretary of Health and Human Services, following a written request from any employer and authorized representative of employees, to determine whether any substance normally found in the place of employment has potentially toxic effects in such concentrations as used or found.

The Hazard Evaluations and Technical Assistance Branch also provides, upon request, medical, nursing, and industrial hygiene technical and consultative assistance (TA) to federal, state, and local agencies; labor; industry; and other groups or individuals to control occupational health hazards and to prevent related trauma and disease.

Mention of company names or products does not constitute endorsement by the National Institute for Occupational Safety and Health.

**HETA 92-294-2301  
APRIL 1993  
SCHNUCK'S, NATIONAL &  
DIERBERG'S SUPERMARKETS  
ST. LOUIS, MISSOURI**

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## **I. SUMMARY**

In June 1992, Local 655 of the United Food and Commercial Workers Union requested the National Institute for Occupational Safety and Health (NIOSH) to investigate whether supermarket cashiers were exposed to significant biomechanical hazards for upper extremity musculoskeletal disorders due to the use of "checker-unload" workstations. In response, an ergonomic evaluation of cashier work activities was conducted at three supermarket chains in the greater St. Louis area. The investigation was performed on October 21-22, 1992.

Cashier work activities performed in all three supermarkets were videotaped and photographed during the evaluation. Checkstand and grocery cart dimensions were also recorded. To identify biomechanical stressors associated with unloading groceries from the customer's basket, an analysis of cashier postures and movements during grocery scanning activities was performed. Data resulting from this analysis were compared to data gathered from cashiers using similar checkstands, but where grocery items were unloaded by the customer and provided to the cashier on a conveyor.

In general, grocery cashiers are exposed to a large number of risk factors commonly associated with upper extremity musculoskeletal disorders. These include repetitive hand/wrist movement, awkward upper extremity postures and excessive manual force application. However, the use of the "checker-unload" workstations places additional stresses on the cashier which may exacerbate the risk of musculoskeletal disorders associated with this job. Specifically, requiring the cashier to remove groceries directly from the cart for scanning increases the frequency of long reaches, awkward shoulder postures and lifts. NIOSH investigators recommend eliminating "checker-unload" as a work practice, and replacing the existing checkstands with models equipped with conveyor-belts for delivering groceries to the cashier. Additional recommendations are provided for reducing the frequencies of awkward postures and forceful manual exertions through alternative work practices and workstation modifications.

Based on the data obtained from this Health Hazard Evaluation, NIOSH investigators determined that a health hazard existed at these facilities from excess biomechanical stress due to the use of checker-unload supermarket checkstands. NIOSH recommends that checker-unload checkstands be replaced by customer-unload checkerstands. Interim recommendations for redesign of existing checkerstands are provided in Section VI.

**KEYWORDS:** SIC 5411 (Grocery stores), ergonomics, carpal tunnel syndrome, musculoskeletal disorders, cashiers, supermarket checkstand.

## I. INTRODUCTION

In June 1992, Local 655 of the United Food and Commercial Workers Union requested NIOSH to investigate whether supermarket cashiers were exposed to biomechanical hazards for upper extremity musculoskeletal disorders due to the use of "checker-unload" workstations. In response, an ergonomic evaluation of cashier work activities was conducted at three supermarket chains in the Greater St. Louis area. The investigation was performed on October 21-22, 1992.

## II. BACKGROUND

The retail food industry is the third largest employer in the United States, employing approximately 3.5 million workers.<sup>(1)</sup> Of these, approximately 1 million are grocery store cashiers. In recent years, evidence of a relationship between musculoskeletal disorders and the work activities of grocery cashiers has gained increasing attention. According to various reports, the prevalence of musculoskeletal disorders among grocery cashiers ranges from 37 - 51%.<sup>(2,3)</sup> Basic biomechanical principles and previous research suggest that workstations requiring awkward postures, long reaches, and frequent lifts are more stressful to the musculoskeletal system than those that do not.<sup>(4)</sup> Checkstand design can greatly influence the cashier's posture and movement patterns during grocery checking tasks.

In 1990, the Food Marketing Institute (FMI) estimated that "checker-unload" workstations, also known as over-the counter (OTC) checkstands, were used by 14.8% of retailers nationwide.<sup>(5)</sup> In these designs, the "input" conveyor-belt common to most "customer-unload" designs is removed, and the grocery cart is docked with the checkstand at a point immediately adjacent to the scanner. The grocery cashier removes grocery items directly from the grocery cart for scanning.

The ergonomic suitability of checker-unload workstations has been the subject of at least one technical report and an OSHA general duty clause citation.<sup>(6)</sup> Problems previously associated with the checker-unload checkstand design include the following:

- (1) High forces and awkward shoulder and trunk postures are required to align grocery carts with the checkstand counter.
- (2) Extended reaches and repeated lifts are required to remove grocery items from the cart for scanning.
- (3) Awkward shoulder and trunk postures are required during scanning and keying tasks.
- (4) Excessive wrist flexion is required during scanning tasks.

Despite these reports, it is unclear whether these problems are unique to the checker-unload design. Awkward postures and excessive static loading have been associated with a number of other checkstand designs. Therefore, in response to this Health Hazard Evaluation request, a study was designed to compare the postures of grocery store cashiers using three checker-unload checkstands to the postures of cashiers using customer-unload designs. This comparison was performed to determine if the checker-unload workstation is associated with a higher frequency of awkward postures during grocery checking tasks. If so, the risk of musculoskeletal disorder development may be increased among cashiers using this design.

### III. STORE DESCRIPTIONS

This investigation was conducted in three grocery store chains (Dierberg's, Schnuck's, and National) in the St. Louis metropolitan area. Site visits were conducted at one store selected by each chain. Although each store employed a somewhat different checkstand configuration, all stores required the cashier to unload the customer's cart for scanning. A detailed description of each store is provided below.

#### Dierberg's

Dierberg's is a 138 year-old privately owned chain of supermarkets, operating 14 large stores in the St. Louis area. The chain employs 3,000 workers, of which 350 are cashiers. Approximately 50% of workers are employed only on a part-time basis.

All Dierberg stores employ the same checkstand design (Figure 1). The checkstand is custom-built according to company specifications, but similar to other checker-unload designs found in the industry. The checkstand incorporates a horizontally-mounted, (vertical-beam) Datachecker scanner, 30-34" in height, positioned directly in front of the cashier. A scale is located to the cashier's left, approximately 16" above counter height. The keyboard is located above the scanner and is adjustable in height. During the transaction, the cashier and customer face each other from opposite sides of the counter, with the grocery cart positioned directly in front of the scanner on the cashier's right side. Grocery carts designed specifically for cashier-unload operations (OTC carts) were provided for customer use. These carts are taller and shallower than conventional grocery carts. Grocery cart dimensions are shown in Figure 2(a).

In addition to cashiers, the store employs baggers in the front-end area. The bagger's primary job is to assist the cashier in putting groceries into bags for the customer, and to assist customers with delivery of groceries to their vehicles.

According to management representatives, an "Ergoscan" program was instituted at the beginning of 1992 in an attempt to address concerns about potential ergonomic

problems related to scanning. The program is designed to provide all cashiers with training in proper scanning methods. Cashiers watch a 15-minute videotape and undergo a 15-minute "hands-on" training session. Cashiers are instructed to (1) reposition ("stage") grocery items near the front of the cart to reduce reach distances during scanning, (2) slide items across the scanner after they have been removed from the cart, and (3) key-in items after three failed scanning attempts. Cashiers are monitored periodically to ensure conformance with these methods. Cashiers are also encouraged to perform various hand/wrist stretches and exercises during break periods.

### Schnuck's

Schnuck's operates 62 stores in the St. Louis area. The chain employs approximately 14,000 workers, of which 5-6,000 are cashiers. Because several Schnuck's stores were acquired from other grocery store chains, seven different checkstand configurations are used within the chain.

The checkstand examined by NIOSH investigators was a Reynolds 4000, 90 degree Right-hand Takeaway (RHT) design (Figure 3). In most applications, the Reynolds 4000 is paired with a conveyor module to provide grocery items to the cashier for scanning; however, in this instance the conveyor module was not provided. Instead, the cashier stands directly in front of the scanner with the grocery cart located on the cashier's left. The cashier removes items from the cart, passes them across the scanner and places them on a take-away belt located on the cashier's right side. The scanner (Datachecker/DTS) is horizontally mounted, with a vertically-directed beam. A scale is provided to the right of the scanner.

Unlike most stores, which employ a specially designed OTC cart with the cashier-unload workstation, Schnuck's provides customers with a conventional (deep-basket) grocery cart. Cart dimensions are shown in Figure 2(b).

### National

National Supermarkets operates 57 grocery stores in Missouri and Illinois, most of which are located in the St. Louis area. The chain employs 8,000 workers, including 2-3,000 cashiers.

The checkstand examined during this investigation was a Reynolds 2100/2200 Scan OTC model with an Orion model (vertical-mount, horizontal-beam) scanner/scale. The checkstand was installed in May 1990. Management acknowledged that the design is similar to previous models used in the store. The checkstand and its dimensions are shown in Figure 4. An OTC grocery cart is provided for customer use (see Figure 2(a)).

#### IV. ERGONOMIC EVALUATION METHODS

Site visits to each of the three stores were conducted on October 21-22, 1992. The work activities of four cashiers at each location were observed and recorded on videotape. The investigators made no attempts to interfere with the work habits of the cashier or the actions of the customers. Because we hypothesized that cashier work style might be influenced by fatigue, customer demands, store activity, etc., cashiers were videotaped for fifteen minutes once every hour for two-three hours.

##### Posture Classification System

To identify biomechanical stressors associated with unloading groceries from the customer's basket, an analysis of cashier postures and movements during grocery scanning activities was performed. Data resulting from this analysis were compared to data gathered from cashiers using similar checkstands, but where grocery items were provided to the cashier on a conveyor. The analysis focused on the following scanning postures and movements:

Initial Reach: Biomechanical principles suggest that the workstation design should enable a working posture in which the elbows are not elevated above mid-torso height and the shoulders are neither flexed nor abducted more than 60°. Similarly, the workstation layout should allow the trunk to be maintained in an upright, neutral posture, neither flexed, bent or twisted more than 20°. Therefore, the posture of the trunk and shoulder at the initiation of each scan was evaluated. At Dierberg's this analysis did not include any of the movements associated with "staging" the groceries at the front of the cart.

**Shoulder flexion** - coded only if flexed more than 60° at the time of initial grasp (illustration (a), Figure 5).

**Shoulder abduction** - coded only if abducted more than 60° at the time of initial contact with the grocery item (illustration (b), Figure 5).

**Trunk posture** - coded if flexed more than 20° at the time of initial contact with the grocery item (illustration (c), Figure 5).

Motion Across Scanner: An advantage of the horizontal-beam scanner/scale is that the cashier is able to slide rather than lift items across the scanner, thereby avoiding forceful exertions with the hands and fingers. However, if removing grocery items from the customer's cart requires the cashier to lift grocery items to the scanner, this advantage is removed. Therefore, motions used by cashiers to pass items across the scanner were coded to determine if the cashier-unload practice increased the occurrence of lifts associated with scanning.

For each item, the rater noted whether the object was "lifted" across the scanner, with the full weight supported by the arm, or "dragged" across the scanning



surface.<sup>(10)</sup> A third category "half lift/half drag" was defined for instances where the cashier lifted the object to the scanner, but then dragged it across the surface of the scanner to the adjoining conveyor, or vice versa.

The motions and postures used by each cashier to scan approximately 100 items (mean = 101) were observed on the videotape and then coded. The relative frequency (percentage score) of each motion and posture was calculated for each cashier, using the total number of scans observed as the denominator.

Previous NIOSH investigations at other supermarkets have utilized similar methods to assess postures associated with scanning. The data collected at the St. Louis supermarkets were compared to data collected at stores which use customer unload checkstand designs. The comparison designs included 2 different styles of checkstand: right-hand takeaway (Figure 6a) and front-facing (Figure 6b). These styles were similar to the designs used at Schnucks and National, however they included an input conveyor belt. The data for the comparison customer-unload stores were collected at four stores, two of each design, from three different supermarket corporations. At each store, five checkers were evaluated. As in the St. Louis stores, cashiers were videotaped for 15-minutes every hour during their work shift. Postures were coded in the same manner as described above.

## V. RESULTS

The results of the postural analysis at the three St. Louis stores are contained in Table 1. A comparison of these checker-unload designs and similar customer unload designs is shown in Table 2. This comparison included only Schnucks and National since those stores used checkstand designs which were very similar to the customer unload designs we had previously evaluated. Additionally, the practice of "staging" used at Dierbergs made a direct comparison extremely difficult.

In all three stores, awkward shoulder and trunk postures and frequent manual exertions were observed. In two stores, cashiers demonstrated an increased frequency of awkward shoulder and trunk postures as compared to cashiers using customer-unload checkstand designs. Cashiers in all three stores were also more likely to lift items across the scanner than cashiers using other checkstand designs. These increases appear to be linked to the use of checker-unload checkstand designs. Grocery cart design also appeared to influence the frequency of awkward trunk and shoulder postures, as shown by the higher frequency associated with the use of the deep cart. Additional problems specific to certain checkstand features (not generic to the checker-unload design) were also noted. These problems and design deficiencies are discussed below.

### Dierberg's

The results of the postural analysis indicated that the frequencies of awkward shoulder and trunk postures during scanning tasks are similar to those observed

among cashiers using customer-unload checkstand designs. The lack of any difference in the frequency of awkward shoulder and trunk postures can probably be attributed to the worker's practice of "staging" grocery items for scanning. However, it should be noted that staging often involved awkward reaches and lifts which were not counted in the analysis (see 3 below). Staging also lengthens the transaction period, since cashiers have to stop scanning to rearrange grocery items in the basket. Other problems noted included the following:

- (1) The location of the scale (46" above floor height, 17" from the edge of the checkstand) increases the frequency of lifting and awkward shoulder postures during weighing tasks.
- (2) Removing bags and boxes from the bottom of the grocery cart requires excessive bending and reaching. The bottom shelf of the cart is 6" above floor height; a second shelf is located near the front of the cart, approximately 14" above floor height. Depending on the exact location of the object, the object's weight and the posture the cashier assumes during the lift, the lift may put excessive biomechanical stress on the back, although calculations based on the 1991 Revised NIOSH Manual Lifting Equation were not performed.
- (3) "Staging" grocery items does little to reduce the frequency of awkward shoulder postures, and actually increases the cashier's workload. "Staging" requires cashiers to handle grocery items twice: once to move the item forward in the cart and once to pass the item across the scanner. Although staging avoids awkward reaching during the scan, several instances of awkward shoulder posture were observed during the staging process, as cashiers had to reach over the side of the cart (12" high, top edge = 44" above floor) to gather items positioned near the back or on the opposite side of the cart. Awkward reaches occurring during the staging process were not "counted" in the postural analysis; therefore, awkward shoulder posture percentages are artificially low.

#### Schnuck's

- (1) The current checkstand design combined with the use of the deep grocery cart requires the cashier to lift every grocery item at some point during the scan (i.e., the cashier is not permitted to drag grocery items across the scanner). This means that at some point during the scan, the full weight of each grocery item is supported by the cashier's hand and arm. **Not allowing the cashier to drag items across the scanner dramatically increases the manual force requirements of the scanning task.** Frequent and excessive manual force application is a risk factor for upper extremity musculoskeletal disorders.
- (2) Compared to cashiers using a customer-unload checkstand, the frequency of

awkward shoulder and trunk postures observed among Schnuck's cashiers was dramatically increased. The average frequency of awkward trunk postures was 55%, compared to 18% for front checkstand users and 46% for standard RHT users. The average frequency of awkward shoulder postures was 59%, compared to 37% for front checkstand users and 51% for standard RHT users.<sup>9)</sup> One reason for the increased frequency of awkward postures is that cashiers are forced to lift items from the bottom of the grocery cart (20" above floor) to the scanner (36" above floor). This results in static flexion of the spine during scanning, as well as repeated asymmetric reaching and lifting. These postures were demonstrated by all cashiers on *almost every order*, since grocery items are placed on the bottom of the cart first. Notably, if the order was very large, cashiers generally had easy access to items located near the top of the cart.

- (3) Bagging groceries requires awkward reaches and shoulder postures. At the time the evaluation was performed, there were no baggers present to assist cashiers with the bagging task, although cashiers would often assist each other if not otherwise busy. Requiring cashiers to bag groceries after scanning increases the cashiers' workload, possibly inducing fatigue and limiting the time available for rest and recovery between exertions.

#### National

- (1) A mismatch between the cart and checkstand counter heights (3") results in excessive lifting. As stated previously, an advantage of the horizontal-beam scanner/scale is that the design allows the cashier to drag items across the scanner, thereby avoiding forceful exertions with the hands and fingers. During the postural analysis, we observed no scans which met the definition of a drag, generally because the height mismatch required cashiers to lift items from the cart. Frequent and highly forceful hand exertions have been linked to the development of tendinitis, tenosynovitis and carpal tunnel syndrome.
- (2) Long reaches, resulting in awkward shoulder and trunk postures, were frequently observed when the cashier was required to retrieve items from the back of the grocery cart. The frequency of awkward shoulder postures (62.1%) was almost twice that reported among grocery cashiers using standard front-facing (customer-unload) checkstands.<sup>9)</sup>
- (3) Lifts are often required to retrieve large or heavy items (e.g., detergent boxes, cases of soft drink) from the bottom of the grocery cart. Frequent lifting, combined with trunk bending and twisting, can put excessive load on the low back.
- (4) Bagging groceries requires awkward reaches and shoulder postures. In many instances, the cashier was required to bag groceries after scanning, without

the assistance of a bagger. Requiring the cashier to bag groceries after scanning results in additional load on the shoulder and trunk muscles and limits time available for rest between exertions.

## VI. RECOMMENDATIONS

Comparing the postural analysis results with data collected in previous studies indicates that a substantial reduction in the frequency of awkward shoulder postures and lifts can be realized by providing grocery items to the cashier on a conveyor belt rather than in a cart. **Therefore, we recommend that the checker-unload work practice be eliminated, and the checkstand be replaced with a model equipped with a front-end conveyor belt for groceries.**

Although a work practice known as "staging" was advocated by one grocery store chain as a method of reducing awkward shoulder and trunk postures during scanning, it was unclear from this study whether staging actually provided some benefit to the cashier. Although staging did appear to reduce the percentage of awkward postures during scanning, long reaches and static shoulder and trunk postures were frequently observed during the staging process. This practice also resulted in cashiers handling each item at least twice, once during staging and once during scanning. This extra handling of items made the cashiers less efficient and could increase the repetitiveness of their job.

In the interim, until the checker-unload work practice is eliminated, the magnitude of postural or biomechanical stress to the cashier could be reduced by making minor alterations in the checkstand design, or implementing certain work practices. Specific recommendations are offered below.

### Dierberg's

- (1) Relocate the scale so that it is immediately adjacent to the scanner or provide the cashier with a combined scanner/scale. These configurations are less likely to require extended reaches and lifts during weighing tasks, reducing the risk of back and shoulder strain.
- (2) Discourage customers from using the bottom shelves of the grocery cart for storage.
- (3) Modifications to the "ErgoScan" training tape are strongly recommended. In the current version, a number of hand/wrist "exercises" are demonstrated, and cashiers are encouraged to perform these maneuvers. To date there is little evidence that exercise is an effective prophylactic measure for upper extremity musculoskeletal disorders. Furthermore, several of these "exercises" place the wrist in extreme flexion or extension. Extreme wrist deviation has been shown to increase pressure on the median nerve, and similar maneuvers are often used to elicit symptoms in patients with median

nerve neuropathies. Because of the potential for median nerve compression, it is recommended that these "exercises" be dropped from the "Ergoscan" training tape.

### Schnuck's

The RHT checkstand is not appropriate for use as a checker-unload workstation. If the store is to continue its policy of having cashiers unload the grocery cart for the customer, the best solution is to replace the checkstand with a front checker unload design, and replace the current (deep) grocery cart with a cart designed for OTC use. A less expensive alternative would be to eliminate the checker-unload practice and to add a conveyor module to the front of the existing checkstands to provide grocery items to the cashier for scanning.

Additional recommendations include the following:

- (1) Provide additional workers to assist the cashier with bagging tasks.
- (2) When replacing the current scanners becomes necessary, consider implementing a combined scanner/scale.
- (3) Provide cashiers with training in the recognition of symptoms and hazards for musculoskeletal disorders, and good scanning techniques necessary to reduce upper extremity trauma.

### National

- (1) Improve mating between the cart and checkstand by increasing the height of the cart or reducing the height of the checkstand. Improved mating would allow cashiers to take better advantage of the horizontal-beam scanner.
- (2) The reach to grocery items in the back of or far side of the cart could be reduced by (a) providing grocery carts with a "drop-side" as well as a "drop-front" feature (allowing the cashier more direct access to the inside of the cart), or (b) modifying the front of the checkstand to permit "offset docking" between the checkstand and the cart (back edge of the cart is rotated approximately 20 degrees towards the cashier). Offset docking represents a compromise between in-line docking (the current method) and right-angle unloading of the cart. This method has been used by other checkstand manufacturers to reduce reach to the back of the cart.<sup>(6)</sup>
- (3) Provide additional workers to assist the cashier with bagging tasks.
- (4) Discourage customers from using the bottom shelves of the grocery cart for storage.

- (5) Provide cashiers with training in the recognition of symptoms and hazards for musculoskeletal disorders, and good scanning techniques necessary to reduce upper extremity trauma.

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**TABLE 1  
HETA 92-294  
POSTURAL ANALYSIS RESULTS**

**Dierberg's \***

CASHIER	ITEMS SCANNED	SCAN RATE' (ITEMS/MIN)	SCAN MOTION (%)			% AWKWARD SHOULDER MOVEMENTS	% AWKWARD TRUNK MOVEMENTS
			LIFT	HALF	DRAG		
1	94	17	29	68	3	47	15
2	100	16	14	84	2	37	35
3	101	13	20	79	1	39	7
4	107	19	12	88	0	16	2
AVG	101	17	18	80	2	35	15

\* This does not include any of the movements associated with staging which would increase the total number of movements required to scan each item.

**Schnuck's**

CASHIER	ITEMS SCANNED	SCAN RATE' (ITEMS/MIN)	SCAN MOTION (%)			% AWKWARD SHOULDER MOVEMENTS	% AWKWARD TRUNK MOVEMENTS
			LIFT	HALF	DRAG		
1	117	24	71	29	0	45	56
2	72	23	61	39	0	50	64
3	101	21	12	88	0	76	58
4	117	36	9	91	0	63	40
AVG	102	26	38	62	0	59	55

**National**

CASHIER	ITEMS SCANNED	SCAN RATE' (ITEMS/MIN)	SCAN MOTION (%)			% AWKWARD SHOULDER MOVEMENTS	% AWKWARD TRUNK MOVEMENTS
			LIFT	HALF	DRAG		
1	99	18	18	82	0	64	30
2	90	21	33	67	0	60	24
3	107	16	40	60	0	65	22
4	108	22	22	78	0	60	23
AVG	101	19	29	71	0	62	25

' Scan Rate = #items scanned/minutes of scanning (denominator does not include time required for other activities, i.e., tendering, bagging)



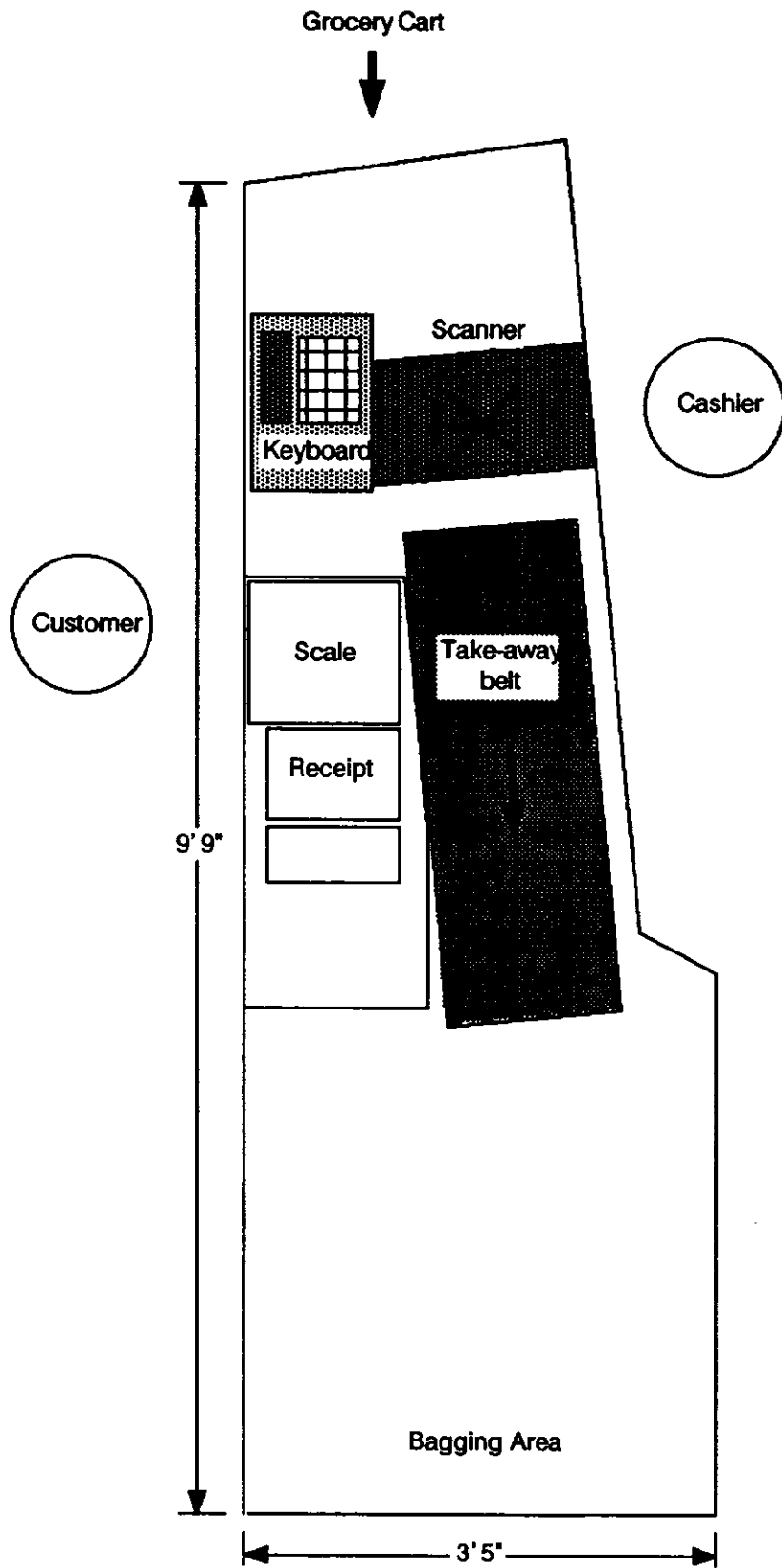
**TABLE 2**  
**HETA 92-294**  
**COMPARISON OF POSTURES**  
**CHECKER VS CUSTOMER UNLOAD DESIGNS**

Style	Method of Unload	# Cashiers Observed	Average % Scan Movements			Average % Awkward Shoulder Movements	Average % Awkward Trunk Movements
			Lift	Half	Drag		
RHT <sup>1</sup>	Checker/Deep Cart	4	38	62	0	59	55
RHT	Customer	10	27	61	12	51	46
FF <sup>2</sup>	Checker/OTC Cart <sup>3</sup>	4	29	71	0	62	25
FF	Customer	10	28	50	22	37	18

<sup>1</sup> RHT=Right-hand Takeaway Design (see Figure 3)

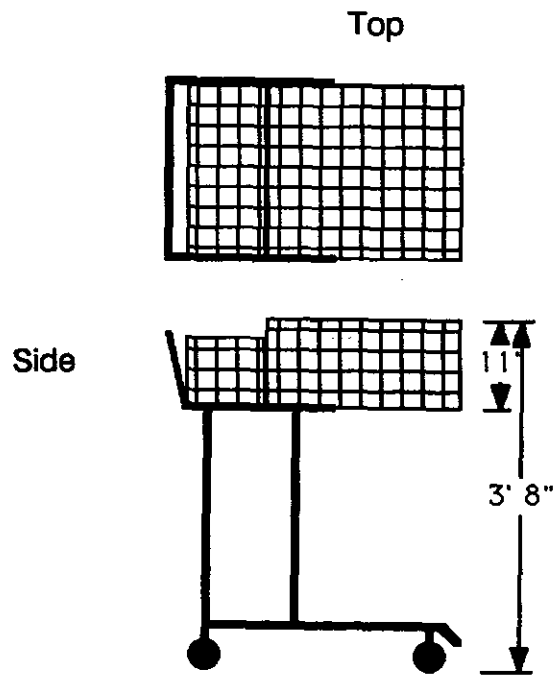
<sup>2</sup> FF=Front-facing Design (see Figure 4)

<sup>3</sup> OTC Cart=Over-the-counter Cart (see Figure 2(a))

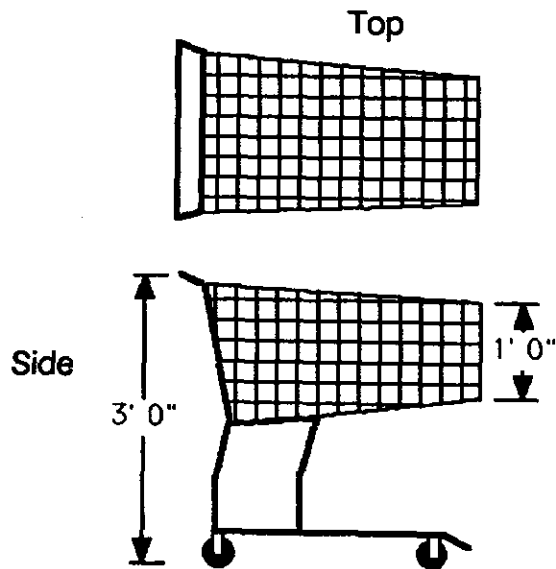


Scale: 3/4" = 1'

FIGURE 1. Checkstand Layout - Dierberg's



(a) OTC Cart



(b) Conventional Cart

Scale: 1/2" = 1'

FIGURE 2. Grocery Cart Dimensions

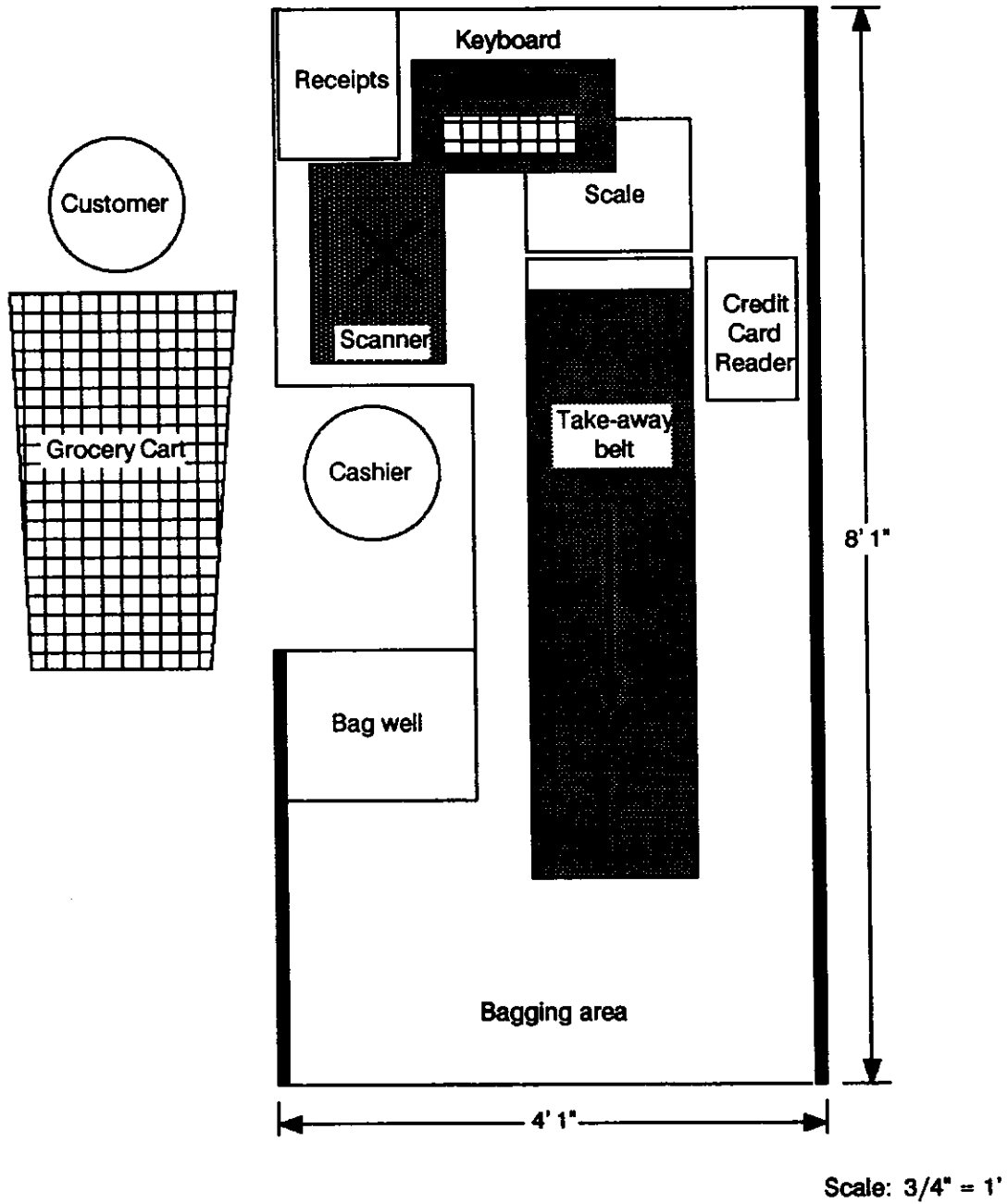
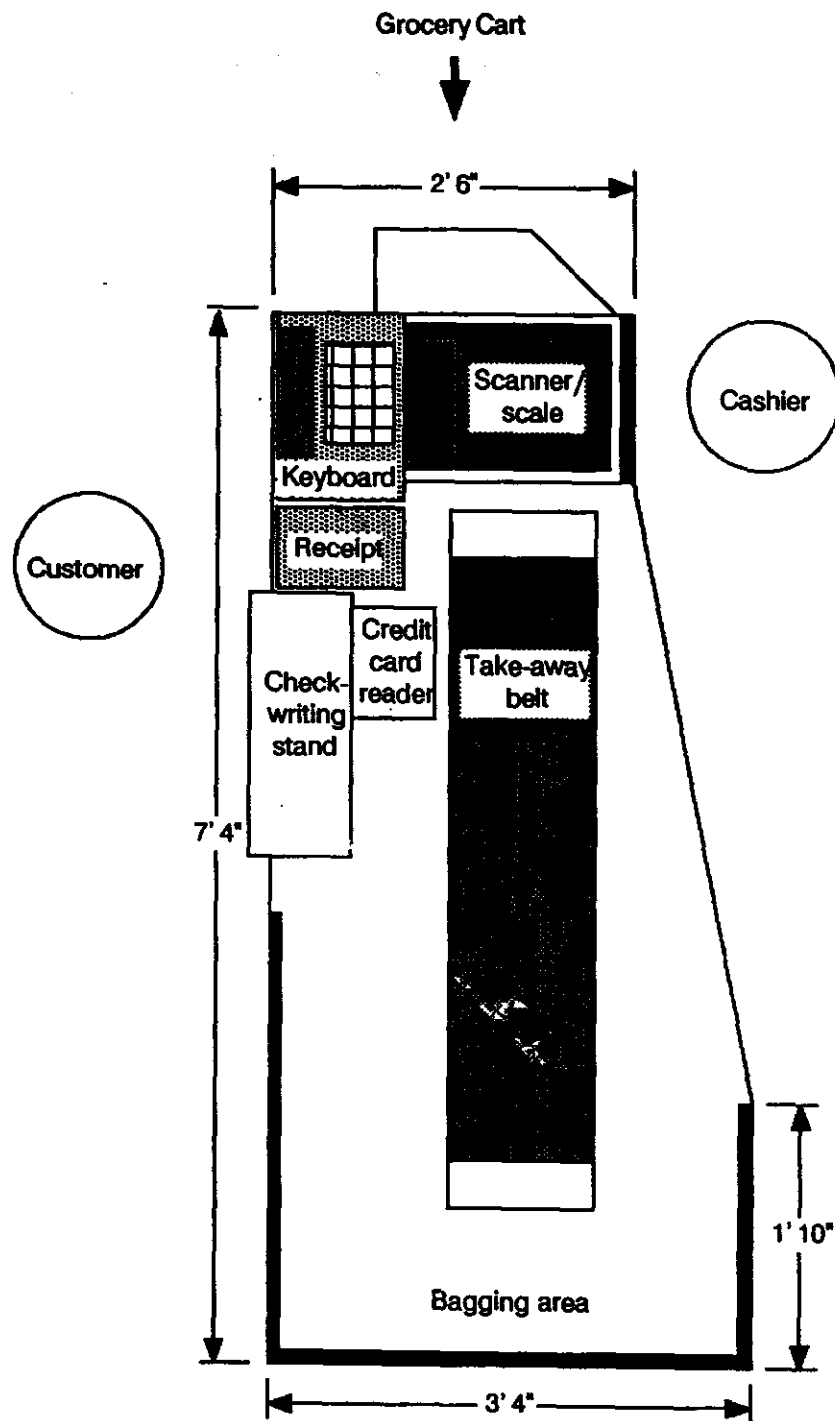


FIGURE 3. Checkstand Layout - Schnuck's



Scale: 3/4" = 1'

FIGURE 4. Checkstand Layout - National

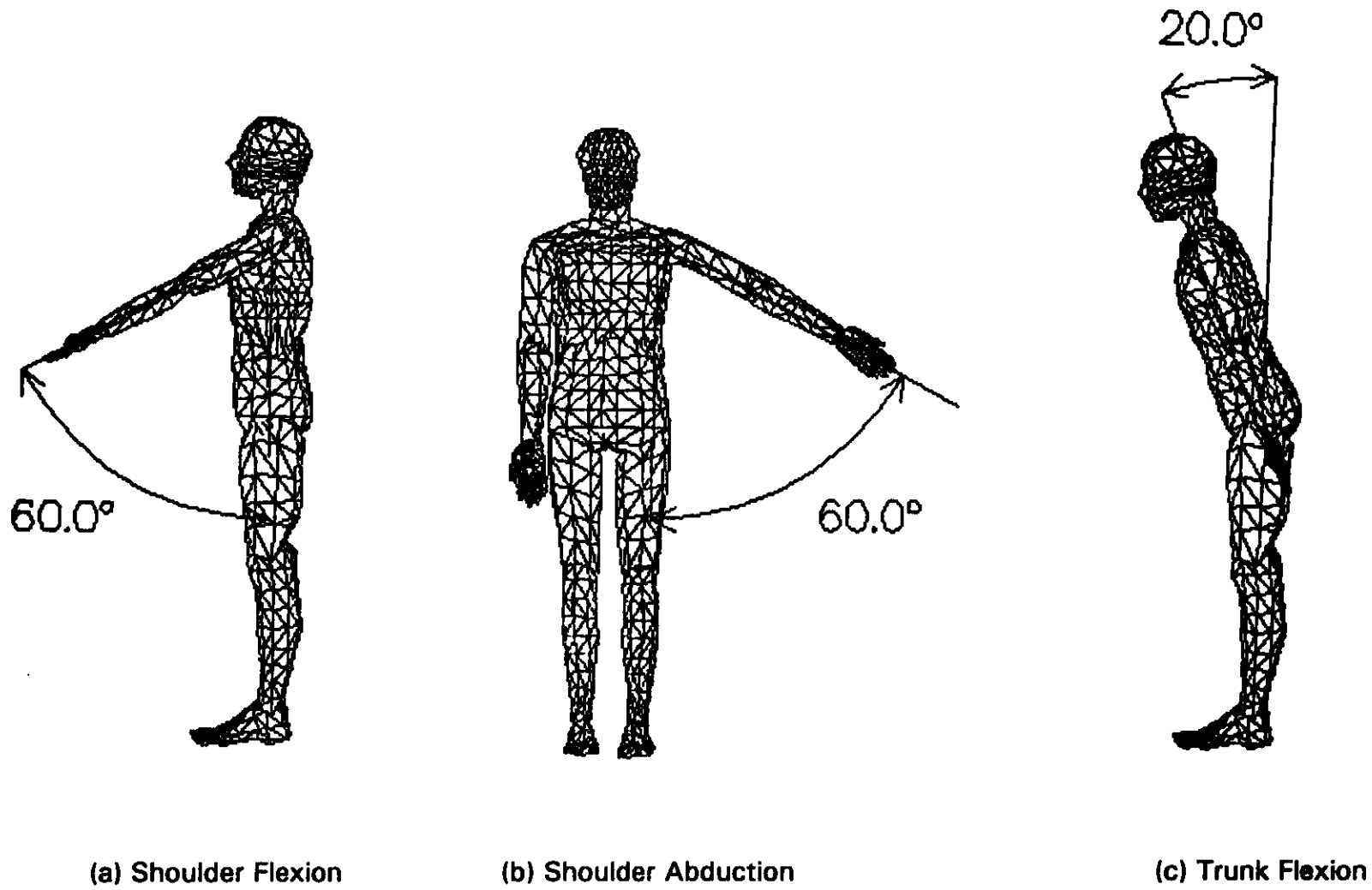


FIGURE 5. Postures Evaluated