Manual handling in warehouses:
the illusion of correct working postures

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Results from a study on load handling in two warehouses are presented. The loads
were mainly handled with the back bent and in twisted postures. The so-called
‘correct lifting’ method was rare. The dimensional constraints of storing systems
and the influence of the environment and load characteristics on handling strategies
are described. As a conclusion, it is proposed that training in lifting skills should
be replaced by training in manual handling in general, and by ergonomic improve­
ments.

1. Introduction
The mechanical handling of goods has not eliminated manual materials handling
(MMH). According to statistics, it appears the percentage of accidents attributed to
handling goods has remained stable over time at the level of one quarter of all accidents
(HM Inspectorate 1991). Manual handling may even increase in the future because of
the need for flexibility in operations and capability for information handling that only
a human operator can provide.

The prevention of manual handling accidents has followed three identifiable lines:
(a) improving the technology and the tools of handling either to eliminate manual
handling or to decrease the load on the worker; (b) improving the capacity of the
workers through selection or physical training; and (c) improving working methods,
often taking the form of encouragement to perform ‘correct lifting’ such as ‘back
straight–knees bent’. Except for some case histories, the effectiveness of correct lifting
in preventing MMH-related problems has not been shown, but such programmes are
still proliferating in industry (Kroemer 1992). As Lortie and Gagnon (1991) have
shown (see also Authier and Lortie 1992), the ways of handling loads vary widely and
even experienced handlers have a low level of mutual agreement on the best methods
of performing correct lifting. Some studies have shown that the handling principles
taught were not used as expected after training sessions (Chaffin et al. 1986, Hale and
Mason 1986).

Several authors observed manual handling under various circumstances (Drury
1982, Garg and Saxena 1980, Baril-Gingras et al. 1990). Although the results vary
in different circumstances, a common observation is that ‘correct lifting’ is a rare
exception in mainstream handling techniques.

The workers’ degree of freedom to adopt theoretically advantageous ways of
handling loads is limited. Several external factors seem to influence the handling method adopted. In fact, analyses of the effects of the manual handling environment on the lifting hazards, strategies or actual possibilities of the handlers to observe lifting techniques that are assumed to be less risky to the back, are scarce.

The purpose of this study was to analyse and describe common handling procedures in two retail warehouses and to identify determinants which influence the adopted lifting method.

2. Methods

The study was carried out in two medium-sized retail warehouses involved in the distribution of grocery articles. The study was part of a larger project concentrating on the methodological aspects of measuring the risks of warehouse work on the back with the ambulatory recording of back muscle EMG (Kuorinka et al. 1987).

Sixteen professional manual handlers volunteered to participate in the study, in which each worker was followed for one working day to record various aspects of the work. Table 1 gives the characteristics of the population participating in this part of the study.

The main means of analysis of the lifting actions was photography. Serial photographs of representative lifting actions (a sequence comprised of lifting and lowering a single load) were taken so that at least the beginning and the end of the action were covered. The worker was followed for an entire working day for the EMG recording, but the lifting actions were photographed intermittently during normal work periods. Altogether, 79 technically successful series (where at least one photo allowed a reliable analysis of the posture) for the 16 people were retained for further analysis.

Simultaneously, in parallel with the serial photographs, a video recording of the same photographed sessions was made. The video sequences covered 92% of the photographed sessions. The purpose of the video was to support the photographic analysis as well as to give a picture of the working conditions in general, and of the simultaneous events occurring near the lifting task.

The postures identified in the photographs were classified by two researchers simultaneously into different classes which were essentially the same as the standard OWAS postures (a work sampling analysis of preclassified postures, Karhu et al. 1977). Due to the fact that three-dimensional photography was not available and two dimensional pictures did not always allow exact measurement of distances and angles, the precision of the classification was limited to a few classes of the basic OWAS system. The abbreviated classification consisted of four back positions, three for the feet and lower limbs, as well as some distances. Table 2 lists the posture classes.

The analysis concentrated on postures at the beginning and at the end of the sequence. These postures seemed to describe the essential aspects of the handling action in warehouse collecting tasks. The analysis of the postures and movements in
Table 2. Recorded positions of the body and lower limbs. The criterion for each category is the same as in the OWAS method (Karhu et al. 1977).

<table>
<thead>
<tr>
<th>Position of the feet</th>
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<tbody>
<tr>
<td>Feet side by side</td>
</tr>
<tr>
<td>One behind</td>
</tr>
<tr>
<td>Other position</td>
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<table>
<thead>
<tr>
<th>Position of the lower limbs</th>
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</thead>
<tbody>
<tr>
<td>Both limbs straight</td>
</tr>
<tr>
<td>Both limbs flexed</td>
</tr>
<tr>
<td>On limb flexed</td>
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<table>
<thead>
<tr>
<th>Position of the back</th>
</tr>
</thead>
<tbody>
<tr>
<td>Back straight</td>
</tr>
<tr>
<td>Back bent</td>
</tr>
<tr>
<td>Back straight, twisted</td>
</tr>
<tr>
<td>Back bent, twisted</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Distance of the load from surface</th>
</tr>
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<tbody>
<tr>
<td>On the floor, pallet or &lt; 50 cm</td>
</tr>
<tr>
<td>50–100 cm</td>
</tr>
<tr>
<td>100–150 cm</td>
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<tr>
<td>&gt; 150 cm</td>
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<table>
<thead>
<tr>
<th>Distance of the load from body</th>
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</thead>
<tbody>
<tr>
<td>Close: &lt; 50 cm</td>
</tr>
<tr>
<td>Far: &gt; 50 cm</td>
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the middle of a lifting act was not done because it required a dynamic movement analysis, which was not available.

The shape of the load (box or irregular load) and the type of hand grip was recorded (symmetrical or not). The weights of the loads were obtained from company records or by asking the workers, who knew the weights from earlier experience.

The handling sequences selected for recording represented the most frequent and common ways of handling loads. The selection was made following the preliminary observations.

3. Results

3.1. Loads

The loads were in most cases rectangular cartons, with the size and shape varying greatly. The shape of some loads was irregular. The loads handled by men weighed 4.5–30 kg (mean 14.3); the women handled lighter loads: 2–15 kg (mean 9.8). The difference between the men and the women is due to the fact that the women worked more often in the dispatch area where loads were lighter. The median weights were 10 and 14 kg (women versus men); one quarter (28%) of all weights were under 5 kg. The loads in most cases were of rectangular shape (96% of the cases) and did not have handles. The sturdiness of the box material and the surface characteristics of the carton varied also from one product to another.

3.2. Hand position

The handlers grasped the rectangular load on diametric corners in 72% of the cases and supported the load on the body as much as possible. Thus, the position of the hands was essentially the same as found by Drury et al. (1982).
3.3. **Position of the trunk and lower limbs**

Figure 1 summarizes the details of the initial postures (63 recorded handling actions) and final postures (59 recorded handling actions; 4 cases excluded because the photo did not allow a reliable posture analysis).

A typical initial posture was as follows: feet were apart (58%), lower limbs straight (68%), back bent (92%). In addition, the back was twisted in more than half of the cases (55%). In this posture, the worker lifted a load, which was usually located 50 cm or less from the floor (73% of the handling actions) and the initial distance of the load from the body was less than 50 cm (83% of the handling actions). In a typical final position, the feet were apart (47%) and the lower limbs extended (92%). The back was straight (27%), bent (58%) and/or twisted (45%). The analysis of the intermediate
positions (not shown in the table) showed that a typical lift was a ‘back lift’ (back bent, 79% of the handling actions) and that the back was often twisted (77%). The load was usually supported next to the body (57%) and this was the case particularly when the weight exceeded 15 kg. If the load was not supported by the body, the weight was in most cases under 9 kg.

The results showed that lifting was seldom done in the sagittal plane, with the back straight and knees bent as proposed in the ‘correct lifting’ instructions.

3.4. Description of the determinants of the handling strategy

The video recordings completed the analyses of the serial photographs. Although they were not analysed systematically, they provided a descriptive analysis of the circumstances and environmental factors influencing the handling actions (which were photographed simultaneously).

A factor, which seemed to have an important effect on the lifting, was lack of space, although the warehouse was not too confined. Each cell of the rack easily accommodated one or two pallet loads. Searching for, and moving and lifting loads in the confined spaces of the rack cells, however, forced workers to adopt lifting techniques that allowed them to complete the task but did not take into account the load on the back.

The mean time for loading one item was typically between 1 and 2 s, but various incidents like searching for the item or removing a broken package could lengthen it tenfold.

The shape and size seemed to influence the speed and handling strategy adopted by the worker. Packages of irregular shape were the slowest to handle. The varying sizes of boxes caused a need for rearrangement, increasing the total load in manual handling.

Broken packages were another source of difficulty because of the need for rearranging such loads. Other packages were soiled or dangerous, due to such things as broken glass, causing additional and unusual handling situations.

The lighting had an impact on the identification of product codes. The general illumination was estimated to be well above the recommended level, but the racks five or six shelves high effectively shadowed the work space. The identification of code labels on packages in mixed product pallets became difficult and required repeated manipulation of loads in order to identify and verify products.

4. Discussion

The handling of materials is a common task in warehouses, shops, etc., and does not show signs of decreasing in the future. The ‘correct lifting’ recommendations are based mainly on biomechanical truisms whose goal is to decrease the compression and shear loads on the back. Such recommendations do not take into account the variety of factors that influence the possibility of complying with a recommendation because of environmental restrictions on the one hand, and on the other hand, because the handling action is a complex, goal-oriented phenomenon involving compromises by the handler.

We have shown that in the two warehouses studied, ‘correct’ lifting techniques were rare, and observed only in a few cases. The lack of space did not allow theoretically correct handling. An adequate grip and posture were influenced by load dimensions and other characteristics. This is in line with other findings, especially those of Lortie and Gagnon (1990). This is in spite of the fact that, during the initial
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(short) on-the-job training, correct handling procedures were taught to the worker, and that the occupational health personnel from time to time gave refresher training so that worker awareness of the manual handling procedures seemed to be quite good, and that a willingness to observe 'correct methods' existed.

The results also showed that, contrary to 'correct lifting' instructions, the position of the feet was usually asymmetrical. Such a position is obviously more stable, but it may also reduce the need for spinal torsion while the lower limbs participate in the torsional movement of the whole body.

The load was found to be in most cases near the body or in contact with it. This position is probably adopted by most people without any specific lifting instructions—if the lifting environment permits it.

Asymmetrical hand grip on the load, observed in most cases, allows an easier manipulation of the load in dynamic and torsional movements and makes body support more effective and stable.

The correct lifting technique seems to be an illusion also, because there is no clear agreement on what a 'correct' technique is. Even experienced handlers do not recognize it. The reason may be that a handler has to make many compromises, varying from case to case, to achieve the goal: the need to adapt the manual handling action to the existing constraints, the need to avoid acute discomfort both in the back and other parts of the body, the need to allow for fatigue and physiological strain during the working day, and the need to accommodate individual characteristics. All these needs must be balanced with the requirement to do the job correctly and efficiently under varying working conditions. This means that the biomechanically-based recommendation on 'correct lifting' applies only in a few cases.

The manual handling strategy adopted by a worker does not limit itself solely to mechanical factors. During another warehouse project, it was demonstrated that the palletizing strategy, the order of individual packages and their placement, the correct collecting order, and various cognitive factors play an important role and have an effect on the work load and the performance (see for example Pelletier and Lortie 1991, Patry and Costa 1990). These factors go far beyond the simple lifting technique.

Based on the results of this study, there appear to be many reasons for abandoning the 'correct lifting technique' instruction philosophy as a sole means of influencing safety and health in manual material handling. In the best cases it is a 'band aid' approach to a complex problem; in the worst cases, it may mask major safety and health risks. Ergonomic improvements and training in material handling in general, and not just in lifting techniques and skills, could be more effective and useful. In fact, research is needed on the principles of training workers in manual handling tasks and on the theoretical basis of that training.

References


Illusion and working posture


