Elements of a Material Handling Ergonomics Program

Analyze management operations

We must first recognize that materials handling is often one of the largest cost components of a product, operation or service. Unnecessary handling of materials costs time and money.

We must understand the relationship between workstation design and the jobs workers are expected to perform. People responsible for designing work methods must pay particular attention to details of the task involved to ensure the greatest possible harmony between the work method and the worker.

Make purchasing agents an important part of the materials handling program. Have them pay attention to details, such as size, weight, packaging and convenience for handling. Use sold to/ship to arrangements to eliminate in-plant handling wherever possible. Products being shipped to your company for distribution may be more efficiently transported from your supplier to the customer, saving freight and handling. Reduce overall work-in-process quantities. Failure to do so often results in overcrowding problems— extra handling, use of larger containers or parts stacked higher. Housekeeping problems may develop, increasing possibilities of materials handling vehicle accidents and damage to materials and finished goods. To reduce work-in-process quantities, it is necessary to tighten controls and shorten forecasting for inventory, scheduling, ordering and shipping. Manufacture products on an as-ordered basis, instead of stockpiling for anticipated use.

Perform product analysis. Changes in the product sometimes result in reduced materials handling. Consider lightening the product, and allowing a worker or conveyor to handle more pieces at one time. Plan to expand or change. Production usually suffers under crowded conditions. Much of this material is dependent upon management's policies and procedures.

But even in the absence of management analysis, you personally can analyze and implement change in the following ways. Establish disposal and storage methods, and ways to improve material flow for scrap, waste materials, containers, tools and equipment. Each workstation must be analyzed.

Material flow

It is usually not enough to simply observe and study a specific manual materials handling task. Key questions arise regarding how the material is routed through the facility or work site that can only be answered by looking at the bigger picture.

Eliminate unnecessary materials handling by combining operations or shortening the distances that the materials must be moved. Look for crossing paths, loops, backtracking and a lack of direction during production. One benefit of short distances is the ability to link workstations by conveyors and reduce carrying distances. Also, less mechanical handling can mean fewer opportunities for forklift accidents. Walk through your operations with an employee. Make immediate simple changes. (Make written suggestions for observed cost-saving and people-saving changes that need approval or further evaluation.)

Simplify, rearrange or change the process. Often, processes that are handled differently can be performed in a similar fashion to simplify the material flow. Plan adequate aisleways for intended material flow, and emergency access and exit. Personnel must be able to evacuate quickly in an emergency. Cramped aisleways may restrict exits and cause panic. Emergency vehicles also must be able to quickly gain access. Adequate aisleways and exits facilitate the orderly movement of materials. Avoid the necessity of working in aisleways.

Workplace

Check floor surfaces. Repair cracks, depressions, holes, damaged flooring and surfaces. Starting forces for carts can double or triple on poor surfaces. Worn-out or damaged wheels also can increase the required force. Insist on good housekeeping. Keep floor surfaces clean. Water, oil, grease and material scrap reduce traction and increase the force required to push or pull carts. Poor housekeeping only increases materials handling obstacles.

Review plant design to remove building obstructions that interfere with materials handling.

In materials handling, “what goes down must come up.” To prevent repeated stooping and bending, the goal is to bring both incoming and outgoing materials at each process to a suitable work height. We recommend at least a minimum of 20 inches from the floor, but ideally to knuckle height of about 30 inches. Reduce the need to raise or lower materials from above shoulder height. If you must raise or lower materials above shoulder height, store lighter objects on top shelves.

Remove constraints that prevent materials from being positioned close to the body. Allow enough space for feet to get under tables and conveyor belts. Provide clear access to shelves and adequate space around pallets. Reduce height differences during load travel. Keep loads between knuckle and shoulder height from origin to destination. Slide objects rather than lifting and lowering them.

Provide adjustable chairs for all operations. Chairs should swivel for side-lifting, whether they are located in the company president’s office or on the small-parts assembly line.

Load Guidance

Some specific considerations when handling loads would include:

- Small is better than big.

Generally speaking, when it comes to the manual handling of loads, small is better than big. Large, awkward loads present the handler with a variety of potential problems including added stress and strain to the upper extremities and the back. Containers should not be so tall that they obstruct vision or, conversely, bump annoyingly against the legs
as they are carried. Loads that will be lifted should be packaged in containers narrow enough to fit between the knees during a squat lift (knees and hips bent, and the back more or less straight). This design will allow the load to be positioned close to the spine, thereby reducing the load's compressive forces on the spine.21

- Loads should not be too light.

Loads that are too light may encourage the handler to lift a number of units at a time, creating an unstable load that is more likely to fall. Conversely, loads should sometimes be made so heavy that people will not attempt to lift the load without the help of another person or will get mechanical assistance. Whenever possible, packages should be labeled with the content's weight so people who handle them will immediately know how heavy a load they are dealing with.

- Containers should be designed to prevent their contents from shifting.

Loads that shift in their containers may move the center of gravity away from the handler, suddenly and traumatically increasing the load on the lower back. Likewise, loads that are unevenly distributed in their container (a nonsymmetric center of gravity) place torsion on the spine. Therefore, it is recommended that packaging "capture" the contained items, to prevent movement within the container and hold the items in as symmetric an orientation as possible. For nonsymmetric loads, the heavier portion of the container should be
closest to the handler in order to keep the center of gravity as close to the spine as possible.

- Boxes, totes, and containers should have handles.

Handles or hand cutouts provide the best coupling between the handler and the object. According to the 1991 Revised NIOSH Lifting Equation, the ideal handle design is 0.75"–1.5" in diameter, at least 4.5" long, and features a 2.0" hand clearance. Handlers should be of a cylindrical shape with a smooth, nonslip surface. The optimal handhold cutout has a 1.5" or greater height, a length of at

least 4.5", a semioval shape, and a 2.0" hand clearance, a smooth nonslip surface, and at least a 0.25" wall thickness. Handholds near the bottom of the container allow the handler to carry the load near knuckle height and minimize static muscle loading of the upper extremities. The edges of the container should be rounded, not sharp. Sharp edges create
opportunities for contact stress between the box and the hand, arm and body.

Analyzing manual materials handling tasks

Prioritize task analysis

Once we understand material flow, it is time to evaluate tasks. This should be done on a priority basis, first examining the worst and most strenuous tasks. The safety and health department should review accident statistics to determine priorities. The employees who perform the tasks being evaluated are a vital source of information. Ask employees for their views on where the most strenuous, demanding and dangerous materials handling tasks exist. Likewise, poll supervisors and other management personnel. This also is the time to examine the accident-investigation procedure to see if it is effective.

Analyze the job — tasks

Once priorities have been set, break the tasks down into elements, which are the simplest single actions needed to define the process at a particular stage of an operation. Among the considerations are:

- Recognize manual materials handling is more than just lifting. It also includes lowering, pushing, pulling, holding, carrying and transferring activities.
- Measure the frequency and duration of the task. Determine the frequency of the task in activities-per-minute. Be sure to note how the activity varies. Be careful in estimating an average frequency which may be cyclical; that is, very fast then very slow. Note the average duration of the task.

Be aware of the tradeoff between frequency and weight. As loads become lighter and are lifted more frequently, fatigue becomes a factor. As loads become heavier and are lifted less frequently, considerations regarding the structure and strength of the back are important. Allow the employee as much time as possible to complete the task, considering the needs of production. Determine the type of pacing. Make additional allowances for forced pacing.

Minimize reach requirements. Design the operation to accommodate the smallest person’s reach. Avoid unnecessary material stacking, storing or placement for work-in-process material (such as neatly orienting parts in containers when they

will be dumped out in the next operation). Structure equipment to use gravity to move materials wherever feasible. Simplify tasks by combining operations and steps.

Analyze the job — load

The load consists of the item or collection of items handled, many of which are stored in containers.
Adjust all containers for the required volumes. Use large containers for high-flow volume and small containers for low volume. Avoid using large containers for low-volume materials to reduce the need for workers to reach.

Remove handling uncertainties. Remove an employee's doubt about whether he or she should manually or mechanically handle an object by using obviously small and large containers or parts.

Plan for incoming materials to arrive in suitable containers to minimize product handling.

Ask customers how you can best design product-needs packaging to meet their materials handling needs.

Reduce deadweight ratio of containers. Consider the weight of the container which must be repeatedly handled and transferred vs. the parts inside. The weight of the container should be minimal compared to the weight of the product. Keep manually handled loads as small as possible, paying attention to the width and length. To prevent obstructed vision, load height should be 30 inches or less when manually handled.

The load center of gravity (or balancing point) should be as close as possible to the person handling it. Stress on the back increases as the distance from your center of gravity increases. For example, a 10-pound dictionary held 30 inches away from the body's center of gravity would be the equivalent of a compact 50-pound load held close to the body.

Ensure that the load will be easy to grip. This can be accomplished by ordering cardboard boxes with handle cutouts; using containers with handles, lift straps or textured containers; and avoiding awkwardly designed items.

Stabilize contents in boxes and containers to reduce surprises. Insert vertical baffles or dividers, balancing the weight in a box or using packing materials to avoid shifting parts. Minimize the potential for injury by protecting the employee from loads with sharp edges or projections. Potential for injury also exists with reactive loads, such as metal shavings.

Equipment

Consider the use of mechanical aids whenever possible to assist employees in their materials-handling needs. Examples include:

- Pallet jack;
- Lift table;
- Two-wheeled hand truck;
- Lift and tilt table;
- Four-wheeled cart;
- Winch;
- Motorized hand truck;
- Manipulator;
- Hoist;
- Positioner;
- Crane;
- Upender;
- Conveyor;
- Dumper;
- Chute;
- Powered industrial vehicle.

Try to incorporate concepts that fit the job to the worker. Consider maintenance and setup needs when planning, designing, purchasing and installing equipment. Build equipment around materials handling requirements.

The person who specifies a materials handling device should understand and clearly define usage expectations and desired outcomes.

This includes, but is not limited to, identifying:

- What will be carried (assessing size, weight, and other pertinent parameters)
- Overall weight and size capacity demands (using worst case load weight and size estimates)
- The terrain and anticipated travel path (identifying the presence of ramps, severe floor irregularities, steps, or other obstacles)
- Pertinent environmental conditions (extremes in temperature, water, or chemical exposures, etc.)
- How frequently the unit will be used (infrequently to constantly)
- Information pertaining to the people who will use the device (user population characteristics versus load and device characteristics), as necessary and appropriate

Such detailed information will help ensure that the specified device will fit the task requirements, reduce ergonomic risk factors, and reduce the human burden. Improperly designed or specified material handling aids have the potential to slow down work, lead the user to abandon the unit, or, worse, result in injury to the handler and perhaps to others. Choosing the right equipment can make work less physically taxing, reduce material handling risk factors, and make performing the task more acceptable to a wider range of people.

There is a host of material handling technologies available, including cranes, hoists, and monorails for lifting, lowering, and transporting; manipulators for picking and orienting; and work positioners and lift tables for lifting, lowering, and rotating objects. Carts, dollies, and trucks are used for transporting loads, and a

wide variety of tools and equipment, intended to reduce physical stressors associated with manual handling tasks, are available. Examples include conveyors, totes, flow racks, and ball transfers. Often teaming a combination of handling devices to work in concert as a system is desirable and should be considered. An example of this would be the use of a lift table used in conjunction with a conveyor and ball transfer to move materials from a receiving department through an incoming inspection process area.

Work scheduling

Bring only enough material to complete the job in the immediate work area. Extra material will either need additional handling to get it back to storage or will create congestion. Likewise, too little will require extra handling.

Consider the following, whenever possible, in jobs with considerable manual materials handling:

- Rotate employees from less strenuous jobs;
- Split work among two or more employees;
- Institute appropriate work/rest schedules.

Provide the worker with specific training in the following areas:

- Using mechanical handling aids. Employees may avoid mechanical aids because they simply do not know how to use them;
- Recognizing materials handling problems in the workplace;
- Identifying procedures that can prevent excessive manual materials handling;
- Proper body mechanics.

Remember that requiring employees to use particular lifting techniques — like the squat lift— has not been shown to be of any significant value. It is not recommended. However, training on manual handling techniques should be part of a comprehensive back injury reduction program (even though lifting training alone is not effective in reducing back injuries).

Environment

Review work areas for proper illumination levels. Poor lighting can contribute to accidents and injuries, and diminish quality of products.

Make allowances for weather conditions including the following:

- Issue appropriate clothing, including gloves;
- Take measures to prevent cold and heat stress;
- Maintain aisles;
- Shield storage areas from mud and snow.

Evaluate noise levels to ensure that workers can hear and heed mechanical handling warning signals. Be sure air-contaminant levels are not excessive. This can be achieved through routine monitoring programs in high-exposure areas.

Recommend, review and implement changes

Once workers, staff and line personnel have identified problems, they must be acted upon. At this point, deficiencies have been identified with possible solutions in mind. The process is broken down into the following stages:

- Prioritize — Priorities are categorized by the degree of hazard and risk associated with materials handling. These are determined as part of the initial management analysis of the materials handling process, essentially a historical approach. Risk is based on the frequency of worker exposure to the hazards of any given task and the number of workers routinely exposed;
- Review — Establish as company policy the review of materials handling safety as part of the planning procedure for any proposed process. This review should be ongoing since new materials handling equipment is on the market, and the state of the art in ergonomics is rapidly changing. The most effective review is conducted in an atmosphere of participatory management. There should be strong involvement and representation from all groups of employees. This can be accomplished generally through established committees or quality circles.

Two key elements of the review process are determining the impact proposed changes will have on other jobs, and what new problems will arise as a consequence of the changes made. Failure to consider these elements can result in a loss of credibility for the newly emphasized materials handling process.