# ‘BIN THERE, DONE THAT!
# A REVIEW OF THE ERGONOMIC CHARACTERISTICS OF SHIPPING BINS

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Bins are large containers that are used to ship parts from suppliers to customers. They are often purchased in large quantities, and circulated between the supplier and the customer, or between many different suppliers. Bins present many challenges to the ergonomist. Parts can be packed in many different configurations, dumped loosely or nested in stacks. They are typically arranged in such a way to optimize shipping costs, without much consideration to ease of retrieval. Solid-walled bins often present accessibility issues, requiring awkward postures to retrieve parts. These bins can be tilted or raised to improve access. Bins with drop sides that improve access to the parts or fold down to reduce shipping costs, are prone to wear, tear, and failure, creating new force and awkward posture issues for the user. This paper summarizes the most common ergonomics issues associated with shipping bins, and provides guidance to address these issues.

Keywords: bins, bin maintenance, bin design

# CHANGER DE COMPARTIMENT! EXAMEN DES CARACTÉRISTIQUES ERGONOMIQUES DES COMPARTIMENTS D’EXPÉDITION

Les compartiments sont de grands conteneurs utilisés pour expédier des pièces entre les fournisseurs et les clients. Ils sont souvent achetés en grande quantité et circulent entre le fournisseur et le client, ou entre de nombreux fournisseurs différents. Les compartiments soulèvent de grands défis pour l'ergonome. Les pièces peuvent être empaquetées de différentes et nombreuses façons, déposées en vrac ou emboîtées en pile. Ils sont généralement disposés de façon à optimiser les coûts d’expédition, sans accorder trop d’attention pour en faciliter l’extraction. Les compartiments massifs et fermés comportent souvent des problèmes d’accessibilité, ce qui entraîne l’usage de mauvaises postures pour retirer les pièces. Ces compartiments peuvent être inclinés ou élevés pour en améliorer l’accès. Les compartiments aux parois rabattables qui permettent un meilleur accès aux pièces ou réduisent les coûts d’expédition ont tendance à s’user, à se détériorer et à se rompre, ce qui entraîne de nouveaux efforts et des problèmes de mauvaises postures pour l’utilisateur. Cet article résume les problèmes ergonomiques les plus courants liés aux compartiments d'expédition et comporte des conseils pour essayer de les résoudre.

Mots clés : compartiments, entretien des compartiments, conception des compartiments

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## BACKGROUND

Large containers, used to ship parts from supplier to customer, are commonly called “bins”, but may also be called cartons, cages, bedsteads, or containers. (Smaller boxes that can be manually handled are sometimes also called bins, or “totes”, but the focus of this paper is on larger shipping containers.) Usually, bins are returned empty to the supplier and re-filled. This paper reviews the characteristics of bins that can contribute to musculoskeletal disorder risk, and design recommendations to optimize the worker-bin interface.

## METHOD OF PACKING

At the supplier, or manufacturer, the parts (or product) are dumped or packed into the bin. If they are “dumped” or “dropped” from a machine into a bin, the parts are randomly arranged in the bin, and may be tangled or nested together. If they are “packed”, the arrangement will be neater, and the parts may be placed in a specific arrangement, or nested and stacked neatly. Some delicate parts may be separated by dividers to protect them from damage during shipping, and this “cartoning” has implications for manual handling; load placement clearance can create static muscle demands when loading and unloading parts, and parts may need to be removed in a specific order or direction. For example, long parts, shipped vertically, will be lifted vertically out of the container, requiring an upward reach to clear the container and a long forward reach for parts in the center or back of the bin. Parts which are stacked or nested together, and then placed into the bin by the supplier, may stick together during transit, requiring several parts to be lifted at once as it is removed by the customer. The packing arrangement is important for the customer, as it influences both the quality of the part (i.e. whether the parts are scratched or bent) and the amount of time required to retrieve parts from the container. The arrangement of long parts inside a container also influences accessibility; parts arranged vertically, or lengthwise (side to side), may be difficult to retrieve from one side, whereas parts arranged with one end close to the unloading side can be easily reached, but may be awkward to unload if the center of gravity of the part is far from the employee. Such parts are often lifted with one hand rather than two, as shown in Figure 1.

**Figure 1:** Removing part from bin with one hand

## BIN DESIGN FOR ACCESS

Bins may be constructed of metal, plastic, or occasionally cardboard, and can have many configurations. The most typical style found in automotive parts manufacturing 10-20 years ago had wire mesh sides (see figure 2) that did not fold down, so the employee had to bend at the waist to retrieve parts from the bottom. (These were used to transport parts between departments, or to customers close by. Little concern was given to making the bin collapsible to minimize return shipping costs.) Tilting and raising these bins sometimes helped, as long as the parts wouldn’t come toppling out, but getting parts from the bottom of this style of bin was usually challenging,

**Figure 2: solid-walled (mesh) bin**

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regardless of the height or angle of the bin. If the bin was higher than hip height, it was virtually impossible for smaller workers to get parts from the bottom without standing on tiptoes and “balancing” on the edge of the bin.

Bins with drop sides have now become more common. These are constructed of metal or plastic, and offer improved access to the parts inside. A bin with drop sides can be raised as it empties, to reduce the amount of bending required. However, with the bin raised, the employee typically has access only to the open side, so parts must be arranged so they could be accessed from that side. Some bins have drop front and back, (or front and side, as shown in Figure 3), and can be rotated on a turn table for improved access. Drop-sides should ideally run along the entire side of the bin, to avoid having parts in corners that are not accessible.

**Figure 3:** bin with front and drop sides

Some parts can be shipped in bins without sides, allowing the operator to walk right into the bin with the part. (These are sometimes referred to as “bedsteads” or “walk in” containers.) This design is ideal from an accessibility perspective, particularly for large parts that do not require bending for placement. However, because the operator often steps onto the floor of the container, it can’t be raised or tilted. Occasionally, bedsteads may be loaded with parts in layers; if the worker can access both sides, the only challenge that this arrangement presents is optimizing part height in the container. However, if access to the back is blocked, and the parts are loaded from bottom layer first, then the reach to the back of these bedsteads can be large. One potential advantage of the bedstead is that parts may be “pushed” off the bedstead using a “pusher” (scissor device) on the front of a fork truck (as shown in Figure 4); while the bedstead rests on the forks, the plate on the front of the device pushes the load off of the bedstead and into the trailer. In this manner, manual loading of the trailer can be eliminated, and the trailer can be loaded to the roof without overhead lifting. (Note, however, that the trailer must then be unloaded manually, as the parts are no longer contained).

**Figure 4:** Fork truck with pusher attachment

Custom-designed bins for larger parts, such as car bumpers, can be designed to allow the operator to walk into the bin while carrying the part (as shown in Figure 5). This design minimizes the load on the back and shoulders, because reaching to the back of the bin can be reduced. If the bin is designed without a “floor” (sides and back wall only), or with a “cut-out” in the floor, then the bin can be raised with a stand to improve loading heights for parts at the bottom of the bin. “Flip down” (or “flip up”) shelves can also be used to optimize access to the lower level in bins. Care must be taken to ensure that whatever clamps or tie downs are required to secure the

**Figure 5:** custom bin with walk-in floor

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parts do not create additional risk factors; high push/pull forces are sometimes required to secure parts in custom-built racks, particularly after wear and tear occurs over time. Custom bins can be designed to accept the parts in the same orientation as they are manufactured, so the manual demands on the shoulders can be minimized. Custom-bins are expensive, and are therefore typically only used in smaller numbers to transport parts short distances. For example, they may be used in-house to transport parts between departments, or to transport expensive, delicate parts to nearby customers. They usually cannot be collapsed, so return shipping costs can be prohibitive (i.e. they are shipped back to the supplier in the same truck as they are sent, whereas several collapsible containers often require only a small fraction of space in a trailer and return shipping costs).

**Figure 6:** spring bottom bin

Another custom bin design that is typically used only in-house is a spring-bottom bin, as shown in Figure 6. This design includes a false bottom, which is attached to the sides by springs. As the load in the bin increases, the bottom drops. Similarly, as the bin is unloaded, the bottom raises, allowing the bin to be unloaded at a good height. These bins have been used in laundry and automotive parts.

## BIN MAINTENANCE

**Figure 7: slide-lock mechanism**

The introduction of drop sides created new maintenance challenges; moving parts are susceptible to wear and tear. The slide-lock mechanism (see figure 7) that holds the drop side in the upright position is prone to damage (bending), which makes the slide very forceful to open and close. If the forces are too high, the workers will leave the door in the upright position and reach over it instead, which slightly defeats the benefit of a drop side. The drop-side doors themselves can also get bent, causing them to stick out toward the operator in a partially “open” position, increasing the forward reach into the bin, as shown in Figure 8. Similarly, clamps or spring-loaded pull-pins on custom-built bins can become forceful to open and close, and are sometimes awkward if insufficient hand clearance is available, which often happens since shipping costs necessitate that the designer maximizes the number of parts per bin. Bins that are used only in-house may be equipped with wheels, which also need to be maintained.

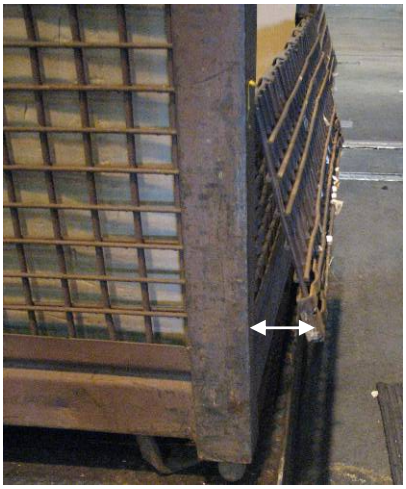

**Figure 8:** drop side that does not lay flat

Ideally, companies need to ensure that they implement a system that allows workers to flag bins for repair or replacement. Literally thousands of the same model of bin may be in circulation, and the same bin may take months or years to find its way back to the same facility. When this is the case, the worker may not consider the

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effort to flag a bin for repair worthwhile. Similarly, a company may be reluctant to take responsibility for repairing a bin if they know that it may not benefit them immediately. These issues need to be addressed between the supplier and the customer, or between suppliers, in order to minimize the risk of overexertion due to bin maintenance issues.

## BIN PRESENTATION FOR LOADING AND UNLOADING

Even a well designed bin can contribute to injury risk if it and the parts are presented poorly to the worker. Bins must be placed so that the worker has easy access to the open side. Heights and reaches can be optimized through the use of stands and, lift, rotate, and tilt tables. Table 1 summarises some of the considerations that should be made when selecting a presentation method.

**Table 1: Bin presentation selection criteria**

| Presentation method | Ideal for |
|---|---|
| Stand (raises bin by a fixed-height)  | • Shallow bins, such that the worker can reach the bottom when the top of the bin is at hip height.<br>• Bins with drop sides.<br>• All parts can be easily reached from one side.<br>• Loading/unloading with a forklift (cannot use a manual pallet jack) |
| Angled stand or tilt table (raises the back of a bin, so the top of the bin is angled toward the worker. May consist of four legs (2 short and 2 long) that the bin is lowered into or the bin is loaded onto a flat surface that is manually tilted after loading.  | • Parts that will slide toward the worker as the bin empties, but will not topple out of the bin when it is full.<br>• Shallow bins, such that the worker can reach the bottom when the top of the bin is at hip height.<br>• For bins with vertically packed parts. Tilting minimises the height to clear the top of the bin. |
| Dumper/hopper (bin is loaded using a fork truck onto an elevated device that tips the bin and allows the contents to flow out the top or through a door in the bottom of the bin] into a hopper or chute).  | • Parts that will flow easily (e.g. food, small metal parts) |
| Lift/spring table (powered table that raises, typically using scissors, and collapses, typically to a height of about 22 cm. The table can also  | • Bins with drop sides (front and back) with walk-around access to both sides.<br>• Bins that are shorter than 100 cm, so that, when the lift table is collapsed, parts at the top of the bin are lower than |

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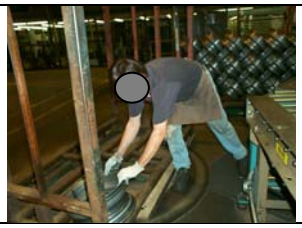
| Presentation method | Ideal for |
|---|---|
| be “self-leveling” so height of highest bin stays the same) | a small worker’s shoulder height. (Lower profile lift tables can be purchased for bins that are higher than this. Similarly, elevated platforms around the lift table can be provided to allow the device to optimize handling heights for taller bins.)<br>• Parts that vary in height. For example, if tall parts are loaded vertically into a bin, a lift table will not improve lifting postures. |
| Lift and tilt table (powered table that raises and tilts toward the operator)  | • Same criteria as the angled stand AND lift or tilt table.<br>• Solid-walled bins. |
| Lift and rotate table (powered table that raises, and allows the bin to rotate)  | • Same criteria as lift table, but where walk-around access may not be available or time-effective.<br>• Workstations with sufficient space to allow clearance to turn the bin (cannot place bins close together).<br>• Note that the footprint of the table must not be larger than the bin, or the reach to the parts in the bin will be increased unnecessarily (as shown at left). Heavy parts require caution to ensure that the force to rotate the table is not excessive. |
| Rotating disc (floor level surface that allows the operator to walk onto it and the bin to rotate)  | • When a bin has to be loaded from both sides.<br>• Operator needs to be able to get right up to the bin to load/unload |

## CONCLUSIONS

As shipping costs increase, so too does the pressure to design bins that collapse easily and safely, and allow good access while being loaded and unloaded. Progress has been made, but further work is needed, both in the design of the bins, and in the presentation of the bins in the workplace. Ergonomists can help to implement optimized designs by considering the suggestions in this paper.

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