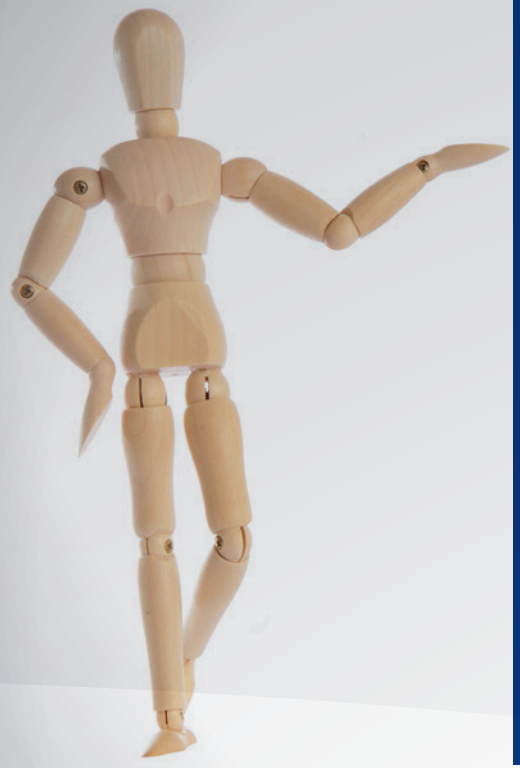

# Guide to Workplace

# \ er-go-no-mics \

Workplace ergonomics can be defined as the interaction between humans and the equipment they use in the workplace. In the context of casters, it's the interaction of moving products efficiently and safely from one area to another.

Ergonomically designed casters take into account the efficiency, comfort and safety of the user during pushing and pulling tasks.

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In collaboration with ergoweb®

# \ How Does Workplace Ergonomics Impact My Business Performance? \

## Productivity & Quality

Using the correct caster for an application will help reduce push/pull forces considerably. By reducing push/ pull forces for a worker moving a heavy cart, productivity can increase considerably because the worker can continue moving product at a consistent pace. Simply put, reducing unnecessary or awkward postures and resistance forces can cut the time and effort it takes to complete a task.

Body motions, visibility, workload, and other important ergonomic parameters will also affect the quality of work and the quality of work product. When a task is matched with the ability of the people who perform it, they make fewer errors and produce less waste.

Using a quality caster also means less maintenance and production downtime for a company, which can affect productivity considerably if there's a large fleet of carts that require constant upkeep.

## Health & Safety

Work Related Musculoskeletal Disorders (WRMSD) risk factors are actions or conditions in the workplace that may cause or aggravate a Musculoskeletal Disorder (MSD). Examples include forceful exertion, awkward postures, repetitive exertion, and exposure to environmental factors such as extreme heat, cold, humidity, or vibration. Often, a combination of these risk factors over time can lead to pain, injury, and disability.

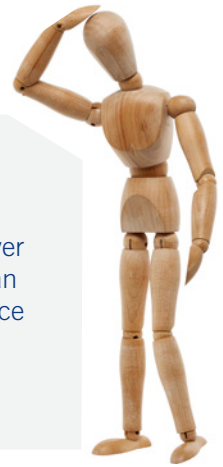
These risk factors can be reduced through informed purchasing and workplace design, retrofit engineering controls, administrative controls, work practice definitions or personal protective equipment.

The manner in which a risk factor leads to an injury/disorder is usually through the accumulation of exposure to risk factors. An event such as pushing or pulling a cart may stress soft tissues in the arms, shoulders, back, or legs, but the exposure may be too low for traumatic injury and the tissues recover. However, repeated exposure to this stress may interfere with the normal recovery process and produce disproportionate responses and eventually an MSD-type injury.

Corporate initiatives designed to identify and control workplace ergonomic concerns have proven to be effective in reducing the incidence of MSDs and have been efficient investments producing measurable bottom-line benefits. By implementing the right casters for the specific application, the risk of fatigue and overexertion is reduced.

## Costs & Consequences

One of the major causes of workplace injuries today is overexertion, accounting for over $14 billion in company costs in the United States alone[1]. Each overexertion injury can cost upwards of $51,000 per case. Costs include workers compensation and insurance claims. Victims of overexertion injuries average about 12 days away from work which has a significant impact on productivity. [1][2][3]



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# \ Major Avoidable Workplace Risks for Pushing/Pulling Tasks \

Pushing and pulling tasks require a force to be exerted to move a cart with a given load capacity. As that load increases, more force is required to move the cart. Overexertion injuries occur when the force required to move a cart is significant enough to cause injury.

Swivelling forces are forces that a worker exerts in moving a cart when casters are not inline with the direction of travel. This type of force can also lead to overexertion if the load is large enough.




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# \ Ergonomics of Safe Pushing & Pulling \

Manual Material Handling (MMH) tasks are physical work activities that involve exertion of considerable force because a particular load is heavy or the cumulative loads during a workday are heavy. Pushing and pulling is a common MMH task that involves movement of a cart or equipment with wheels or casters.

Researchers have identified a number of key factors that must be considered when designing manual pushing and pulling tasks. Surprisingly, the weight of the load or equipment is not as important as most people think. It is actually the horizontal push force that matters most. With the right caster selection and job design, thousands of pounds can be moved safely and efficiently.

For improved workplace ergonomics and to ensure decreased risk of painful, debilitating and costly injury, pushing is preferable to pulling for several reasons:

- when pulling, the workers feet can be “run over” by the cart/equipment
- when pulling while facing in the direction of travel, the arm is stretched behind the body, placing the shoulder and back in a mechanically awkward posture
- when pulling while walking backwards there is an increased risk of accident because the person is unable to view the path of travel.
- research demonstrates that the operator can usually exert higher push forces than pull forces.




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# \ Ergonomics of Safe Pushing & Pulling \

**Ergonomic considerations for pushing and pulling tasks to prevent overexertion and workplace injuries include 4 factors:**

## 1. Human factors:

**height, weight, age, gender, strength, posture, physiology and capacity**

A pushing task requires the person pushing to overcome the forces that resist motion. The person must be capable of generating adequate strength and must have adequate traction at their feet and then apply their force to the equipment. When people push wheeled equipment, they must transmit force through a contact point with the equipment. Traction at the feet must be at least equal to the resisting forces of the equipment otherwise the feet will slip, potentially causing injury. Researchers have shown that a person pushing with good traction can generate as much as 50% more force than when pushing with poor traction.

When significant force must be applied by the operator, a posture will be assumed that maximizes the ability to generate high forces using the large muscle groups and extending the feet behind the body, requiring high foot-floor friction forces. At lower forces, the operator will stand in a more upright posture.

## 2. Task factors:

**distance moved, movement initiation force requirements, sustained motion force requirements, direction and nature of movement, duration of pushing/pulling task**

The forces that resist movement of a wheeled object is called rolling resistance. Rolling resistance defines how much force a person must generate and apply. The force required to push wheeled equipment is always greatest at the start, just before movement begins, called starting force. Sustained or rolling force is generally lower than starting force. Turning force, the force required to change the path of travel of equipment already in motion, also impacts total required force.




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# \ Ergonomics of Safe Pushing & Pulling \

### 3. Cart/equipment factors:

### handhold height/orientation/type, caster/wheel design, stability, size, weight

Most carts and equipment have handholds. Handhold height is important because it defines the posture the person will assume. Clearly, no single handle height is “correct” for all people; logically, the right height for a 6-ft 4-in person would be very different from the right height for a 5-ft 4-in person. An adjustable handle system is an ideal way to accommodate people of various sizes. An alternative would be continuous vertical handles that can be grasped anywhere along their length.

Handholds are required for pulling tasks. Handhold width should be as near as safely possible to the outer edge of the cart/equipment but not so far as to risk crushing injuries. A handle should be shaped so that it does not concentrate pressure on any specific part of the hand. Also, the handle should be wide enough to accommodate the entire hand and allow the person to grip with the fingers. The palm should be in contact with the handle without finger overlap.

In a wheel or caster system, there are three locations where friction can act to resist movement, increasing the required push forces:

- In the axle-wheel interface
- In the swivel housing (for swivel casters); and
- At the ground-wheel interfaces when a wheel is slid or pivoted on a surface.

By selecting well-designed casters that utilize modern design technology and materials, resistance due to friction can be kept to a minimum. Friction between the wheel and the floor is negligible, unless it occurs from pivoting the wheel on the floor surface, or from sliding the wheel across the floor perpendicular to its rolling direction.

Typically, wheels and casters are offered with either precision bearings, which are best when sealed and therefore should be maintenance free, or bearings that require maintenance, such as cleaning and lubrication. Some wheels are offered with only a bushing and these should be avoided.

Bearing technology has improved to the point that for better casters, the wheel material and diameter are actually more important than the type of bearing. However, sealed precision bearings provide the added advantage that they are maintenance free.

Maintenance is often overlooked in caster selection, which can be an expensive mistake. When bearings become dirty or contaminated with debris, or the lubricant breaks down and is not refreshed through maintenance, the rolling resistance can quickly and significantly increase. If precision bearings are not chosen, a strict maintenance or inspection regime should be put in place to ensure that rolling resistance at the bearings is kept to a minimum.




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# \ Ergonomics of Safe Pushing & Pulling \

### 4. Floor/ground factors:

### surface characteristics, slope, embedment/contaminants

Rough or uneven surfaces, debris, and other contaminants can create physical barriers to rolling. When a wheel encounters such physical barriers it must roll up and over that barrier. The forces required to do this depend upon the size of the barrier relative to the diameter of the wheel. As the diameter of the wheel increases, the resistance will become lower. Wheel diameter is one of the most important factors, yet it is often overlooked.

When a slope is encountered, the weight of the equipment also comes into play, acting either for or against the operator. Going down usually requires no push force because the force created by gravity overcomes the other forces acting to resist movement. In fact, as the slope increases, the operator may have to apply pulling forces so as not to lose control of the free moving equipment.

Brakes are recommended for wheeled equipment that has a tendency to “run” when going down sloped surfaces. In the same way, gravity acts against the operator when equipment is pushed up a slope. The steeper the slope, the more the equipment weight must be borne by the operator. As the slope approaches vertical, the operator is essentially bearing the entire weight of the equipment plus any friction, physical, or dynamic forces.

Another consideration is embedding which occurs when debris gets stuck or embedded on the wheel surface. Embedded materials can result in increased rolling resistance, vibration, and noise.

It’s also important to note that certain operating environments require specialized casters and wheel materials. For example, in flammable environments and medical facilities, static electricity is a significant safety concern and special equipment may be required. Clean rooms and environments where chemicals are present also require special equipment selection.




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# \ 5 Factors to Designing Safer Pushing & Pulling Tasks \

**If a pushing/pulling job is to be performed manually, your primary goal is to minimize the forces required by the operator to initiate and sustain rolling, turning, and positioning.**

**Five main topics must be considered in order to design a safe and productive push/pull task:**

## 1. The people

- Design force requirements for a smaller person – likely to generate the least amount of force on a pushing/pulling task.
- Match footwear with floor conditions to maximize traction and avoid slipping. Researchers suggest a Coefficient of Friction (COF) of 0.6 or greater.

## 2. Task design

- Explore the effects of distance pushed, repetition, and duration of task on push force limits - depending on task, equipment, and operator factors, you will find that acceptable force levels for females can range from as low as 13 lbs. to as high as 57 lbs.

## 3. Operating environment and floor conditions

- The rougher or more uneven the rolling surface, the larger the wheel diameter should be.
- The more potential for floor debris, the larger the wheel diameter should be.
- Floor contaminants like oil, grease and chemicals can reduce traction making it difficult for the operator to apply the necessary force and can interfere with caster maintenance and function.
- Environmental conditions like special floor coatings, dust, high moisture, wash down or extreme temperatures must be investigated and analyzed when selecting casters to ensure optimal performance.
- The path of travel should be free of obstacles and the operator should have clear visibility in the direction of travel
- Implement effective floor inspection, cleaning and maintenance procedures to avoid negative impact on forces experienced by the pushing/pulling operator, the stability of the load and the life of the equipment.




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# \ 5 Factors to Designing Safer Pushing & Pulling Tasks \

## 4. Cart or equipment design

- For pushing, handhold height should be between elbow and hip height
- For pulling, handhold height should be between hip and knee height
- For pulling, handhold may need to be offset from the equipment to ensure adequate foot clearance
- The loaded cart or equipment must be stable as an unstable load can fall and injure people or damage product/equipment.
- Handholds should not extend beyond sides of equipment to avoid exposure to crushing injuries.
- A handle is required for effective pulling, but is not always necessary for pushing.

## 5. Caster and wheel design

Selecting the right caster and wheel design can be the most critical part of your manual push/pull task design, because reducing the rolling and turning forces reduces the forces that are required by the operator. The next section covers caster and wheel design in detail.




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# \ How to Choose the Right Caster to Reduce Workplace Injuries \

Selecting the right caster and wheel design can be the most critical part of your manual push/pull task design because reducing the rolling and turning forces reduces the forces that the operator must apply thereby reducing the risk of workplace injuries.

There are numerous casters on the market and a competent supplier can assist you in selecting the right design for your specific application.




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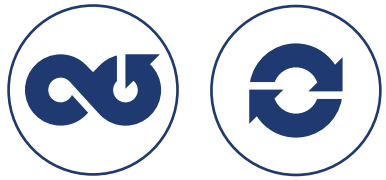
# \ How to Choose the Right Caster to Reduce Workplace Injuries \



## Important caster selection considerations include:

- **Understand the specific task, operating conditions, environment, and the people** that will be performing the work before beginning caster selection.
- **Match wheel material and diameter with floor surface conditions –** What type of floor will the casters go over? Is it a smooth concrete floor, soft carpet or rough terrazzo? Knowing the floor type can determine whether a hard or soft wheel should be used for the application. Typically, a hard caster can be used on harder floors with no coatings and softer wheels are used on soft, coated and rougher floors. Small details like cracked floors, "pot holes" and debris will also determine the type of wheel to use. Hard wheels work best for smooth, level floors, whereas softer wheels are geared towards rough or damaged floor surfaces. This may involve a trade-off between wheel material characteristics and wheel diameter.
- **Match weight of loaded equipment with load ratings for specific casters –** Knowing the load capacity that will need to be moved is an extremely important first step. By knowing this value, you can quickly narrow down the type of casters you will be able to use for your application. A general rule is that each caster should be able to withstand at least 1/3 of the total load weight by itself.
- **Position swivel casters under the handholds –** Often a cart will have two swivel casters and two rigid casters. For such designs, the swivel casters should be located on the same side of the cart as the handholds.
- **Brakes may be needed if heavy loads will be moved on sloped surfaces.**
- **Test potential wheels and casters under actual operating conditions –** Your goal is to match the horizontal force requirements with the force levels required. For best results, test in actual operating conditions using a push-pull force gauge to measure initial (starting), sustained (rolling), and turning forces.
- **A mix of manual and assisted pushing and pulling may be needed in some situations –** Sometimes one or more people can perform parts of an equipment movement task but other parts of the same task may require powered assistance due to elevated force requirements (e.g., going up or down a slope).
- **Environmental consideration –** This looks at the type of environment the caster will be in, whether it is outdoors where it rains often, a high temperature oven or on a hospital bed that is cleaned with detergent often, choosing the right caster will make the difference between a high maintenance caster that will require constant upkeep and frequent replacement or one that will require little to no upkeep because of its specific design.

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# \ Custom Casters to Meet Your Specific Performance Requirements \

Darcor will always strive to meet a customer's specific application requirements. Our highly knowledgeable engineering team will help your company build the right design to meet expectations.

The customized caster option can be beneficial if your company requires specific features such as a particular colour of wheel or rig, a special rig offset to reduce swivelling forces or adding cable pushers. Give us your challenge and we'll work with you to provide an effective solution.




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# \ Ask Our Engineers How the Right Caster Can Cut Costs & Improve Productivity \

For over 80 years, Darcor has provided the best casters in the world, constantly evolving to meet the workplace ergonomic needs of our customers. This constant growth has also created a proven track record. It's a fact that Darcor casters are proven to reduce work-related joint and back issues, increase productivity and lower overall workplace injury costs. An initial investment now could save your company a variety of costs in the long run.

**Contact us at ergonomics@darcor.com or 1.800.387.7206.**

We are happy to help guide you to the right caster for your specific application's ergonomic needs.

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# \ References & Credits \

References:

1. Bureau of Labour Statistics, http://www.bls.gov/iif/#tables
2. BLS News Release, http://www.bls.gov/news.release/archives/osh2_11262013.pdf
3. Liberty Mutual Workplace Safety Index, http://www.libertymutualgroup.com/omapps/ContentServer?c=cms_document&pagename=LMGResearchInstitute%2Fcms_document%2FShowDoc&cid=1138365240689

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