

GROUNDWORK:

Wheels *of* Fortune

by Cheryl D. Fields, *TeamRehab Report*

Wheelchair tires and wheels have a dramatic impact on the life of the wheelchair rider. The smoothness of the ride, maneuverability, speed and control are all related to a chair's wheels, tires and casters.

Choosing these components is not such an easy task. The rehab team must select a combination that will meet the client's lifestyle, performance, maintenance and affordability needs— requirements that may be mutually exclusive.

Information on selecting tires was in the November/December issue. The following is an overview of what rehab teams should know before choosing wheels. In the March/April issue, there will be a discussion on casters.

Surveying the World of Wheels

There are two types of wheels used on wheelchairs: spoked or wire wheels and, molded or mag wheels. Mag is a reference to the material of magnesium originally used to create wheels in the molded style. Today most mag-style wheels are not made of magnesium. Solid disk wheels are also available, but are rarely used by wheelchair riders.

The most obvious difference between wire and molded wheels is their appearance. Wire wheels resemble standard bicycle wheels. They are made of metal and typically have more than 30 wire spokes radiating from the center out to the perimeter.

Molded or mag wheels are made of solid or composite materials (nylon, plastic or aluminum) and usually have fewer than 10 spokes.

The difference in performance between these two wheel types is determined largely by how they are used by individual wheelchair riders. One characteristic of the wheel, however, that inherently affects performance is its weight.

Studies have shown that the more weight a wheelchair carries, the harder it is to maneuver. Since wheels add weight to the wheelchair, they can affect the chair's mobility.

"We've learned from people who do sports that the lighter the wheel, the quicker you can overcome inertia," says Marty Ball of Medical Composite Technology, a wheelchair material maker. Ball, also a wheelchair athlete, has encountered rehab teams that defeat the purpose of a lightweight wheelchair by fitting them with heavy mag wheels. "If the [mag] look is what they're going for, it's fine, but if they want the most mobility, this is not the best choice."

If weight is a significant concern for your client, then high-end, lightweight wire wheels might be the best choice since these are the lightest wheels available.

Historically, molded wheels have been heavier than wire wheels, and many still are. But recent innovations with composite and other lightweight materials have enabled some manufacturers to develop molded wheels that are comparable in weight to standard wire wheels. Considering these developments, rehab teams should not assume that all molded wheels are heavier than wire wheels. Instead, the team should find out exactly how much weight, if any, might be saved by choosing one over the other. In some cases the difference could be negligible.

There remains, however, a considerable difference between wire and molded wheels when it comes to maintenance. Molded wheels are virtually maintenance-free, requiring only periodic cleaning. Wire wheels, on the other hand, must have their individual spokes adjusted periodically to ensure that the proper tension is maintained equally around the circumference of the wheel.

Wire wheels depend upon the even distribution of tension in the spokes for support. Loose spokes can lead to weak spots in the wheel resulting in a bumpy ride, increased hazard and the potential for a bent rim.

The frequency with which spoke adjustments must be made depends upon the user. Some riders need adjustments only once a year. An athlete who competes in his wheelchair might need adjustments more frequently. Spoke adjustments are difficult and should be made by an experienced person or by a skilled wheelchair- or bicycle-repair technician, since improper adjustments can cause other complications.

Truing a Wheel

The "trueness" of a wheel refers to the relationship between its shape (lateral and vertical) and its ability to roll smoothly. A wheel that appears to wobble when spinning on its axis is probably not true. Wheels in this condition will ride neither

smoothly nor in a straight line. They also demand more from the wheelchair rider to propel.

One way to tell if a wheel is true is to watch what happens when you spin it on its axis. Stand behind the wheel facing the rear of the chair, take the weight off the wheel and spin the wheel. Wheels that are true will appear to stand in place. There is a problem if the wheel wobbles from side to side.

The trueness of a wheel applies to both wire and molded models. Molded wheels are trued upon fabrication and should remain true unless exposed to extreme conditions. The trueness of a wire wheel is more vulnerable to change. Collisions at high speed and lateral and extreme vertical impact can all distort the shape of a wire-spoked wheel. Minor problems can usually be fixed by a knowledgeable wheel-repair technician.

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According to Jon Raudman, founder and vice president of wheel maker Skyway Recreation Products, molded composite wheels are more forgiving in this respect.

"It is possible to get one of these wheels to warp if you load it up and expose it to extremely hot temperatures," Raudman said about Skyway's composite wheel. "But if you unload it, it will eventually come back to its original position."

Extreme temperatures can also cause some molded wheels to expand enough to burst a pneumatic tire, Raudman says his company heat tests its wheels to prevent this problem. Consumers should ask what effect extreme heat will have on a pair of wheels before making a purchase.

Durable though they might be, molded wheels are not invincible, and damage from warping or wheel breakage is also possible.

Because most molded wheels are made of synthetic materials, they are not negatively affected by moisture and, therefore, will not corrode in damp climates. People who intend to use their wheelchairs near the ocean or in other sites where moisture and other corrosive conditions exist, need to be aware that wire-spoked wheels are more difficult to maintain in these climates.

Options to consider would be for the wheelchair rider to use one type of wheel for everyday life, including work or school, and a different type

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of wheel for weekend activity, sports or even school bus safety (molded wheels for the latter), according to Adrienne Bergen, P.T., sales manager for Dynamic Medical, Westbury, N.Y.

Wheel Size and Alignment

Wheelchair wheel sizes range from 3-inch casters to 26-inch rear wheels. The standard size rear wheel used on a manual adult wheelchair is 24 inches. On power chairs, the standard is 18 inches.

Wheel size can affect the rider's comfort and the amount of energy that must be exerted to propel the chair.

Camber is used to make propelling the wheelchair easier for the rider. The most common camber position is when the top of the wheel is tilted in toward the wheelchair, bringing the tires closer to the rider's body.

Rear wheels should be selected in a size that allows the rider's feet to be positioned at a comfortable height off the floor. If the

rider is self-propelling, the wheels should cover a comfortable pushing distance while requiring the least amount of physical exertion. Wheel size combinations can affect seat height and therefore can provide additional ways to further customize a chair.

To determine if the wheel is the right size and is used in the right way, Bergen provided the following basic rule: There should be a 30-degree elbow bend when the sitting rider grasps the top crest of the wheel. That allows for the most push for the least exertion. This interface can be affected and altered by changes in cushion height (above the rails versus dropped between the rails), frame relationship to wheel position (raising or lowering axle position), and the size of the wheel, Bergen explains.

She recently modified a chair for a child who began to lean over his chair to push. While initial consideration was given to a chest strap, Bergen looked at the functional reason for the lean. The child was growing, and it was more difficult for him to reach the wheels. Bergen changed the cushion height and chair's axle position, thereby lowering the child into the wheel base.

Beyond wheel size, alignment of the wheels is also important. Wheel alignment determines how the wheelchair rides, its

stability, wear on the tires and the amount of energy required to propel it.

The term *camber* describes the inward or outward tilting of a wheel in its vertical plane. Camber is used to make propelling the wheelchair easier for the rider. The most common camber position is when the top of the wheel is tilted in toward the wheelchair, bringing the tires closer to the rider's body. This position effectively broadens the base of the wheelchair, adding more stability and making the wheels easier for the rider to reach for propelling.

While camber is typically used by people

who are self-propelling, it can also be used effectively for people who are dependent on a caregiver, but need added lateral stability.

"I use camber with some clients who have cerebral palsy because it gives them more stability," says Simon Margolis of Rehabilitation Designs, Madison, Wis., especially if a person has a lot of spasticity and is going to be moving around a lot in the chair." This includes both lateral rocking by the client or simply trying to reach to pick an object off the floor.

To determine the best camber position, Bergen suggests a look from the front of the

chair. When the rider reaches for the wheel, the shoulder, elbow and wrist should be in a vertical approach as straight as possible to maximize the use of the strength in the shoulder and arm.

Another alignment issue is toe. *Toe-in* and *toe-out* describe the off-parallel relationship between the two rear wheels. Toe-in describes the wheels in a pigeon-toed formation, where the distance between the front end of the wheels is less than that between the rear end (See Figure 1). Toe-out is when the front measurement is greater than that of the rear (See Figure 2).

The rehab team should avoid both of these misalignments, since even a half-inch of toe dramatically increases rolling resistance and wear on the tires. 1

Resources: Studies done at the University of Virginia Rehabilitation Engineering Center include: "Wheelchair Mobility: Task 7, Tire Analysis," by J.J. Kauzlarich, Ph.D., and J.G. Thacker, Ph.D., 1988 and 1989; and "Task 16, Tire and Wheel Design," by Kauzlarich and Thacker, 1983-89. To order these studies contact the university's Rehabilitation Engineering Center, P.O. Box 3368, University Station, Charlottesville, VA 22903; 804/977-6730; fax: 804/977-1258. For a copy of "Wheelchair 1 V: Batteries, Wheels, Tires, Frames and Drive Trains," by Thacker, 1989, contact: RESNA Press, Department 4813, Washington, DC 20061-4813; 202/857-1199.

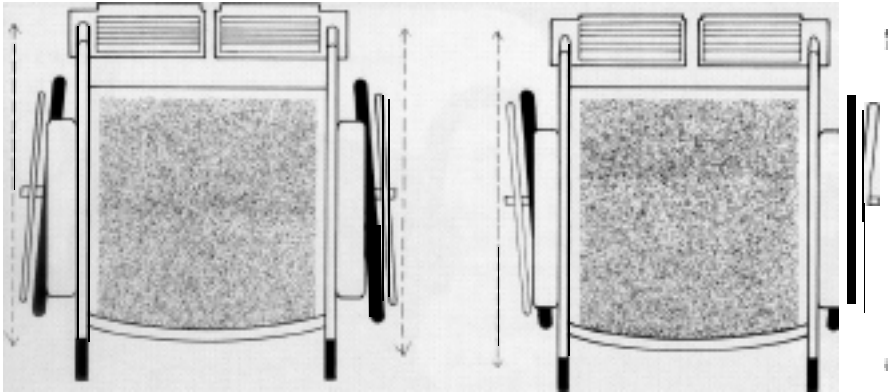


Figure 1 — Aerial View — Figure 2