HOW WHEELCHAIR SET UP AFFECTS PERFORMANCE

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Introduction

In performing a Seating and Mobility Assessment many clinician's neglect the mobility part of the equation. Once the seating needs have been met in order to determine the chair that is optimal for your client you must understand the impact each option, accessory and adjustment will have on the chairs overall performance.

Objective

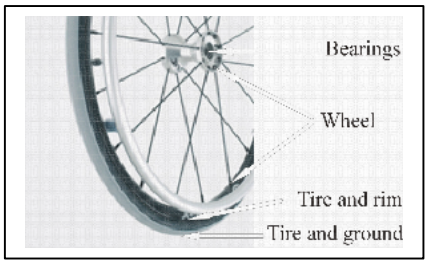
- The participant will understand the main factors that contribute to rolling resistance.
- The participant will be able to explain how horizontal centre of gravity location impacts chair performance
- The participant will have their long held beliefs about solid tires challenged.

Overview

Once you have established an appropriate seating system and whittled the choices down to a specific wheelchair for example a Quickie 2. You then have to select the appropriate configurations, options and accessories to optimize the selected chair to meet the client's needs. One glance at the order form will tell you that there are many choices to make. For example the chair is available in 12 widths and 11 depths. That is 132 different seat sizes and you are only just beginning. When all options and adjustments are factored in you can configure a Q2 in over 3,000,000,000,000,000,000,000 different ways. To put things in perspective there are less than 7,000,000,000 people on earth.

In order to arrive at the one chair that is optimal for your client you must understand the impact each option, accessory and adjustment will have on the chairs overall performance.

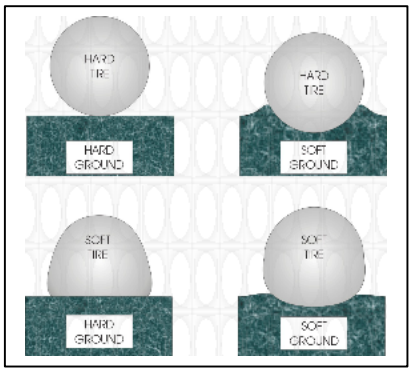
The seating configuration will determine static comfort and will have an impact on dynamic comfort and efficiency of wheeling. You will have to make compromises in setting up a chair for someone. Knowledge of the effect each component has will let you make an educated decision.



For every individual, optimizing mobility will involve reducing the effort required to push the chair (rolling resistance) and optimizing the users efficiency in applying that effort.

Rolling resistance of a chair is the combined drag between ground and tires, tires and rims, wheels and bearings. The more efficiently these elements interface the less the rolling resistance will be.

At the ground / tire interface you want to get as little distortion as possible.



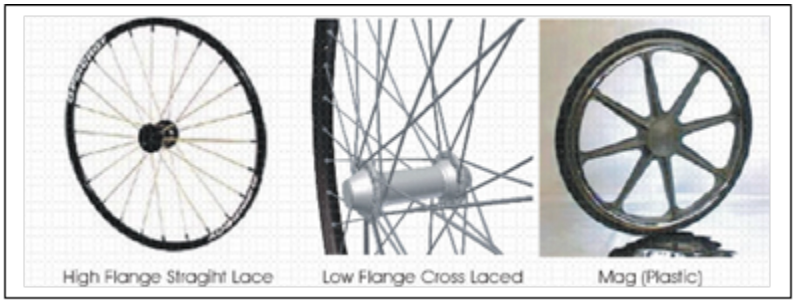
A hard tire on hard ground produces very little deformation and very little rolling resistance.
A hard tire on soft ground sinks in and deformation of the ground occurs which produces rolling resistance.
A soft tire on hard ground squishes out at the bottom and increases rolling resistance.
A soft tire on soft ground deforms a little and sinks in a little but the overall deformation is less than that produced by the hard tire on soft ground and therefore will roll more easily.

There is no perfect tire you must match tire selection to the type of terrain your client will be wheeling on.

A tire deforms hysterically, I mean hysteretically. As it rotates from the top its cross section is the resting shape but as it makes contact with the ground some deformation occurs. Hysteresis is inversely proportional to an objects willingness to return to it's original shape after being compressed. Pneumatic tires in general have low hysteresis. Solid and semi pneumatics have a high hysteresis. High hysteresis tires do not spring back to their original shape and return any of the energy used to deform them in the first place.

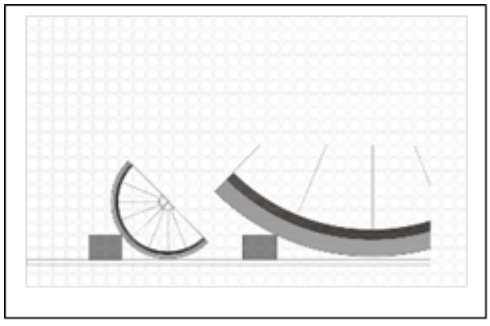
Tread design also impacts energy absorption. On hard surfaces a tall tread with big gaps between the blocks will collapse a little as weight is applied, this collapsing absorbs energy (increasing rolling resistance). However on soft slippery surfaces a smooth tread would not provide enough grip and the resulting wheel spin absorbs energy.

At the tire/wheel interface microscopic movement occurs, the greater the amount of movement the greater the energy lost. High-pressure clinchers (pneumatic tires without tubes) produce the least movement and lowest rolling resistance. A pneumatic tires movement on the rim is proportional to the air pressure in the tire. Higher pressure will press the tire/tube to the wheel rim with more force and reduce energy absorption and rolling resistance. Solid and semi pneumatic tires in contrast to pneumatic tires have a very loose and therefore inefficient interface. Better airless tires have tighter tolerances and require special tools to apply them to the wheel. This results in a lower amount of energy lost but the fit doesn't come close to the intimacy achieved with a pneumatic tire.



Loose spokes will increase energy expenditure and generally speaking a short straight-laced spoke will transmit forces more efficiently than a long spoke arranged in a cross laced pattern. Plastic wheels are even less efficient since they flex, are not generally as round and weigh more.

Bearings provide the interface between the chair and wheel; in a perfect scenario this is the only place where movement takes place. The more freely a bearing spins under load the less the rolling resistance.



The same considerations apply to choosing an appropriate caster. It has to match the terrain being wheeled on just as much as the drive wheel.

Larger diameter wheels roll over objects easier than smaller ones and also tend to keep spinning due to a fly wheel effect. Less weight produces less rolling resistance. Therefore when you have a large and a small wheel on a device, like a wheelchair, weight distribution will have an impact on the overall rolling resistance. More weight on the wheel with the better rolling characteristics will make the chair easier to wheel

Once you have a thorough understanding of the components that impact on rolling resistance it is time to focus on the second part of the equation; optimizing the users efficiency in applying that effort.

Speaker Bio:

Ian Denison has worked as a physiotherapist and equipment specialist at GF Strong since 1980. He is a regular presenter at conferences in the US and Canada on various aspects of mobility. He has received awards for his work on understanding and enhancing mobility from OT, PT and Seating & Mobility Associations. Including the Mundy Award in 2004 and the Vancouver Coastal Health Healthcare Hero Award in 2015.