Assistive Technology & Seating Service
Vancouver Coastal Health

GF Strong Rehab Centre
4255 Laurel Street
Vancouver BC V5Z 2G9

To: Tony Allport, Bert Germaine

From: Ian Denison

Re: PowerTrike

Thank you for the opportunity to check out your new wheelchair attachment.

The PowerTrike appears to be a well-designed unit that will meet the needs of a number of wheelchair users. Everyone who saw it liked its appearance. This is unusual; we had comments from all age groups and people with varied exposure to disabilities. Many people weren?t even aware that it was part wheelchair.

We set up our evaluation unit on a 16" Quickie GP rigid chair with 3 degrees of camber. The overall length was 60 " and width 27". The unit had 20% of the total weight on the front wheel. A 70kg able-bodied clinician did performance testing. Three people with mobility disabilities performed supplementary testing along with three able bodied testers whose weight ranged from 30 to 80 kg

Construction

The PowerTrike is very well constructed; there is obvious attention to detail throughout the entire design from the welds to the gussets, and from dust sleeves to the motor kill on the brake.

Ease of mounting

The A kit (for rigid chairs) took me about 30 minutes to attach to a Quickie GP. It is well engineered easy to adjust and very secure. It adds 1.8 kg to the weight of the chair.

We were unable to attach it to:

- Ti Sport -the rear cross member was too close to the front of the chair.
- Kuschall 3000 - only has one cross member.
- Action A4 - has "V" shaped cross members.

These chairs are very popular rigid chairs and would probably constitute a significant amount of lost sales if a solution is not developed.

Fitting kit B takes about the same length of time to attach to a folding chair and adds 3.1 kg to the weight. It can be removed by releasing 4 quick release clamps but this will only be done when the chair has to be folded.

We came across an interesting factor that needs to be considered when setting up- the chair. If a chair has camber, (a desirable trait for chairs that can travel at speed) lifting the front end by two inches induces a significant toeing error. The error is significant enough that the tire life will be significantly reduced and enough to make reversing very difficult.

Ease of attaching

Attaching the unit was very easy and possible for someone with compromised hand function and trunk balance. The most difficult task is securing the unit with the bicycle wheel clamp. People may also have trouble lifting the battery although correct placement is quite easy.

Removing the unit is a little tougher. Lifting the battery out requires more power than setting it in

place. Also sliding the unit forward out of the under seat receiver is quite difficult.

Adjustability

The unit can be moved closer or further away by a small amount and the handle bars can be raised and lowered through a range of about 4" they can also be tilted forwards and back through a large range.

Batteries

The four sealed lead acid batteries (two x 12v - 7ah and two x 6v ? 7ah) connected in series to generate 36v provided ample power for us to zip around on a variety of terrain for fifteen miles. Although what constitutes a mile is not exactly clear. I say this because according to the odometer the unit traveled 15.8 miles (25 km) before the batteries died. However, when I clocked the distance around GF Strong in both directions, the odometer clocked 0.9 miles(1.4km). We measured the distance to be 0.62 miles (1 km). At that rate of exchange the unit can travel about 10 real miles (16 km) on a charge. The gauge gives adequate warning of impending battery failure although in bright sunlight it is difficult to tell whether the yellow and green lights are illuminated.

Braking

The dual brakes proved very effective in slowing down the PowerTrike. The motor kill incorporated in the left had brake is a particularly good idea for people who tend to keep the power on while slowing down. Even people with limited dexterity and strength reported no difficulty stopping and slowing the trike. We were able to stop the trike from 19km/h in about 3 metres

Charger

The 36volt charger is a CE certified unit with no obvious design flaws. The instructions are clear, there are good strain relief devices and no holes in the casing large enough for children to poke pencils or fingers into.

The plug that connects the charger to the battery case however, gives me some concern. It is the same type used to power computers and monitors and is usually associated with mains voltage. Many people have that type of cable around the house and may inadvertently plug it in to the battery box thinking it has an onboard charger.

Wiring and connectors

Good quality connectors are used throughout with dust/water seals covering exposed wires.

Strain relief was achieved primarily though the placement of plastic ties. There is no relief for wires coming out of the controller although there is a grommet designed to protect the wires from the boxes sharp edge.

The battery is secured in its cage by friction in a cleverly designed slot. The retention mechanism is adequate for smooth terrain but requires supplementary restraint when negotiating bumpy ground.

The plug connecting the controller to the battery box is not anchored adequately, normal driving causes the plug to shake loose, breaking contact without actually falling out. This may cause people to misdiagnose the fault.

Noise

The trike has a high-pitched whine that becomes less evident the faster you go due to other noises that tend to drown it out. The noise is not particularly invasive and pretty well ignored after the first few trips.

Performance indoors

It is easy to be very precise in controlling the PowerTrike, both in terms of steering and speed control. The trike is surprisingly manoeuverable. The front wheel drive allows a very small turning radius (a little over a metre in our set up) and is no wider than the wheelchair it is mounted to.

Our throttle tended to stay on, kind of like cruise control. A slightly stronger return spring or lubrication of the cable would probably alleviate this slight fault.

The main problems we had related to getting through doors, the front of the trike projects so far that it is very difficult to reach a door handle.

The black rubber front tire can leave marks on walls and floors if the driver is a little careless. However the precise control offered by the handlebar steering and twist grip throttle make this unlikely to happen inadvertently

The trike cannot be reversed under power. To back up the driver has to let go of the steering and either wheel backwards using the wheelchair wheels or push off fixed objects. This makes manoeuvering in tight spaces tricky, particularly since the steering doesn?t tend to want to stay straight unless the driver is backing up in a straight line. In fact the effect is counter intuitive, if the driver wants to back up and turn to the left he would typically do it by pulling the right wheel back while holding the left wheel still. This causes the front of the trike to turn to the right further thwarting his efforts to steer. The solution is to back up with one hand while holding the

handlebars with the other to steer.

If the chair has any camber, the induced toeing error makes reversing very difficult.

Performance outdoors

The throttle has a nice progressive response but we found that the last bit of throttle rotation accounted for quite a lot of speed. Keeping the throttle twisted hard against the stop was a little fatiguing.

The top speed of the PowerTrike on a flat surface is about 19 km/h and average speed around GF Strong, which includes a number of inclines up to a maximum of 1:5 (12 degrees, 20%) is 16km/h. This is a perfect speed to accompany buddies on roller-blades or steady cyclists.

Ascending a slope with an average incline of 1:8 (7.5 degrees, 12 %) slowed the trike to 12 km/h, while descending saw the speed rise to 22km/h.

We experienced wheel spin when the slope we were ascending exceeded 1:8 but were able to regain full traction by leaning forwards a little.

It is easy to ascend a 3" curb in a sedate manner while sitting back in the chair. A 4" curb can be negotiated with a little body English. The caster wheels hanging up, causing the trike to high centre limit the curb climbing potential. Descending an 8" curb is relatively smooth, requiring that the driver lowers the front wheel over the curb, when the casters high centre the driver lets go of the handlebars and pushes forwards on the push rims until the casters clear, then uses the brakes to gradually lower the rear end.

Steering is very precise and the spring device designed to keep the wheel pointing forward is good. We did notice a tendency for the front wheel to shimmy when traveling at speed. This was a progressive phenomenon that starts gently and only occurs if you are not holding the handlebars or holding them very lightly. Most people who operate the trike and keep hold of the bars would dampen the oscillations as they started and would probably be unaware of them.

All three wheeled vehicles have an inherent weakness that some people call tippiness. It occurs when the driver is traveling at speed and changes direction quickly. Turning sharply to the left

causes the left rear wheel to lift off the ground. If the driver continues turning hard left, the caster will touch the ground and help to put the chair back on an even keel. It is possible however, to flip the chair if the driver is not aware of what to do (turn back to the right) to correct the situation.

Performance off road

The only place we got bogged down was off road where uneven terrain on an incline proved too much resistance for the battery/motor combination to overcome.

From a standing start the trike had difficulty maintaining traction on a 1:15 (4 degree, 7%) grassy hill. It could not start on dry grass if the incline was 1:12 (5 degrees or 8%) or more. It had adequate traction to stop on a descent of 1:3 (17 degrees 31%) and could handle a side slope of 1:3 (18 degrees 33%). Above this angle the chair turns down hill.(We also tested a chair that was narrower and instead of turning down hill it flipped sideways.)

All these limitations need to be born in mind when venturing off road. But a driver with good judgment who is able to anticipate will have tons of fun in this unit. If the driver is skilled enough and has adequate judgment he can use momentum to ascend significantly steeper sections of hill. We were able to make it up a 20 degree hill with a running start but if you judge things a little too finely and the trike runs out of oomph before the top, the chair will roll backwards very quickly and not necessarily in a straight line since with no weight on the front end you can not steer.

In the trails is where the trike really excels, steering is very precise at all speeds and the unit is able to contend with irregularities of up to two inches without too much weight shifting by the driver. Just be careful not to high centre the casters.

Summary

The PowerTrike is an excellent addition to the alternatives our consumers have for powered mobility. It drew attention wherever it went and with out exception feedback from all age groups

was positive. It needs a supplementary retention strap for the battery to be used by people negotiating bumpy terrain. It also needs a redesign of the plug connecting the battery to the controller/charger.

It could be made significantly more user friendly if the throttle could be rolled forward to reverse the motor. This would add dynamic braking for people with very limited grip strength, allow powered reverse and give people an opportunity to back up and take a run at little obstacles that they may have to negotiate off road.

I wish you well in your efforts to market the PowerTrike.

Yours truly Ian Denison