Development of Wheelchair Standards for Less-Resourced Settings

*International Society of Wheelchair Professionals (ISWP)*
*Standards Working Group*

03/02/2017
Breakdowns!
Consequences

• Injuries to users
• Missing work or school
• Stay at home
• Complications
• Wheelchair abandonment
What is different in less-resourced settings?
How they affect?

• Rapid aging

• Wear and tear

• Corrosion

• Contamination
Failures
Factors → Failures

• Delivery of inappropriate designs
• Poor maintenance
• Lack of resources
  • Repairs
  • Replacements
  • Skilled Labor
• Access to rehabilitation services is poor
• Lack of appropriate provision
• Policy issues
Global Need for High-quality Wheelchairs

- WHO Guidelines
- UN-Convention of Rights for People with Disabilities (Article 20)
- WC Consensus Conference – 2006
- WHO GATE initiative
- WSTP-B, WSTP-I
- ISWP
WHO Guidelines refer to ISO standards

- ISO 7176 series – Wheelchair Standards
  - Stability
  - Performance
  - Wheelchair Dimensions
  - Durability
ISO 7176-8 Tests

- Section 8 – strength, impact, fatigue
ISO Multi-drum fatigue test
ISO Kerb-drop test
Passing requirements on fatigue tests

- 200,000 test cycles on multi-drum test
- 6,667 test cycles on kerb-drop test
- Equivalent use of 3-5 years outdoors
WHO Guidelines recommend...

• For less-resourced settings,
  • ISO 7176 can be used as baseline standards
  • Develop additional quality testing standards
    • Based on local conditions
Research Evidence – Field studies

• Immediate failures with hospital-style chairs.
• Models appropriate for LREs, ISO tested
  • Short-term repairs, replacements and missing parts (3-8 months).
• With 1-2 years of use, a host of failures which require repairs by technicians.
Types of Failures

• Common failures in ISO tests
  • Fractures with cross-braces, side frames, backrests, castor spindles and footrests.
  • Tire cracks

• Field failures in less-resourced settings
  • Flat and cracked tires
  • Wobbly rear wheels
  • Bent frames
  • Non-functional brakes
  • Worn-out bearings
  • Damaged armrests
  • Torn seat covers
  • Loose upholstery
  • Collapsed cushions
  • Rusting and loosening of several parts
## Application of ISO durability tests

<table>
<thead>
<tr>
<th>Components</th>
<th>Failure modes</th>
<th>ISO test methods</th>
<th>Test factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Castors, Rear Wheels &amp;</td>
<td>Tire type, wheel and castor features, and bearings affect rolling resistance.</td>
<td>Not in ISO 7176</td>
<td>Rollability: Effort required to propel wheelchairs on paved and unpaved surfaces</td>
</tr>
<tr>
<td>Bearings</td>
<td>Broken castor and wheel parts.</td>
<td>Yes (ISO 7176 – 8), but does not reproduce complex load conditions that occur in LREs.</td>
<td>Durability: impacts and loads; fracture loads</td>
</tr>
<tr>
<td>Worn out tyres</td>
<td>Not in ISO 7176</td>
<td></td>
<td>Durability: abrasion</td>
</tr>
<tr>
<td>Parts degradation</td>
<td>Not in ISO 7176</td>
<td></td>
<td>Durability: accelerated aging</td>
</tr>
<tr>
<td>Corroded bearings and</td>
<td>Not in ISO 7176</td>
<td></td>
<td>Durability: corrosion</td>
</tr>
<tr>
<td>metallic parts</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fluttering castor may</td>
<td>Seen on ISO 7176-8 multi-drum test but not tested for.</td>
<td></td>
<td></td>
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<tr>
<td>waste effort and cause</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>accidents</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tire puncture</td>
<td>Not in ISO 7176</td>
<td></td>
<td>Air retention for wheels, puncture tests</td>
</tr>
<tr>
<td>Worn out bearings, dirt and</td>
<td>Not in ISO 7176</td>
<td></td>
<td>Test lubrication quality, seal design &amp; quality</td>
</tr>
<tr>
<td>dust in bearings</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trueness of wheels over</td>
<td>Not in ISO 7176</td>
<td></td>
<td>Wheel alignment</td>
</tr>
<tr>
<td>time is affected, camber</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>issues</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Seat Cushion &amp; Upholstery</td>
<td>Seat cushions flatten over time.</td>
<td>Not in ISO 7176</td>
<td>Durability: cushion compression</td>
</tr>
<tr>
<td></td>
<td>Exposure to fluids causes deterioration</td>
<td>Not in ISO 7176</td>
<td>Chemical resistance &amp; Waterproof testing</td>
</tr>
<tr>
<td></td>
<td>Tearing and wearing of cushion and cover, loosening upholstery</td>
<td>Not in ISO 7176</td>
<td>Durability: aging, tearing, abrasion, loosening</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Footrest</td>
<td>Broken footrests</td>
<td>ISO 7176 – 8</td>
<td>Durability: strength</td>
</tr>
<tr>
<td></td>
<td>Difficulty in folding, adjusting for height</td>
<td>Not in ISO 7176</td>
<td>Durability: corrosion</td>
</tr>
<tr>
<td>Brakes</td>
<td>Loosening and corrosion of locking mechanism</td>
<td>Not in ISO 7176</td>
<td>Durability: cyclic testing, aging, corrosion</td>
</tr>
<tr>
<td>Frame and cross braces</td>
<td>Bent push handles</td>
<td>Not in ISO 7176</td>
<td>Durability: loading</td>
</tr>
<tr>
<td></td>
<td>Wear on coatings, coating deterioration</td>
<td>Not in ISO 7176</td>
<td>Paint chipping and corrosion</td>
</tr>
<tr>
<td></td>
<td>Rusted holes, welds, and areas where paint is chipped off</td>
<td>Not in ISO 7176</td>
<td>Durability: corrosion &amp; testing folding mechanism</td>
</tr>
<tr>
<td>Fasteners &amp; Arm Pads</td>
<td>Bolts and pads loosen out</td>
<td>ISO 7176 – 8</td>
<td>Loosening</td>
</tr>
<tr>
<td></td>
<td>Pads deteriorate, exposing edges</td>
<td>Not in ISO 7176</td>
<td>Aging and abrasion testing</td>
</tr>
<tr>
<td></td>
<td>Rusted components</td>
<td>Not in ISO 7176</td>
<td>Durability: corrosion</td>
</tr>
</tbody>
</table>
ISWP Testing

• Develop a series of wheelchair tests
  • Castor Durability Testing
  • Rolling Resistance Testing
  • Corrosion Testing
  • Whole-chair Testing

• Resources for wheelchair design and selection
  • ISWP Product List
  • Design Guidelines
Castor Durability Testing

- Castor failure is frequent in the field
- Diversity in Castor failures
  - Tire failures
  - Bearing failures
  - Hub fractures
  - Fork fractures
  - Stem hub assembly issues
- ISO tests subject them to vertical loads
- Outdoor conditions are more stressful
Video of Castor testing
Castor bearing testing
Rolling Resistance Testing

• Resistance to wheelchair rolling - performance issue
  • Rear wheels
  • Castors
• Propelling wheelchairs on variety of surfaces is difficult.
• Resistance causing factors
  • Elastic rebound between the tyre and different surfaces
  • Tyre tread design
  • Type of tyre (pneumatic versus solid)
  • Camber level
  • Toe-in/toe-out
  • Type of spokes
  • Play characteristics of the axle hub bearings
Video
Corrosion Testing

- Corrosion of wheelchairs is a universal issue
  - Parts are unable to operate after being rusted
  - Footrests don’t fold, brakes don’t engage and become non-functional.

- ISO testing includes climatic testing for power wheelchairs only
  - Does not simulate moisture and acidic exposure.

- Corrosion adds to fatigue during field use for certain wheelchair parts like bearings.
  - Conducting fatigue and corrosion testing simultaneously.

- Recommended standard – ASTM B117
Corrosion Testing
Whole Chair Testing
Resources - ISWP Product List

• In less-resourced settings, there is lack of information on
  • Product Quality and Specifications
  • Performance in the context of use
  • Product usability – ease of use, comfort
  • Other factors like reparability, portability, aesthetics
Whirlwind Roughrider
by Whirlwind Wheelchair

Chair Description: The award-winning Roughrider is designed to handle rugged terrain with ease. It has been proven in over 25 countries by thousands of riders who live in the worst of conditions and need the best of chairs. Riders use it as a super-durable daily-use...more

Intended Users: Teenagers, Adults, Older Adults, Older Adults with Postural Support Needs.

Website: www.whirlwindwheelchair.org

To send an inquiry about this product: info@whirlwindchair.org

Leave a Comment

UCP Wheels Expression
by UCP Wheels for Humanity

Chair Description: A custom fit active wheelchair for image-conscious users in urban and semi-urban areas who are economically disadvantaged. Chair features light weight, super durability, transportability, extensive fit and positioning options, and a sleek urban look...more

Intended Users: Children, Teenagers, Adults, Older Adults.

Website: www.ucpwheels.org

To send an inquiry about this product: king@ucpwheels.org

Leave a Comment
The award-winning RoughRider is designed to handle rugged terrain with ease. It has been proven in over 25 countries by thousands of riders who live in the worst of conditions and need the best of chairs. Riders use it as a super-durable daily-use chair or as a backup when life calls for off-pavement adventures. See it in action here. The RoughRider is Whirlwind's answer to expensive fragile chairs that unnecessarily limit access. Priced at less than half of other outdoor wheelchairs, the RoughRider is by far the best-value rugged wheelchair. Now available in the USA.

Manufacturer: Whirlwind Wheelchair

Make an inquiry about this product: info@whirlwindwheelchair.org

Website: http://www.whirlwindwheelchair.org/

<table>
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<tr>
<th>Features</th>
<th>Key Specs</th>
<th>More Info</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Adjustable back height</td>
<td>Seat Width:</td>
<td>Intended Users: Teenagers, Adults, Older Adults, Older Adults with Postural Support Needs</td>
</tr>
<tr>
<td>- Tension adjustable back</td>
<td>12 inch / 30.5 cm</td>
<td>Assembly: Optional – Ships with wheels on or off</td>
</tr>
<tr>
<td>- Adjustable seat depth</td>
<td>14 inch / 35.6 cm</td>
<td>FDA clearance status:</td>
</tr>
<tr>
<td>- High-tension sling seat</td>
<td>16 inch / 40.6 cm</td>
<td></td>
</tr>
<tr>
<td>- Fixed 10-degree tilt</td>
<td>18 inch / 45.7 cm</td>
<td></td>
</tr>
<tr>
<td>- Padded back</td>
<td></td>
<td></td>
</tr>
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Other information about the Whirlwind Roughrider: The award-winning RoughRider is designed to handle rugged terrain with ease. It has been proven in over 25 countries by thousands of riders who live in the worst of conditions and need the best of chairs. Riders use it as a super-durable daily-use chair or as a backup when life calls for off-pavement adventures. See it in action here. The RoughRider is Whirlwind's answer to expensive fragile chairs that unnecessarily limit access. Priced at less than half of other outdoor wheelchairs, the RoughRider is by far the best-value rugged wheelchair. Now available in the USA.

Since 1979 Whirlwind has worked with wheelchair riders around the world to design durable and highly functional wheelchairs that perform well on rough terrain and are built in factories that contribute to local economic development.
More about the product list...

• Users and clinicians can review products
• Post products to their social media
• Manufacturers can
  • Know about product performance
  • Optimize product as per reviews and ratings
• Connect with individual users for feedback
• Improved decision making
• Empower users – active participation in provision
Resources – Design Considerations

- Lack of resources and environmental factors present challenges for designers, engineers and manufacturers.
- Design Guidelines developed by experts for basic and intermediate wheelchairs.
- Pediatric wheelchairs are included too.
- Design trade offs have been highlighted
  - Manufacturability
  - Serviceability
- Wheelchair interactions with environment and users in less-resourced settings.
Resources – Design Considerations

• Indicates types of testing available
  • Qualification Tests
  • Research and Development tests
  • User Evaluation Tests

• Recommendations for individuals, service providers, and/or governments to select and purchase wheelchairs

• Aid engineers and manufacturers to develop appropriate, durable and functional wheelchair designs
Implementation of Standards

• ISWP is validating test methods currently.
• ISO integration
  • Attending ISO meetings
  • Add as Technical Specifications
• Referenced by WHO Guidelines
• Part of the WHO GATE initiative
• Collaboration with manufacturers and charitable organizations for implementation.
Thanks!