Beneficial Designs
research/design/education
Designing beyond the norm to meet the needs of all people.

Peter Axelson
Beneficial Designs, Inc.
Minden, NV
Beneficial Design
Designing Beyond the Norm to Meet the Needs of All People

Research
Design
Education

Stanford University
19 February 2019
Peter Axelson
Beneficial Designs’ Mission Statement

Beneficial Designs works towards universal access through research, design, and education. We believe all individuals should have access to the physical, intellectual, and spiritual aspects of life.
Beneficial Designs’ Mission Statement

We seek to enhance the quality of life for people of all abilities, and work to achieve this aim by developing and marketing technology for daily living, vocational, and leisure activities.
Peter Axelson
Director of R&D
Chris Lynskey
Board of Directors
Bill Blythe
Facility Manager
Stephanie Schnorbus
Research Assistant and Office Manager
Ria Axelson
Office Assistant
Ria Axelson
Office Assistant
Hannah Wetmore
Office Assistant
Jo Anne Snarr
Bookkeeper
Paul Schnorbus
Machinist
Stephen Pieters
Wheelchair Test Lab Leader
Sam Schnorbus
Testing / Assessment Technician
Kyle Hollingshead
Programing Assistant
Ben Hubbard
Graphic Artist
Martin Clemons
Electrical Engineer & Firmware Programmer
Todd Ackerman
Sidewalk Assessment Coordinator
Nathan Tolbert
Sidewalk Assessment Coordinator
Kent Nelson
BOD, Travel Asst., Amusement Park Asst.
Design of Consumer Products

Product Development
Assessment of Products
Universal Design of Products
Product Development

Mainstream Products
Opportunity for Universal Design
Adaptive Products
Personal Technologies
Activity Specific Technologies
Establishing Balance

Physical
Intellectual
Spiritual
Sociological Dimension

Dependence
Independence
Interdependence
Personal Technologies
Activity-Specific Technologies
Environmental Technologies
Activity-Specific Technologies
Arroya Sit Ski
Mono Ski
Dynamic Seating Spring Assist
Cross Country Ski
Pax Back

Available from BES Rehab Ltd
Clutch, Brake, and Gas on Hand Control
Dynamic Seating
Dynamic Seating
Hand Bike
Hand Bike
Contoured Seating
Seat Cushion Testing
SKELI Used on Foam

2" HR45 Foam Cushion
2" HR45 Foam  
Jay 2 by Sunrise Medical  
ROHO High Profile by ROHO Inc.

Contoured by Supracor  
Model P by Vicair  
Model P Deep Immersion by Vicair
ASLI Prototype
ISO Part 2 Shape
Pressure Measurements Symmetric
Pressure Measurements
10 Pelvic Obliquity
Pressure Measurements

15 Posterior Pelvic Tilt
Pelvis Movement During Extensor Thrust Activity

Pelvis Moves Up, Out and Rotates

Force at Thigh and Backrest During Extension
Variations of Belt Angle

Downward Pull
Limits Upward Movement

Allows Posterior Pelvic Rotation

Limits Full Anterior ROM
HipGrip Concept
HipGrip Ph1 - Prototype 2
What Is the HipGrip?

- Dynamic Pelvic Support
- Provides Pelvic Stability
- Allows Controlled Anterior Tilt ROM
HipGrip Test Fixture
Functional Forward Reach
Functional Reach Downward
HipGrip

Available from Bodypoint
FlexRim – Combining the discrete compliant fasteners into one
The best profiles were fully developed and tested
FlexRim Ergonomic Pushrim
Frictional improvements

Preliminary tests show over a 2x increased frictional coefficient
Impact absorption
Applied a 120 lb repetitive load in one place until failure

Pushrim cracked after 444,072 cycles
Baseline study – FlexRim
Subjects are tested over a wide variety of usage environments.
respiration

motion capture

pushrim forces

heart rate

grip EMG
FlexRim

**Design**

The FlexRim consists of a dynamic high-friction rubber surface that spans between the aluminum pushrim and the wheel. The shape of the rubber is ergonomically designed to conform to your hand when gripped, making it the most comfortable pushrim you will ever use.

**Overuse Injuries**

Shoulder and wrist problems are very common among wheelchair users. Impact loading is one of the contributing factors. Your hands and arms absorb impact stress when you first hit the pushrim, illustrated in the graph below.

- Reducing impact is one strategy recommended to help protect you from developing overuse injuries.

**Impact Testing**

Impact loading of the FlexRim was studied for a wide range of impact intensities.

- The FlexRim was found to consistently reduce impact loading by 50%.

Because the rubber is flexible, the pushrim can compress to allow your wheelchair to squeeze through narrow doorways.

**Population Testing**

In lab testing, wheelchair users pushed with both a standard pushrim and the FlexRim on a research treadmill. Grip muscle activity, oxygen demand, and power generated were all measured during propulsion and compared across pushrims.

- Results of the testing were:
  - Users required 12% less grip force to push with the FlexRim.
  - Overall grip exertion was reduced by 15%.
  - On average users required 2% less oxygen to push with the FlexRim than with a standard pushrim.
  - Users generated 15% more power when using the FlexRim.

The ergonomic benefits of the FlexRim have been published in numerous scientific journals and in a PhD dissertation at Stanford University.

**FLEXRIM**

Advanced Ergonomics

Beneficial Designs

research/design/education

Designing beyond the norm to meet the needs of all people.
GripRim
Adaptive Canoe Seating
Methods - Endurance

MedGraphics VO2000 portable metabolic system
Lateral Balance Test
Water Egress Testing
Wave Ski
Environmental Technologies

Things that do not move
Small Watercraft Launch Access
# Water Trail Access Information

## Crane Cove Park Watercraft Launch Site

### Amenities & Allowed Uses

- **Boat Building**
- **Kayak**
- **Canoe Access**
- **Hand Launch**
- **Drinking Water**
- **Restrooms**

### Access Route

**To Launch Environment**

<table>
<thead>
<tr>
<th>Length</th>
<th>+ 350 ft</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elevation Loss</td>
<td>5 ft</td>
</tr>
</tbody>
</table>

**Grade**

- Typical: < 5%
- Maximum: < 8%

**Cross Slope**

- Typical: < 2 ft

**Tread Width**

- Typical: > 10 ft

**Surface**

- Type: Asphalt / Concrete
- Stability: Paved
- Amount: 100%

### Water Access Route

**Pathway to MLLW to Transfer Area**

<table>
<thead>
<tr>
<th>Length</th>
<th>+ 150 ft</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elevation Loss</td>
<td>7.5 ft</td>
</tr>
</tbody>
</table>

**Grade**

- Typical: < 5%
- Maximum: < 8%

**Cross Slope**

- Typical: < 2 ft

**Tread Width**

- Typical: 72 in

**Surface**

- Type: Sand w/ Structural Overlay
- Firmness: Firm
- Penetration: < 0.3 in
- Stability: Stable
- Penetration: < 0.5 in

### Transfer Area

**Launch Type**

- Beach

**Clear Space**

- Length: Unlimited
- Width: 200 ft
- Grade: < 5%

**Cross Slope**

- < 2%

**Surface**

- Sand w/ Structural Overlay

**Height Above Water**

- Extends to MLLW

**Boat Orientation**

- Unlimited

---

**WARNING:** Conditions may have changed since December 2016 when this facility was assessed. Temporary obstacles are not reported. Signage created by Beneficial Designs Inc. using data collected by a certified trail assessment coordinator.

The State Coastal Conservancy is leading the implementation of the San Francisco Bay Area Water Trail (Water Trail) in close collaboration with the Association of Bay Area Governments (ABAG), the San Francisco Bay Conservation and Development Commission, and the Department of Boating and Waterways. The Water Trail is a growing network of access sites (or "trailheads") that will help people using non-motorized, small boats or other beachable sail craft, such as kayaks, canoes, dragon boats, stand-up paddle and windsurf boards, to safely enjoy single and multiple-day trips around San Francisco Bay.

[http://scc.ca.gov/2016/07/30/san-francisco-bay-area-water-trail/]
Universal Trail Assessment Process (UTAP)
Key UTAP Information

Length
Grade

Width
Surface

Cross slope
Features & Facilities
UTAP Assessment Team
UTAP – Implementation Status

Over 1300 people trained to lead UTAP assessments
Over 155 trainers to teach UTAP workshops
High Efficiency Trail Assessment Process
### Pah Rah Interpretive Trail

#### Golden Eagle Regional Park

**Length**: 0.5 mi (0.8 km)

**Elevation Gain**: 36 ft (11 m)

**Elevation Loss**: 36 ft (11 m)

#### TRAIL USE

- Bikes
- Dogs on Leash
- Hikers
- No Equestrians
- No Motor Vehicles

#### GRADE

**Typical Grade**: 2.5%

86% of trail is 0% to 4%

395 ft (120 m) is 4% to 5%

**Standard Ramp Grade**: 8.3%

#### CROSS SLOPE

**Typical Cross Slope**: 1.9%

96% of trail is 0% to 4%

107 ft (32 m) is 4% to 5%

#### TREAD WIDTH

**Typical Width**: 8 ft (2.4 cm)

**Minimum Width**: 3.5 in (1.1 cm)

#### SURFACE

**Surface Type**: Asphalt

100% of trail is Paved

100% of trail is Stable

**Typical Firmness**: 0.16 in

Minimum Firmness: 0.16 in

Minimum Stability: 0.18 in

#### OBSTRUCTIONS

- Obstructions: None

#### VIEW MAP

Scan QR code to view Golden Eagle Regional Park Map

Google Maps

**WARNING**: Trail conditions may have changed since June 2009 when this trail was assessed. Temporary obstructions were not recorded.

Signage created by Beneficial Designs Inc. using data collected by a certified trail assessment coordinator. Funded by the Nevada Recreational Trails Program.
Trail Access Information (TAI)

TAI to convey to users in a Nutrition Facts Label format:

Grade
Cross Slope
Tread Width
Surface
Obstructions
# Tahoe Rim Trail

**Tahoe Meadows to Spooner Summit**

<table>
<thead>
<tr>
<th>Metric</th>
<th>English</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length</td>
<td>21.8 mi (35.0 km)</td>
</tr>
<tr>
<td>Elevation Gain</td>
<td>2894 ft (882 m)</td>
</tr>
<tr>
<td>Elevation Loss</td>
<td>5528 ft (1685 m)</td>
</tr>
</tbody>
</table>

## Trail Use

- **Hikers**
- **Bicyclists**
- **Runners**
- **Pleasure Use**
- **Equestrians**
Developed Outdoor Recreation Assessment Process
Outdoor Constructed Features

Bench
Camp Shelter
Cooking Surface/Grill
Fire Ring, Wood Stove/Fireplace
Outdoor Rinsing Shower
Parking Area
Picnic Table
Pit Toilet

Tent Pad/Platform
Toilet Building
Trash/Recycling Receptacle
Utility/Sewage Connection
Viewing Area at Overlooks
Viewing Scope
Water Spout
Picnic Table Clearance Space
COVER SHEET

Agency

Park Name

Campground / Trail Name / Picnic Area / Etc.

Are you using an external sensor box?  N  Y

Sensor ID (3 digits)

Segment ID (3 letters)

Funding
Phase I & II funding for the Developed Outdoor...
**Required Spaces**

**Is the table Circular?**

**Table Diameter**

- **Compliant**
- **Not compliant**

**Clear Space**

- Measures the height from the ground to the table top
- Measures the Wheelchair clear space length. The length may extend a maximum of 25 inches beneath the table.

**Manufacturer Info**

- **Manufacturer and Model**
  - If available, enter the model and manufacturer of the feature.
- **Manufacturer**
- **Model**

**Suggested Maintenance**

**Notes**

**Optional Photos**
Knee & Toe Clearance Profile Tool

Unobstructed Knee & Toe Space
Adjustable Height Cooking Grill
Water Pump with Closed Fist Operation
Water Pump Actuation Force
Water Pump Height Measurement
Please return elements so that this campsite remains accessible.

If you do not require access and mobility features, please do not use this site between 11AM and 6PM.
Site 18

Single Site

PRIORITY USAGE

If you DO NOT require access and mobility features, please DO NOT use this site between:

11 AM  6 PM

Accessible Elements

Tent Pad

Size: 11.6 ft x 16.0 ft
Accommodates: 4 Persons

Table

Pivot Grill

Fire Ring

Hydrant

RESET BEFORE YOU GO

Please return elements so this campsite remains accessible

WARNING: Campsite conditions may have changed since March 2011 when this campsite was assessed. Temporary obstructions were not recorded.

Phased I & II funding for the Developed Outdoor Recreation Assessment Process is provided by the U.S. Department of Agriculture through the Small Business Innovation Research Program Grant number 2013-33610-21051

CAMPsite ACCESS INFORMATION

Signage created by Beneficial Designs Inc. using data collected by a certified campsite assessment coordinator
Have you ever finished a three-hour hike in one hour? Have you struggled on a "moderate" trail? Have you ever encountered barriers on an "easy" trail? If so, you already know the benefits of having objective trail information. The Trail Explorer website conveys objective trail information in a unique Trail Access Information format to help trail users make informed decisions about which public lands to visit and which trails will best meet their interests, abilities, and desired experiences. Trail Explorer benefits all users, but is particularly helpful for individuals who may have specific trail needs, such as individuals with disabilities, older adults, parents with young children, and novices hikers.

Acknowledgment
Trail Explorer was designed by Beneficial Designs in collaboration with American Trails, land management, and disability organizations and with the support of the US Department of Education.
Trails with desired access features

<table>
<thead>
<tr>
<th>Trail</th>
<th>Park</th>
<th>Nearest Level(s)</th>
<th>Length</th>
<th>Uses</th>
<th>Typical Grade</th>
<th>Surface Smoothness</th>
<th>Trail Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trail 10</td>
<td>McCormick’s Creek State Park</td>
<td>IN</td>
<td>0.7 miles (1.1 km)</td>
<td>Hiking</td>
<td>3.3%</td>
<td>Firm</td>
<td>Trail 10 begins near the stairs on Trail 3. The trail follows McCormick’s Creek downstream to the Old Stationhouse. Trail 2, depending on the season and water levels, trail borders the creek, crosses the creek numerous times, and is completely in the creek.</td>
</tr>
<tr>
<td>Trail 8</td>
<td>McCormick’s Creek State Park</td>
<td>IN</td>
<td>0.7 miles (1.1 km)</td>
<td>Hiking</td>
<td>2.3%</td>
<td>Paved</td>
<td>Trail 8 connects the campground to the swimming pool and Nature Center. Bike rentals, shelter, and picnic areas can be reached from the trail.</td>
</tr>
<tr>
<td>Trail 4</td>
<td>McCormick’s Creek State Park</td>
<td>IN</td>
<td>0.2 miles (0.3 km)</td>
<td>Hiking</td>
<td>2.2%</td>
<td>Firm</td>
<td>Trail 4 is a connector trail from the Class A campground to Trail 7.</td>
</tr>
<tr>
<td>Trail 6</td>
<td>Spring Mill State Park</td>
<td>IN</td>
<td>0.4 miles (0.7 km)</td>
<td>Hiking</td>
<td>2.3%</td>
<td>Paved</td>
<td>Trail 6 is a paved loop trail near the Virginia “Gus” Bristow Memorial.</td>
</tr>
<tr>
<td>Trail 7</td>
<td>Spring Mill State Park</td>
<td>IN</td>
<td>0.9 miles (1.5 km)</td>
<td>Hiking</td>
<td>3.3%</td>
<td>Firm</td>
<td>Trail 7 loops around the Oak Ridge Picnic Area and connects with Trail 7.</td>
</tr>
<tr>
<td>Trail 12</td>
<td>Spring Mill State Park</td>
<td>IN</td>
<td>0.4 miles (0.6 km)</td>
<td>Hiking</td>
<td>3.9%</td>
<td>Firm</td>
<td>Trail 7 connects Trail 7 from the Oak Ridge Picnic Area to Trail 4.</td>
</tr>
<tr>
<td>Trail 10</td>
<td>Turkey Run State Park</td>
<td>IN</td>
<td>0.1 miles (0.2 km)</td>
<td>Hiking</td>
<td>0.9%</td>
<td>Firm</td>
<td>The spur connects to Canal’s Rock. It begins at the junction of Trail 10. The short trail ends at Canal’s Rock. There is an observation deck and bench.</td>
</tr>
<tr>
<td>Trail 11</td>
<td>Turkey Run State Park</td>
<td>IN</td>
<td>0.2 miles (0.3 km)</td>
<td>Hiking</td>
<td>3.1%</td>
<td>Firm</td>
<td>Trail 11 connects the Service Road and Turkey Run Inn. A short hike about Turkey Run Hollow to the Luther Memorial and Log Church.</td>
</tr>
<tr>
<td>Trail 7</td>
<td>Turkey Run State Park</td>
<td>IN</td>
<td>0.1 miles (0.2 km)</td>
<td>Hiking</td>
<td>3.3%</td>
<td>Firm</td>
<td>Connector trail between the Campground and Trail 7.</td>
</tr>
</tbody>
</table>
Develop standards for trail and sidewalk design

Architectural Barriers Act Outdoor Recreation Access Guidelines
Public Rights of Way Access Guidelines
ADA Recreation Trail

Grade

- up to 30% of length > 8.33%
- 5% for any distance
- 8.33% for 200 feet
- 10% for 30 feet
- 12.5% for 10 feet
- 14% for 5 feet in drains if cross slope < 5%
ADA Recreation Trail

Cross Slope
  5%
  10% in drains if width > 42 inches

Rest Areas
  60 inches length, trail width, 5% slope

Edge Protection
  3 inches minimum height when provided
ADA Outdoor Access Route

Surface
  firm and stable

Width
  36 inches
  exception 32 inches for up to 24 inches

Openings
  < 0.5 inch sphere
Rotational Penetrometer

Objective surface measurement device

Available from Beneficial Designs
Trail with firm but unstable sandy surface
Trail after Installation of surface stabilizer

Gravelpave2
# Rotational Penetrometer Readings - Gravelpave 2

<table>
<thead>
<tr>
<th>Firmness</th>
<th>Stability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before</td>
<td>Application</td>
</tr>
<tr>
<td>0.18</td>
<td>0.77</td>
</tr>
<tr>
<td>0.17</td>
<td>0.87</td>
</tr>
<tr>
<td>0.17</td>
<td>0.77</td>
</tr>
<tr>
<td>0.18</td>
<td>0.88</td>
</tr>
<tr>
<td>0.18</td>
<td>0.79</td>
</tr>
<tr>
<td>0.18 Avg</td>
<td>0.82</td>
</tr>
</tbody>
</table>
Street Name: OLIVIA WEST  Segment Name: *
*N COUNTY ROAD TO MACKLAND

Project #: 216-2  Date: 4/27/09  Distance: 233.9"
Sidewalk Assessment Process
Digital Measuring Wheel

Wireless

High accuracy
with resolution of 0.1 Inches (1 mm)
Digital Height Measuring Device

- High accuracy
- Fast measurement
- Resolution of 0.01 inches (0.1 mm)
Data Collection Software
NDOT
Right of Way in Minden, NV

Tread Width
NDOT
Right of Way in Minden, NV
Cross Slope
NDOT
Right of Way in Minden, NV

Tripping hazard height
<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Route</td>
<td>10th St to Jones St</td>
</tr>
<tr>
<td>Side of Street</td>
<td>East</td>
</tr>
<tr>
<td>Length</td>
<td>329 ft</td>
</tr>
<tr>
<td>Elevation Change</td>
<td>- 7.5 ft</td>
</tr>
<tr>
<td>No Skateboarding</td>
<td></td>
</tr>
<tr>
<td>Grade</td>
<td></td>
</tr>
<tr>
<td>Typical Grade</td>
<td>12.0%</td>
</tr>
<tr>
<td>4000 ft (1216 m)</td>
<td>5% to 8%</td>
</tr>
<tr>
<td>24 ft (7.3 m)</td>
<td>8% to 10%</td>
</tr>
<tr>
<td>Cross Slope</td>
<td></td>
</tr>
<tr>
<td>Typical Cross Slope</td>
<td>1.8%</td>
</tr>
<tr>
<td>300 ft (91.4 m)</td>
<td>2% to 4%</td>
</tr>
<tr>
<td>Width</td>
<td></td>
</tr>
<tr>
<td>Typical Width</td>
<td>8.3 ft</td>
</tr>
<tr>
<td>2 ft (0.6 m)</td>
<td>33 in (84 cm)</td>
</tr>
</tbody>
</table>

**Warning:** Sidewalk conditions may have changed since December 2017 when this sidewalk was assessed. Transactions observed were east and westbound.

Funded by Department of Transportation, City of San Jose.
Main St

Route: 10th St to James St
Side of Street: East
Length: 320 ft
Elevation Change: - 7.5 ft

No Skateboarding

GRADE

Typical Grade: 13.6%
420 ft (128 m) is 5% to 8%
24 ft (7.3 m) is 8% to 10%

CROSS SLOPE

Typical Cross Slope: 1.8%
300 ft (91.4 m) is 2% to 4%

WIDTH

Typical Width: 8.3 ft
2 ft (0.6 m) is 33 in (84 cm)

WARNING: Sidewalk conditions may have changed since December 2017 when this sidewalk was assessed. Temporary obstructions were not recorded.

Funded by
Department of Transportation
City of Carson City

SIGNAGE CREATED BY BENEFICIAL DESIGNS INC., USING DATA COLLECTED BY A CERTIFIED SIDEWALK ASSESSMENT COORDINATOR
Universal Design Standards for Products
Universal Design of Fitness Equipment (UDFE) Standards
Low Step-up Height Design
Universal Design of Products used by persons with Cognitive Impairments

Goal – To increase Access to Technology for People with Cognitive Impairments
Universal Design of Amusement Park Rides for Persons with Mobility and Sensory Impairments
Focus on Air Travel

One focus area is air travel
Assistive technologies
Standards
Issue 1: Steep Jetway Slopes

Typically steeper than standard ramp
Dangerous for Mobility Device users
Exempt from ADA guidelines
Dangerous Environment

Over 300 non-ambulatory passengers have been surveyed. 12% have tipped over laterally in boarding chairs because of this problem. Causation is Jetway bubble area cross-slope of 6 to 14 degrees. Boarding chairs have to be narrow and tip over at 7.5 degrees.
Potential Solution to Issue 1

Develop technologies to level surface of bubble area of jetways
Issue 2: Poor Boarding Devices

Non-ambulatory passengers are transported onto aircraft using narrow boarding devices.

Current boarding devices have many design issues that non-ambulatory passengers are dissatisfied with.
Boarding devices
Assessment of Traditional Aircraft Boarding Devices - Stability

Chest support straps
Assessment of Aircraft Boarding Devices Observation

Arm supports provide lateral stability
Foot support issues
Potential Solutions to Issue 2

Develop design specifications for improved boarding devices and on-board aisle chairs
Issue 3: Dangerous Transfer Methods

Passengers who are non-ambulatory must often be physically transferred by untrained contractors to boarding chairs and then into AC seating. This results in injuries to the contractors and the passengers.
Aircraft Compatible Wheelchair
Aircraft Boarding
Using a
Personal
Aisle Chair

Removable
Wheels
Aircraft Boarding
Using a wheelchair with narrow accessory wheels

Fewer Transfers
Aircraft Seating Using a Personal Aisle Chair

Feet Remain Secure
Transfer Assist Technology

Overhead Lift track
Safety for passengers
attendant providers
Transfer Assist Technology
Eagle Lift

Overhead Gantry Style Boarding Device
Transfer Assist Technology

Moves laterally over aircraft seating
Issue 4: Hazardous Sitting Pressures

Persons without sensation need pressure spread out to avoid sores.
Boarding devices
Sitting on an S boarding device without cushion

<table>
<thead>
<tr>
<th>Minimum (mmHg)</th>
<th>0.00</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum (mmHg)</td>
<td>200.00</td>
</tr>
<tr>
<td>Average (mmHg)</td>
<td>15.64</td>
</tr>
<tr>
<td>Variance (mmHg²)</td>
<td>1823.88</td>
</tr>
<tr>
<td>Standard deviation (mmHg)</td>
<td>42.71</td>
</tr>
<tr>
<td>Coefficient of variation (%)</td>
<td>272.99</td>
</tr>
<tr>
<td>Horizontal center (in)</td>
<td>10.47</td>
</tr>
<tr>
<td>Vertical center (in)</td>
<td>10.20</td>
</tr>
<tr>
<td>Sensing area (in²)</td>
<td>289.27</td>
</tr>
<tr>
<td>Regional distribution (%)</td>
<td>100.00</td>
</tr>
</tbody>
</table>
Aircraft seating with pressure relief cushion from wheelchair

legs hanging
shoulders forward
neck extended
arm not supported
Aircraft seating with pressure relief cushion and “accessories”

foot support
lumbar and spine support
neck / head support
arm support
Aircraft seating with pressure relief cushion and “accessories”

feet supported
lumbar and spine supported
neck / head support
arm arm supported
Potential Solution to Issue 4

Educate travelers without sensation to use pressure relief seating accessories when sitting in aircraft.

Educate health-care professionals who serve travelers without sensation.
Issue 5: Lack of Accessible Bathrooms

Wide body aircraft have two aisles and bathrooms that transform into one large accessible bathroom.

Medium and large size single aisle aircraft cannot do this without blocking the aisle.
Issue 5: Lack of Accessible Bathrooms

Passengers needing a personal caregiver are not accommodated by the current size of bathrooms. Including infants and older adults and non-ambulatory passengers that must use an on-board aisle wheelchair.
Issue 5: Lack of Accessible Bathrooms

Would only fly 2-3 hours without bathroom access
Issue 5: Lack of Accessible Bathrooms

Explained that removal of three seats to create an more accessible bathroom would cost a 2% increase in fare (based on 145 person cap)

9 of 14 knew persons that need assistance in a bathroom

14 out of 15 people indicated they would pay for one larger bathroom
Issue 5: Lack of Accessible Bathrooms

Explained that removal of six seats creates 1.2 inches of increased legroom which would create a 4% increase in fare.

11 out of 14 people indicated they would pay some amount for more legroom – 50% want 2.4 inches more.
Potential Solutions to Issue 6

Develop minimum clear width requirements for commercial aircraft....

To allow boarding device manufacturers to optimize the lateral stability of boarding devices
Issue 7: Mobility Device (MD) Damage

MDs are often damaged
MDs typically stored with baggage
Manual wheelchairs
Powered wheelchairs
Scooters
Examples of Damage

Courtesy Open Doors and Global Repair Group

Rehabilitation Institute of Chicago / Beneficial Designs / PVA #3028
Damage to drive wheel that came off powered wheelchair
Potential Solution to Issue 7

Create design standards for Air Transportable Powered Wheelchairs through the RESNA Assistive Technology for Air Travel Standards Committee
Assistive Technology for Air Travel Standards

Airline carriers and manufacturers
Wheelchair manufacturers
Disability organizations
Government agencies – DOT - FAA
Wheelchair repair companies
1. **Remove Seat Cushion (User)**
   - Remove seat cushion; store in aircraft overhead bin.

2. **Remove Head Support (User)**
   - Remove head support to store in aircraft overhead bin.

3. **Lower Back Support to Fit Into Aircraft (User)**
   - Remove the back support cushion. It is fixed in place by means of velcro on the rear of the cushion.
   - Remove the upper section of the back support by carefully pulling it straight up.
   - Using the control panel, tilt the back support forward.
   - Store back support in aircraft overhead bin.

4. **Remove Joystick (User)**
   - Remove joystick controller; store in aircraft overhead bin.

5. **Disengage Drive System**
   - If the joystick controller is not removed, first shut off power using the control panel.
   - Rotate the lever on each motor to disengage the motors and release the brakes, enabling the chair to be manually pushed.

6. **Isolate Battery Power**
   - Switch breaker to off to fully disconnect power.

7. **Raise Foot Supports**
   - Move foot supports to upright position.

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**Travel Configuration**

**Driving Configuration**

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**Unoccupied Product Weight (including accessories)**

450 lb / 205 kg

**Battery Information**

**WARNING:** Only sealed lead acid group 34 batteries may be installed on this product.

This wheelchair was manufactured with 2 lead acid sealed gel cell non-spillable batteries conforming to DOT CFR 173.159 (d), IATA Packing Instructions 806, and IATA Provision A67.
Disengage Drive System
A manual brake release is located on each drive wheel that can be released to make it possible to move the chair manually. The brake release levers are located at the front of the wheelchair. Move levers outwards to disengage motors which releases the brakes.

Manual Lift Points
WARNING! This product should be lifted using a mechanical lift to avoid injury. Unoccupied product weight is 450 lbs / 205 kg.
The Permobil M300 Corpus HD unoccupied weight is 450 lbs. Manual lifting requires multiple lifters. Use designated lift points!
Manual lift points are located on all four caster arms. When lifting chair with a device, use securement points.

Chair Securement
When fastening the chair, re-engage the drive system to lock the chair. Use fastening straps attached to the designated transport eye locations at the front and rear of the chair. Attach fastening strap to RESNA WC19 securement location.

Isolate Battery Power
The circuit breaker is located in the rear beneath the tail lights. It also acts as a battery isolator and is controlled via the lever located inside the hole at the bottom of the rear battery cover. Switch breaker to off to disconnect power from the battery.

The make and model of wheelchair selected to draft this prototype of an Air Travel Configuration card was selected based on the product having a built-in electrical isolation switch to isolate the batteries. The data was obtained from a user manual that was available online. Some values are estimated and do not necessarily represent the actual data for this product. The manufacturer of this product has not reviewed or approved this information.
Drive Disconnect
Front of chair
Move the levers *outwards to release* the brakes. The chair can now be moved manually.
PMD Labeling Guidelines

Weight

WHEELCHAIR

82 kg

180 lb

WEIGHT
PMD Labeling Guidelines

Location of power disconnect

Off ↔ On

O I
Air Travel Symbols

- International Symbol
- Wheelchair
- Prohibited Items
- Walking
- Baggage Hook
- Baggage Cart
- Service Animal
- Security Items
- Weight Limit
Development of PMD Handler Training Procedures

Experience of handling different types of PMDs may be infrequent for baggage handlers.

Prevention of injury to handlers.

Prevent damage to PMDs.
Standards for PMDs designed for air transport

Create specifications for design features that will enable powered mobility devices to be able to withstand the rigors of being loaded and unloaded from aircraft.
PMD with transit option
Identification of Power Disconnects
Air Transportable PMD design specifications

Folding or removable back support to reduce height

Height of typical baggage access door can be as short as 30 inches on DC-9 models
Protect input control device
Fully protect input control device
Elastic strap to hold WC folded
Typical location of webbing with elastic and side release buckle
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