LEARNING OBJECTIVES

- Identify the different techniques for turning a corner with front-wheel drive, mid-wheel drive, and rear-wheel drive power wheelchairs.
- Discuss the pros and cons of having 6 wheels on a wheelchair (mid-wheel drive) compared to 4 (front/rear-wheel drive).
- Demonstrate how to turn toward the obstacle in front-wheel drive to maneuver in certain situations.

SELECTING THE MOST APPROPRIATE WHEELCHAIR BASE

1. Understanding Consumer's Needs
   - Goals and Lifestyle
   - Environment and Transportation
   - Medical Issues
2. Objectively Compare and Contrast Features of Power Wheelchair Bases
   - Real life information
   - Realistic expectation

OTHER POWER WHEELCHAIR CONSIDERATIONS

- Seat to Floor Height
- Ability to Accept Seat Functions
- Drive Performance
- Growth/Weight Capacity
- Transportability
- Ventilator Compatibility
- Aesthetics

WHERE WILL THE CHAIR BE USED?

- Mostly Outdoors
- Mostly Indoors
- Both Indoors and Outdoors
- Home Layout
- School/Work Needs
- Vehicle Requirements

*Identify the most critical areas for wheelchair selection!
**CHOOSING THE RIGHT BASE**

**REAR-WHEEL DRIVE (RWD) – GENERAL PERCEPTIONS**

- Good tracking for higher speeds
- Most sensitive to changes in weight distribution
  - Limited power seating angles
- Typically has good suspension
- Obstacle climbing – needs to be straight on
- Front swiveling casters
  - LE positioning/stand pivot transfers
  - Largest Turning Radius

**CHOOSING THE RIGHT BASE**

**MID-WHEEL DRIVE (MWD) – GENERAL PERCEPTIONS**

- Good stability for power seating
- Intuitive Driving
  - Drive wheel directly below user
- 6 wheels on the ground can limit smoothness of ride
- Obstacle climbing – needs to be straight on
  - Potential to "high center" in certain situations
- Front swiveling casters
  - LE positioning/stand pivot transfers
- Smallest overall turning radius
  - Smallest overall turning radius

**Turning Radius**

**RWD**

**Turning Radius**

**MWD**
CHOOSING THE RIGHT BASE

FRONT-WHEEL DRIVE (FWD) – GENERAL PERCEPTIONS

- Good stability for power seating
- Intuitive driving
- Some people may need to learn technique
- Superior obstacle climbing from any direction
- Handles well across all terrains
- Perception of poor tracking at high speeds
- Not an issue with today’s tracking technology
- Accommodates tight hamstrings
- While maintaining low seat to floor height
- Smallest front turning aspect
  - "Hugging" the corner

Drive Wheels

Turning Radius FWD

FWD – END OF HALLWAY

Casters

IMAGINE A SMALL BATHROOM, ACCESS REQUIRED TO SINK RIGHT NEXT TO WALL. THE ONLY CONFIGURATION ABLE TO GET THE USER CORRECTLY TO THE SINK IS FRONT WHEEL DRIVE. OTHER CONFIGURATIONS MIGHT WORK BETTER IN ALTERNATIVE SITUATIONS.

Turning Radius FWD

IMPORTANCE OF FRONT TURNING ASPECT

Front Wheel Drive
Mid Wheel Drive
Rear Wheel Drive


DESIGN FEATURES THAT IMPACT MANEUVERABILITY

“Mid-wheel-drive PWCs required the least space for the 360°- turn in place compared with front-wheel-drive and rear-wheel-drive PWCs (P<.01) but performed equally as well as front-wheel-drive models on all other turning tasks.”

“Even though the front-wheel-drive models were longer and likely had larger swing angles in the rear compared with mid-wheel drive and rear-wheel-drive configurations, users maneuvered these chairs in the least amount of space around the L-turn.”


DESIGN FEATURES THAT IMPACT MANEUVERABILITY

“Our PWC findings combined suggest that front-wheel-drive and mid-wheel-drive wheelchairs are better than rear-wheel-drive wheelchairs for maneuvering in confined spaces. Maneuverability of front-wheel-drive PWCs may be more intuitive and easier to learn for users who are new to powered mobility or have impaired proprioception because turns can be initiated closer to the bend.”

“The handling of front-wheel-drive PWCs may be more intuitive for some users because the center of rotation is toward the front of wheelchair, enabling the user to initiate a turn at the bend versus having to judge when to begin initiating a turn in order to accommodate a wider front-end swing angle.”

CHOOSING THE RIGHT BASE

INFORMATION ABOUT THE STUDY
Note: From the Human Engineering Research Laboratories, Veterans Affairs Pittsburgh Health Care System (Koontz, Brindle, Kankipati, Cooper), Departments of Bioengineering (Koontz, Brindle, Cooper), Rehabilitation Science and Technology (Koontz, Kankipati, Cooper), University of Pittsburgh, Pittsburgh, PA; Department of Design and Environmental Analysis, Cornell University, Ithaca, NY (Feathers).

Supported by the United States Access Board (project no. 070213), Department of Veterans Affairs Rehabilitation Research & Development Service (project nos. BX 142C, and the National Science Foundation (grant no. EEC 0552351).

No commercial party having a direct financial interest in the results of the research supporting this article has or will confer a benefit on the authors or on any organization with which the authors are associated.

Reprint requests to Alicia M. Koontz, PhD, Human Engineering Research Laboratories (15 1R1-H), VA Pittsburgh Health Care System, 7180 Highland Dr. (151R1-H), Pittsburgh, PA 15206, e-mail: akoontz@pitt.edu.

CHOOSING THE RIGHT BASE

MANEUVERABILITY CONSIDERATIONS

• RWD
  • Drives most like a car (wider turns; front end moves)

• MWD
  • Turns on itself (tight turning; quick turns)

• FWD
  • Drives like a forklift (back end moves)

CHOOSING THE RIGHT BASE

FWD: SPECIFIC SKILLS TRAINING

• Turn toward the obstacle/problem
• Pull all the way in before starting the turn
• Hug the corner
• Obstacle climbing . . . Commit!
• Navigating declines . . . Slower without abrupt stopping

CHOOSING THE RIGHT BASE

MWD: SPECIFIC SKILLS TRAINING

• Keep feet in as close as possible – avoid front caster interference
• Line up drive wheel with corner for turning around obstacles
• Obstacle climbing . . . Line up front casters – straight on
• Navigating uneven terrain:
  • Soft curbs – go up from the side instead of straight on to avoid high centering
  • High centering is a risk with any MWD chair

CHOOSING THE RIGHT BASE

RWD: SPECIFIC SKILLS TRAINING

• Keep feet in as close as possible – avoid front caster interference
• Wider turns are necessary around corners
• Obstacle climbing . . . Line up front casters – straight on
• Be careful with weight distribution/stability when navigating inclines and rough terrain

CHOOSING THE RIGHT BASE

SIZE MATTERS - WHEELS AND CASTERS

• Larger Wheel
  • Better obstacle climbing
  • Better negotiation of soft/uneven terrain
• Generally, on power wheelchairs, LARGE diameter wheel is considered to be:
  • 14” drive wheel
  • 8” caster (exception MWD – 6”)

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CHOOSING THE RIGHT BASE

TRACTION – TREAD, FOOTPRINT, SHAPE, WIDTH

Traction – adhesive friction between wheel and surface
- Larger surface area – greater traction
- Tread pattern can increase traction
- Useful in soft terrains
- Narrow, Rounded Shape
  - Less resistance on hard surface
  - More resistance on soft surface

FIRMNESS AND RESILIENCE

Important for efficiency and shock absorption
- Pneumatic
  - High resilience: conforms to surface irregularities
  - Absorbs jolts and vibrations due to impact
- Solid Inserts
  - Vary in resilience
  - Transmits, rather than absorbs, forces
  - Tread life expectancy decreases

SMOOTH RIDE

The fewer the wheels . . .
The smoother the ride!

FWD/RWD fare better than MWD in this area.

DEFINING OBSTACLES

- Single Obstacle
  - One time, short duration resistance
- Soft Terrains
  - Constant, variable resistance
- Continuous Rough Terrain
  - More similar to soft terrain

HARD VERTICAL OBSTACLE

- BASIC RULE:
The highest point of the obstacle must be below mid-point of axle.

CLIMBING FORWARD

- ANSI/RESNA testing (allows 50 cm running start)
- ISO testing does not allow any running start.
**Continuous Soft Obstacle**

Continuous obstacles appear like a ramp to the wheel.

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**Choosing the Right Base**

**RWD/MWD**
- Drive wheel is pushing casters.
- Direction of force is forward and downward
- Plowing effect
- Drive wheel loses traction

**FWD**
- Drive wheel is pulling casters.
- Direction of force is forward and upward
- Reduced tendency to lose traction

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**Weight Matters**

Weight Distribution for Optimal Performance:
- Less weight on casters
- More weight on drive wheels

Too much weight on casters:
- Difficulty turning – resists rotation
- Ramp up power resulting in “jerky” turn

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**Intuitive Feel (Likeability)**

- Pivot point close to driver’s head
  - More natural/intuitive feel
  - Typically shortens the learning curve

- Pediatrics vs. Adults
  - Shorter seat depths may be better in FWD – sitting over drive wheel
  - Helps provide appropriate weight over drive wheel for adequate traction – improved performance

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**Choosing the Right Base**

**Seating Options**

- Not every base offers all the power seat functions a consumer might need.
- What angles are available for power seating?
- How does adding power seat functions alter the seat to floor height?
- Think about Now and the Future!
CHOOSING THE RIGHT BASE

TRACKING TECHNOLOGY

Gyroscope
- Monitors actual chair direction

Tachometers
- Monitors wheel speed (RPM)
- Requires traction on the wheel to work accurately

Uses J of Tracking Technology:
- Switched/Digital Driver Input
- Front Wheel Drive - reduces fishtailing at high speeds
- Ventilator – added weight can alter tracking

Questions?
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References
