The intent of this lecture is to provide the reviewer a basic understanding of the components of a powered wheelchair. References are provided that will facilitate viewing commercial examples of commercial products, as well as locating information on the industry performance standards to which most of the products are now being tested.
Learning Objectives

• To become familiar with power wheelchair components and their functions
• To become familiar with reference resources related to powered wheelchairs
• To acquire information useful for alerting users and caregivers about key safety issues.

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Performance Objectives

- Evaluate powered wheelchairs from a more informed perspective.
- Observe or share safety concerns.
- Communicate information on voluntary industry standards.
- Obtain additional information as may be necessary.
• Input Devices: joy sticks, head switches, etc
• Controllers: Controller (integrates data from all elements of system); Power controller (directs energy to motors)
• Motors: motors and drive train
• Battery: energy source, usually lead acid
Input Devices

- **Function**
  - Device used by user to specify velocity or directional command.

- **Types**
  - Proportional (joystick).
  - Non-proportional (switch inputs, sip and puff).
  - Scan-control (reduces number of switches).
Controller

- **Functions**
  - Translates command signal from input.
  - Device to velocity/direction command for power controller.
  - Monitors performance. (1)
  - Provides feedback to user. (2)
  - Microprocessor-based allows:
    - Custom adjustments to control parameters (3)

(1) Many internal electronic parameters.
(2) Status of battery charge and mode of controller operation (on/off) commonly displayed to user.
(3) Maximum speed, starting/stopping acceleration, joy-stick sensitivity, turning speeds are common adjustments.
Power Controller

• Function
  – Controls power distribution to the motors.\(^{(1)}\)

• Most Common Type
  – Pulse width modulated DC to DC converter (PWM).

\(^{(1)}\) Control of the electrical energy to the motors controls the wheelchair speed, and in the case of dual motor drives, controls the direction (steering).

Scooters often have only one motor and therefore steering must be done with a manual tiller.
Drive Train and Motors

- Motors
  - Function
    - Converts electrical energy to rotational motion (drive torque) (1)
    - Provide steering control
  - Common types
    - Permanent magnet (PM) direct current (DC)-with brushes (2)
    - PM brushless DC

(1) The conversion efficiency of most PM motors is in the range 60-80%
(2) Brushes are a replaceable component within motors that transfer electrical energy to the armature.
Drive Trains

• Function
  – transmit motor torque to drive wheels
  – provide the desired speed Vs. torque reductions (1)

• Types
  – Gear to belt drive reduction (older)
  – Direct drive gear reduction (2)

(1) In order to increase efficiency motors must run at a high speed. Drive trains convert high motor speed to lower speeds but with increased torque. This conversion is done with an efficiency in the range of 50-70%.

(2) Direct drive gear reductions are much compact and safer then the older belt-drive devices.
Battery

• Function
  – Source of electrical energy (direct current)

• Important characteristics
  – Capacity: WH (Watt-hours) or AH (Ampere-hours) (1)
  – Cycle life: (charge/discharge cycles)
  – Energy density: (watt-hour/kg) (2)

(1) A measure of how much energy can be stored in the battery (capacity).
(2) A measure of how heavy the battery will be for a given battery capacity.
Battery

- Types used
  - Deep discharge wet cell lead acid
  - Deep discharge gel-cell lead acid (1)

- Charging
  - need “smart” charging to avoid damage or injury (2)

(1) The electrolyte in gel cells is a gel versus a liquid as in wet cell batteries. This means that there is much less chance of injury or acid damage should the battery case be damaged or flipped over. Wheelchair batteries must be designed to take many full (deep) discharges, in contrast to auto batteries which only see a shallow discharge.

(2) Overcharging batteries using “dumb” chargers will not only shorten battery life but also can cause serious over heating.
Product Performance

• Voluntary Industry Standards
  – What is available in US (1)
    • 22 tests and performance standards.
    • 8 tests specific to powered wheelchairs.

  – What is required?
    • All standards are voluntary.(2)
    • Some tests are pass/fail
    • Most have test information disclosure requirements
Product Performance Standards

• What test information exists specific to powered wheelchairs?\(^{(1)}\)
  • Dynamic stability
  • Effectiveness of brakes
  • Energy consumption
  • Climate effects (rain/heat) on electronic systems
  • Obstacle climbing ability
  • Safety of power and control systems
  • Electromagnetic interference safety
Additional Information

• ANSI/RESNA W/C Standards (1)
  – Vol. 1-Requirements and test methods for all wheelchairs
  – Vol. 2-Additional requirements and test methods for electrical wheelchairs
  – Cost: $250.00 US per volume
  – www.RESNA.org

• Standards Development (2)
  – http://www.rerc.upmc.edu/STDsDev/stdsindex.html

(1) Complete copies of the 22 parts that comprise the W/c standards, packaged in two volumes, can be obtained from RESNA.
(2) This www site tracks standards developments related to wheelchair transportation and wheelchair seating products.
Product Performance Standards

How to purchase:
RESNA (The Rehabilitation Engineering and Assistive Technology Society of North America)
1700 N. Moore St, # 1540
Arlington, VA 22201
  • Tel: 703-524-6686
  • Fax: 703-524-6630
http://www.RESNA.org

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More Information....

- Commercial examples: on WheelchairNet within the directory for Products and Services:
  - http://www.wheelchairnet.org/

Self-testing Questions

- How is a W/C with two motors steered?
- What controller parameters may be adjusted for a new user?
- Why are the use of “gel-cell” batteries an important safety issue?
- Why is it important to use the correct battery charger?