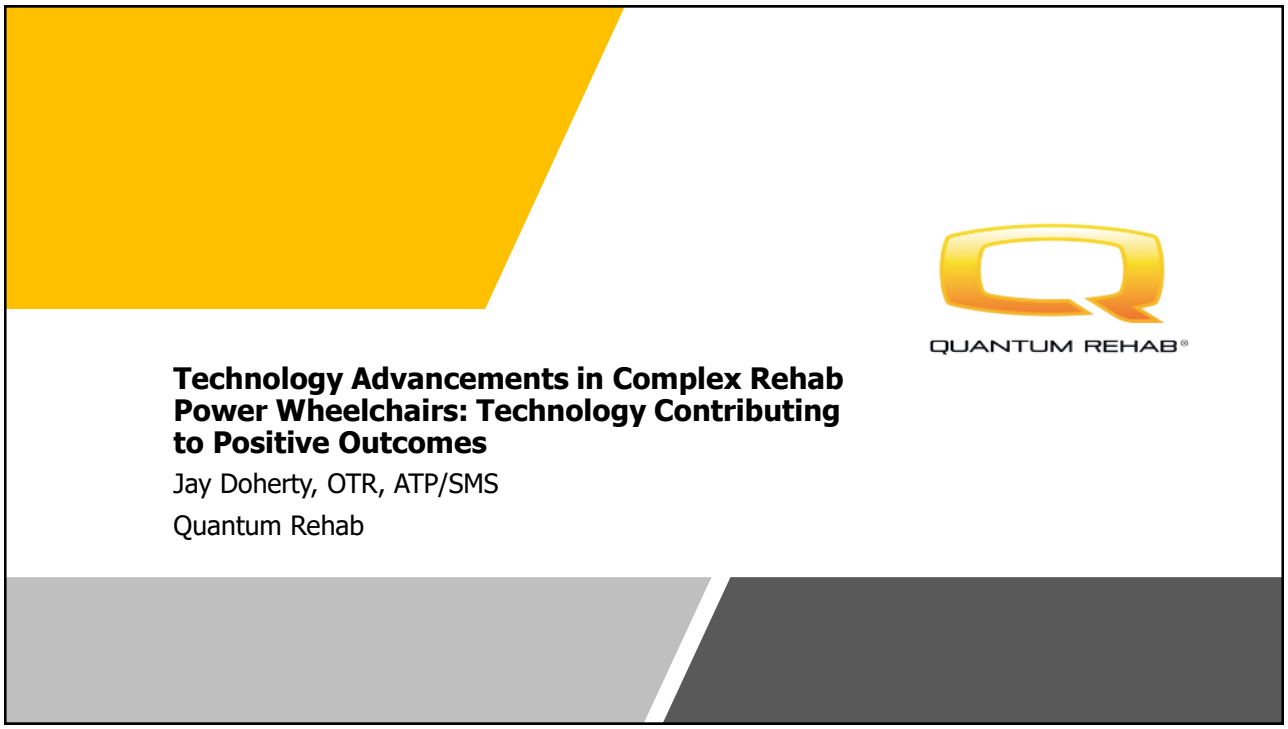


Technology Advancements in Complex Rehab Power Wheelchairs: Technology Contributing to Positive Outcomes

Jay Doherty, OTR, ATP/SMS

Quantum Rehab

1

Disclosures

- Jay Doherty is the Director of Clinical Education for Quantum Rehab
- Although the pictures and equipment utilized are heavily Quantum Rehab products, the main four power wheelchair manufacturers all have Bluetooth capabilities and similar ways of accessing the technology discussed in the presentation.

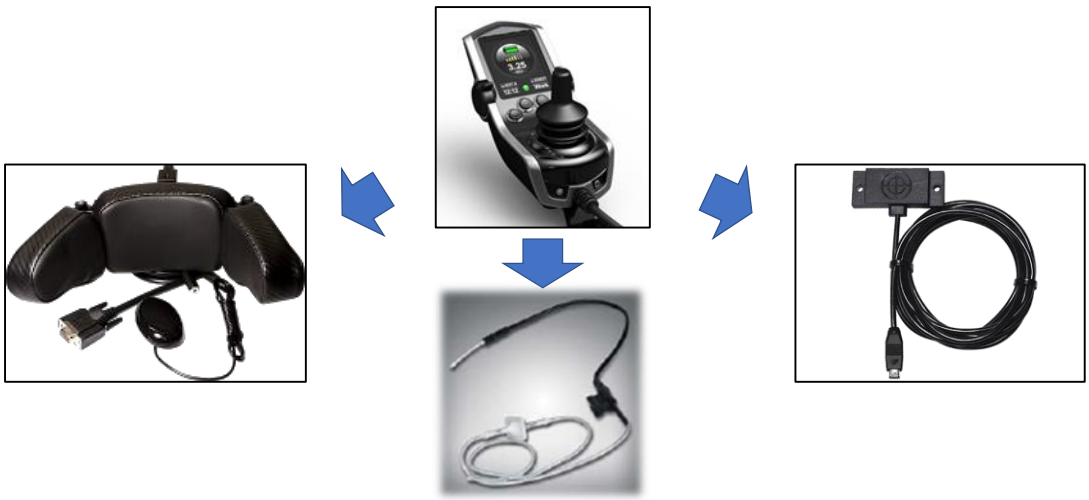
2

Learning Objectives

- Participant will be able to differentiate three different access methods for power wheelchair control and the benefits each offers consumers.
- Participant will be able to compare 2 ways power wheelchair electronics can promote a higher level of independence in the consumer using the wheelchair.
- Participant will be able to list 2 considerations for controlling power positioning through their specialty controls.

3

Traditional Methods of controlling a power wheelchair



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Hierarchy of Input Devices

Proportional Controls

- Standard Joystick
- Standard Joystick with Modifications
  - Handles, mounting/placement, programming
- Alternative Joysticks
  - Mini, chin, forearm, foot, head
- Alternative proportional Controls
  - Touch Pads

Digital/Switch Controls

- 3 to 5 Switch Controls
  - Head array, tray mounted, hardware mounted
- Pneumatic Controls (Sip and Puff)
- 2 Switch Controls
- 1 Switch Control

5

Decision Making Process and Considerations

- What consistent movements does the individual have on their body.
- How is the endurance of the consistent movements.
- Will they require changes to the system in the future?
- Programming Capabilities
- Physical Specifications of the Device
- What other technology can they benefit from?
  - Communication devices
  - Computer access
  - Environmental access

6

Specialty control Options and Outcomes

7

Proportional Controls

Alternative Joysticks

- Can be us in a variety of locations and configurations including:
  - Micro
  - Mini
  - Chin
  - Forearm
  - Foot
  - Head

- Should be chosen based on:
  - Force of deflection required
  - Amount of Joystick Throw

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Minimum Movement Proportional Controls

Mo-Vis Micro

- 8.5 grams - least amount of force required for any of the joysticks Stealth carries.
- 3.3 mm throw – shortest throw for any of the joysticks Stealth carries.
- Developed for easy use for those with poor or weak muscular power or restricted movement, use with finger, lip, tongue…
- Micro Ball Top (IDM-04) and Cup Top (IDM-05) can be ordered separately.

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Minimum Movement Proportional Controls

Mo-Vis Multi

- 49.89g of force
- 7.1mm throw
- Designed for users with limited muscular power such as ALS or MS, ideal for use as a chin-, lip- or finger joystick.
- 2 - 3.5mm jack inputs are built into the joystick for adding switch options.

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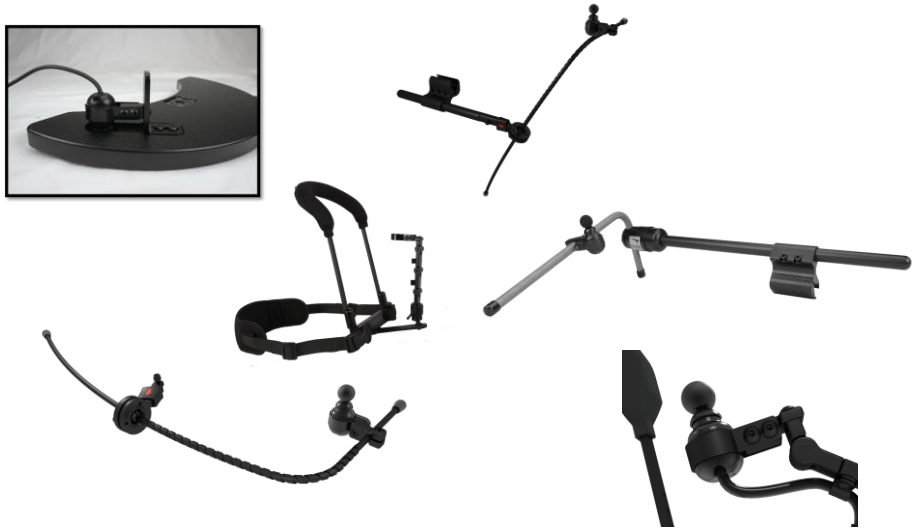
Minimum Movement Proportional Control Mounting Options



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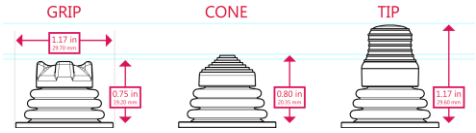
Minimum Movement Proportional Controls

Precision Mini Proportional Joystick (PMPJ)

- 43 grams force
  - Castle – 9.5mm throw
  - Cone – 10.3mm throw
  - Finger Tip – 14.4mm throw
- The reaction can be fine-tuned so the slightest change offers precision control.
- Can be used for finger or chin control



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Alternate Proportional Control Example

Alternate Proportional Control Example

Alternative Proportional Controls

All Around Lite

- 120g-Standard joystick.
- 7mm Throw.
- All-round use: can be used as a chin joystick, standard joystick.
- Shorter overall height than All Around.
- 2 3.5mm jack inputs are built into the joystick for adding switch options.

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Alternative Proportional Controls

All Around

- 249g-Standard joystick.
- 19.5 mm Throw.
- All-round use: can be used as a chin joystick, standard joystick.
- 2 3.5mm jack inputs are built into the joystick for adding switch options.

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Mounting Options

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Alternative Proportional Controls

Mushroom

- 227g force
- Unique mechanical and tactile configuration
- Appears to amplify minimal force and ROM
- Can be used for hand or foot control

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Alternative Proportional Controls

Switch-It Arm Drive

- Compact Joystick Mounted below the armrest trough
- Allows driving with more gross motor movements
- Requires Elbow flexion and extension as well as shoulder internal and external rotation

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Alternative Proportional Controls

ASL Foot Control Mounting Adapter

- Allows individuals with strong foot movements to drive a power wheelchair with proportional control
- Allows wheelchair control through plantarflexion/dorsiflexion along with right/left foot movements
- Mounts on footrest hangers in place of the footplate.

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Alternative Proportional Controls

ASL RIM Control

- Proportional Joystick attached to headrest
- Set up like 3-Direction Proportional Joystick with either reset switch or toggle for forward <->reverse changes
- Can be hard on the neck muscles.
- Typically found used with individuals who have always used this input device.

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Alternative Proportional Controls

Switch-it Touch Drive 2

- Cell Phone Touchscreen technology
- No force required
- Maintain contact with screen for driving
- Built in Mode Port
- Configured for Absolute or Relative start position
- Available for Q-Logic, P&G, and R-Net (not on Invacare)

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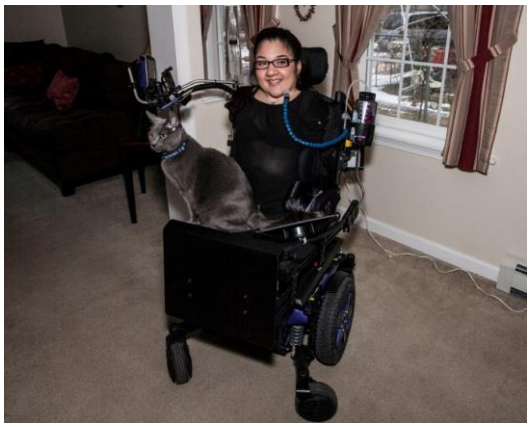
Case Study Zoe

- Diagnosis: Tetra-Amelia Syndrome (Congenital Lack of All Extremities)
- Age: 17 years old
- Secondary medical conditions: Chronic Lung disease, Ciliary Dyskinesia, Difficulty regulating temperature.
- Goals: To allow Zoe to be independent in as much of her daily life as possible including management of her medical conditions.



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Case Study Zoe

- Technology Zoe requires for independence:
  - Chin control for control over the power wheelchair.
  - Power boom (chin control, mouth stick and Smart phone are mounted on boom).
  - Switch on headrest to control power booms movements.
  - Mouth stick for access to her phone.
  - Bluetooth for access to her tablet through her chin controls for her school work.
  - Infrared for access to television at home.

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Case StudyZoe

- Zoe controls her main power boom through a switch mounted on her head rest.
  - This boom has her enhanced display, smart phone and proportional chin control mounted on it.
- Her wheelchair also has an ECU module which she uses to control:
  - Her power boom with her tablet which she uses for school work.
  - Her fan which she uses to regulate her body temperature.

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Case Study Zoe

- Zoe driving her power wheelchair with her proportional chin control.

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Proportional vs Digital/Switch

Digital/Switch

- All or nothing response- switch is “on or off”
- Each direction is controlled by a different switch
- Speed changes require mode changes and programming
- Requires less motor control, skill, and in some cases strength to operate

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Non-Proportional Alternative Controls

- 3 to 5 Switch Controls
  - Head Array
  - Tray Mounted
  - Hardware mounted

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3 to 5 Switch Control

- **5 switches** provide the client with forward, left, right, reverse and mode.
- **4 switches** provide forward, Left, Right, Reverse, and the left switch provides mode changes with a double command.
- **3 switches** provides forward, Left, Right, Reverse with a quick tap/toggle of the forward switch to change the directional arrow on the display to reverse, and a double command on the left or switch provide a mode change.

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Non-Proportional Alternative Controls

Overview of the iDrive 4

- iDrive 4 has (6) smart input connections
  - Will recognize if a mechanical switch or proximity switch is plugged into the system
- Sensors and mechanicals can go anywhere
- Clinically can progress/change with the person to meet their needs.
- Is programmable with a smart phone app.

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Considerations for Digital/Switch Controls

Sip and Puff Programming

- Latched/Momentary
- Latch Options (Cruise, 3 –Step, 1-Step)
- Braking Options (Decel Stop/Quick Stop)
- Double Command

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Combo Sip and Puff Head Array

- These are ideal for people who have left and right head movements but find lifting their head off of the rear pad difficult.
- These systems use the head array for left and right and sip and puff for forward and reverse.
- These are also great for the person that is unable to differentiate between a soft and hard Sip or puff.
- You may consider this for users with a high Spinal Cord Injury, Multiple Sclerosis, Brain Injury, or many other diagnoses.

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Lindsey – Sip and Puff Head Array combination

- C3-7 incomplete quadriplegia.
- Used sip and puff initially after rehab but didn't like it.
- Ruled out chin control.
- Ruled out head array.
- Best luck was with head array and sip and puff combination.

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Lindsey - Sip n Puff Head Array Combo Case Study

- She did not like the latch function with sip and puff. She liked the function but not the extra command to stop the wheelchair. Concern was if the straw comes out of her mouth how will she stop the chair.
- Solution: cut off the end of the sip and puff straw so it is smooth and flush, she can then seal the end of the straw once the pressure is provided which tricks the system into thinking it is latched.
  - Offers piece of mind that the wheelchair will stop if she loses contact with the straw.

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Lindsey – Sip and Puff Head Array combination

- Use of Power Positioning
  - Changes mode by performing a double left command on her head array pad to get into her seat functions.
  - Uses a puff/forward command to control her foot position.
  - Uses Advanced Seating: The left and right head array pads control tilt and recline. She prefers this since she is always afraid especially with recline that she will lose contact with her straw.

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Non-Proportional Alternative Controls

2 Switch Controls

Standard

- Set up in the Q-logic programming as 2 switch control

Linked Driving

- Using iDrive 4 this is set up as 3-Direction Proportional switch operation

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Non-Proportional Alternative Controls

Standard 2 Switch Driving

- **Forward Drive Command**: Double hit and hold of the right switch
- **Reverse Drive Command**: Double hit and hold of the left switch
- **Left Drive Command**: Hit and hold of the left switch
- **Right Drive Command**: Hit and hold of the right switch

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Non-Proportional Alternative Controls

2 Switch Linked Driving

- **Left Drive Command**: Hit and hold the left switch
- **Right Drive Command**: Hit and hold of the right switch
- **Forward Drive Command**: Hit and hold both left and right switches together.
- **Reverse Drive Command**: Tap both left and right switches to flip the arrow from forward to reverse, then hit and hold both left and right switches.

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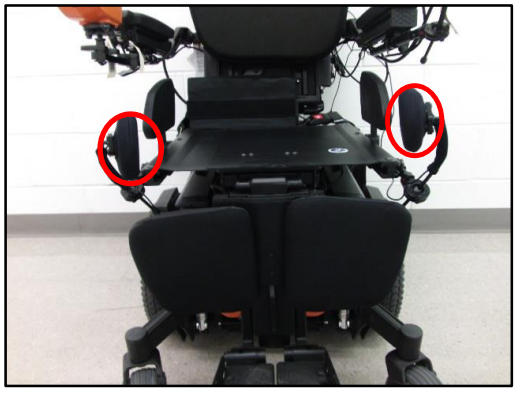
Examples of Linked Driving

Proximity Switches



Mechanical Switches

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Examples of Linked Driving

40

Non-Proportional Alternative Controls

1 Switch Control (Scanning)

- Directional Options are scanned on the display
- When the desired direction is highlighted then the switch is activated and hold the switch as long as they want to go that direction
- To stop the chair the switch is released

Non-Proportional Alternative Controls

1 Switch Control (Scanning)

- Allows a person with just **ONE** switch access site on their body to independently drive a power wheelchair and control all of the features the power wheelchair offers.
- Provides a **level of independent driving** that an individual would not have without a scanning option.
- **Built into the system** for people who have a progressive condition.

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1- Switch Scanning

Mounting Options

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Andrew

- 3 year old boy at initial evaluation
- Cerebral Palsy: Double Hemiparesis; Not diagnosed until 6 months of age.
- Andrew lives with his father, mother, little brother and little sister.
- He has difficulty with controlled movements in his upper extremities.
- He has significant difficulty with head, neck and trunk control.
- His tone fluctuates. His upper and lower extremities have high tone while his trunk and neck have low tone.

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Andrew

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Digital/Switch Controls

- Eye Gaze
  - Gaze Operated System that is a combination system with speech-generating
  - 4 quadrant screen that end user looks at the desired direction
  - Not available in the US
- Future Possibilities
  - Brain, voice, computer generated – not likely
  - Tongue Drive – prototypes in the field

Think Globally About The Individuals Needs

- What are the individual's electronic needs?
- Do they need expandable or non-expandable electronics?
  - What does expandable electronics offer that would be useful to the individual?
    - Specialty control use?
    - Bluetooth and Infrared use?
    - Specialized programming for increased level of independence?
- What other technology can they benefit from?
  - Communication devices
  - Computer access
  - Environmental access
  - Work or school

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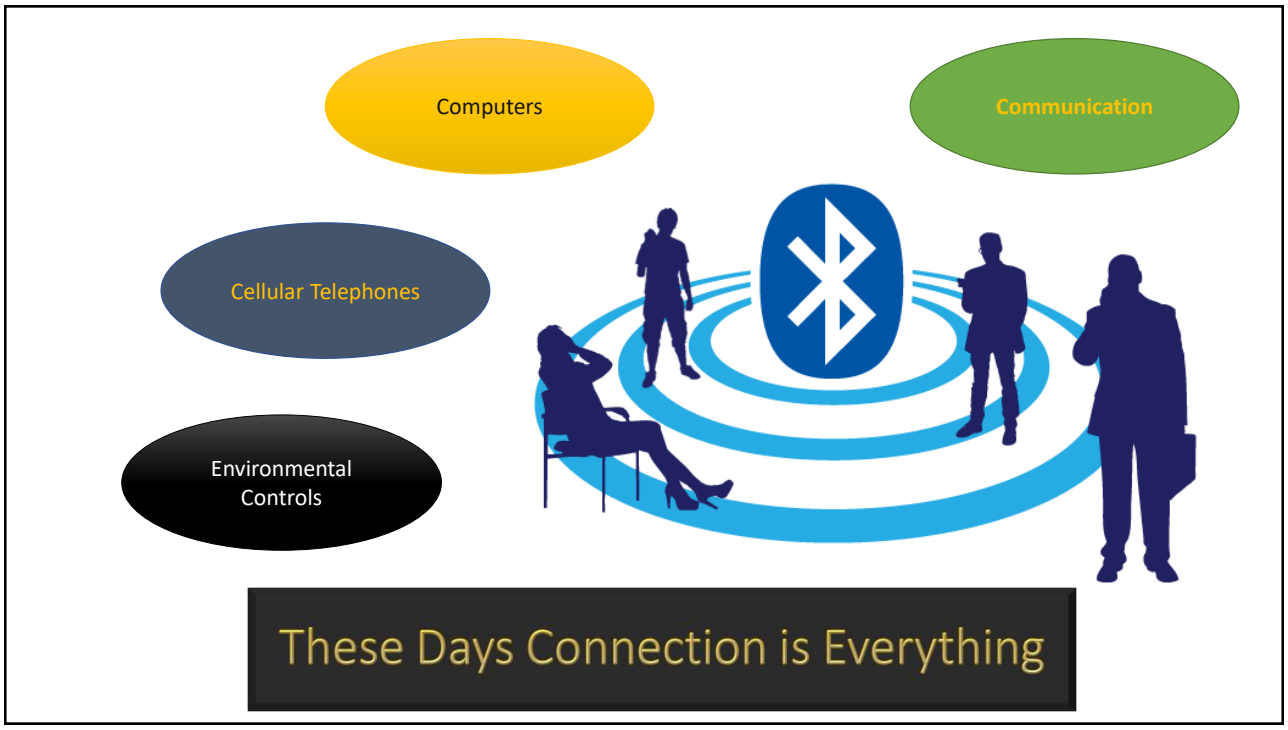
Computers
Communication
Cellular Telephones
Environmental Controls
These Days Connection is Everything

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Global Dependency on Mobile Devices

- Today there is a Global dependency for work/school/interpersonal competence for immediate access to view/respond to text messaging/email/telephone/documents
- Mobile devices are a need by society today for how people interact, shop & learn
- Crucial for individuals who are dependent on powered mobility due to limitations in their motor control. Mobile devices provide accessible solutions- This is an important consideration for power wheelchair users to provide improved independence.

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Why Environmental Control is Important to the Power Wheelchair User?

- It can help manage health issues.
  - Having the ability to call for help if it is needed.
  - Regulate the temperature of the home environment.
    - Thermo-regulation is extremely important with some medical diagnoses.
    - Can allow control of heat or cooling
- Safety
  - Being able to independently lock and unlock the doors.
  - Knowing who is at the door before unlocking the door.
  - Alarms are an option to alert others if someone breaks into the home.
  - Monitoring for water leaks on different floors of the home

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Why Environmental Control is Important to the Power Wheelchair Users?

- Improve independence – decrease dependency on others.
  - Entertainment
    - The consumer can control the television (most smart TV's have apps that control the TV via Wifi)
    - Roku and fire sticks are all controlled by Wifi through apps on smart phones or tablets
    - Control of music and skip around until find what is desired
    - Possibly play online games
  - Control of general environment
    - Be able to independently control lights (on/off, brightness)
  - Communication
    - Control a smart phone or tablet to be able to text, make calls or answer calls.
    - Email and other communication functions

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iPhone Controlled by Wheelchair Electronics Controlling the Environment

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Example of Bluetooth and Infrared Used in Persons Home

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Bluetooth and Infrared Controlling a Childs Toy

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Access to Environmental Control With Use of a Communication Device and Consumer technology

55

Tilt / Recline and Elevating Legs

It is RESNA's position that these features are often medically necessary, as they enable certain individuals to:

- Re-alignment posture and enhance function
- Improve physiological processes such as
  - Orthostatic Hypotension
  - Respiration, Swallowing
  - Bowel and bladder function
- Enhance visual orientation, speech, alertness and arousal
- Improve transfers biomechanics
- Regulate spasticity
- Accommodate and prevent contractures and orthopedic deformities
- Manage edema
- Redistribute and relieve pressure
- Increase seating tolerance, pain management and comfort
- Independently change position to allow dynamic movement

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Tilt and Recline Considerations

- Can the consumer drive the power wheelchair within the desired ranges of tilt and recline?
- Can the consumer control tilt and recline through the entire arcs of motion?
- When the consumer is back resting can they re-engage the alternative controller to get back to an upright posture?
- Are there other programming features that an electronics system offers that would alleviate any of these problems that may arise?

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Features to Solve Access Issues with Power Positioning Control

- Presets can allow one command to control a power positioning system with one command.
- Presets can also reduce positional challenges with access to the control device.
- A switch placed in a different location such as the head to control power positioning can alleviate access issues when using tilt and recline.
- Latching actuators can alleviate access issues for controlling actuators as well.

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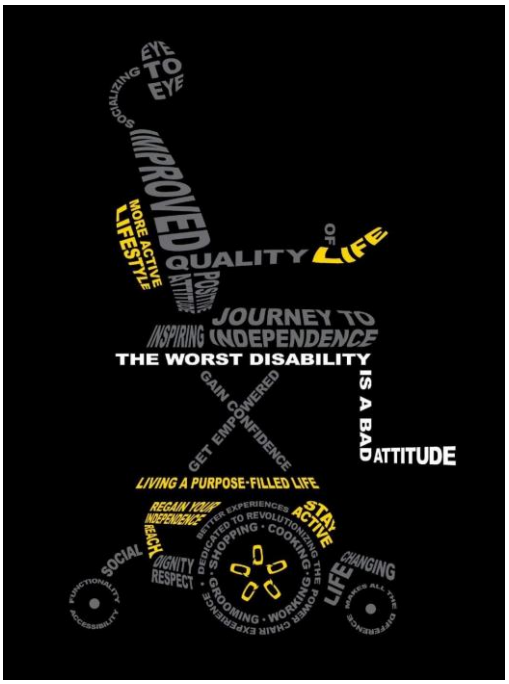
Power Adjustable Seat Height (PASH)



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Transfers

- Transferring from a wheelchair to other surfaces such as a bed, toilet, or other surface is a necessary part of the daily routine.
- Transferring is a means to accomplish MRADLs, and therefore it is considered a medical necessity.
- Seat-elevating devices can facilitate safer and more independent transfers

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Transfers

- Transferring in a downward direction requires less upper extremity strain (Wang et al., 1994)
- Rising from an elevated seat has been shown to require less lower extremity strength and extension momentum at the hips, knees, and ankles
  (Alexander et al., 2001; Brattstrom et al., 1981; Burdett et al.,1985; Edlich et al., 2003; Janssen et al., 2002; Rodosky et al., 1989; Weiner et al., 1993)
- Reduce the level of assist
- Reduced risk for injury
- Prolong independence

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Transfers

Transfers

- 8 Transfers per day (total in and out)
- 6 (40%) of 15 mEMA responders reported using PASH for transfers more than 50% of the time
- 16 of 24 people transferred while elevated at least once (all at least 5 times)
- 14 people changed the seat height between transferring out and transferring back in (at least once)

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Functional reach

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Psychological and Physiological

- Reduce trunk and/or neck strain
- Promote “eye to eye” communication
- Fully interact with the environment

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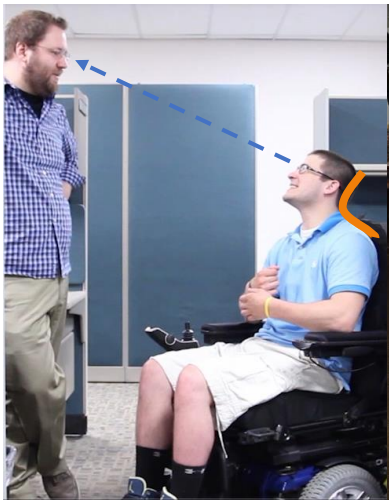
Psychological and Physiological

- When talking at eye level with others, **typical hyperlordotic cervical curvatures of the spine can be reduced**. This relieves strain on the neck and may help enhance vision, thus helping to prevent secondary complications.
- An elevating seat may also allow a person in a wheelchair to **hear and engage in conversations** within a noisy environment, as well as to **see and navigate** more safely through a crowd of people.



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Quantum Position

Power Wheelchairs provide 360° of movement in a 2 dimensional plane

The addition of a highly functional power adjustable seat height system is medically necessary to raise and lower the client in their seated position, without changing the seat angle(s), to provide changes in vertical position and access to the environment in a 3 dimensional plane.

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Power Adjustable Seat Height Functional Advantages

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Technology Advancements that Provide Additional Benefits to Power Mobility Users

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What does Suspension Provide?

- Absorption of jolting /vibratory forces on wheelchair and wheelchair user
  - Influences an individual's posture and balance in the (stability of positioning)
  - Reduces or mitigates spasticity and/or reflex activity
  - Supports pain management
  - Increases sitting tolerance
  - Improves durability of the power base
- Ability to maneuver over a variety of terrains, optimizing environmental transitions
- Stability of the power base

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Impact of Suspension on the Individual

- "Vibration, shock (single event and repeated), and motion have a significant effect on the health and quality of life for individuals who utilize a wheelchair for mobility.
- Vibration and shock can cause back pain and injury, which has been well documented in the literature."

(Griffin, 1975, 1990; Kitazaki & Griffin, 1998; Paschold & Mayton, 2011; Wilder, Magnusson, Fenwick, & Pope, 1994)

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Impact of Suspension on the Individual

TRUE shock absorption limits the jolting/vibratory forces, which decreases the terrains effect on the individual to:

- Support postural control, maintain positioning in the chair and contact with support components
- Preserve access to the drive control device, especially a specialty control
- Manage spasticity
- Minimize pain
- Decrease fatigue and increase sitting tolerance
- Reduce fear of driving across rough terrain and increase access to **all** environments of use

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Impact of Suspension on the Individual

- "Long-term exposure to seated whole-body vibration (WBV) is one of the leading risk factors for the development of low back disorders."
  - Blood, R.P.; Yost, M.G.; Camp, J.E.; Ching, R.P., **Whole-body Vibration Exposure Intervention among Professional Bus and Truck Drivers: A Laboratory Evaluation of Seat-suspension Designs,** J Occup Environ Hyg. 2015;12(6):351-62. doi: 10.1080/15459624.2014.989357.
- "Research on truck drivers and heavy equipment operators indicates that intense, long-term whole-body vibration increases risk to the spine."
  - "Whole-body Vibration", Texas Department of Insurance Division of Workers' Compensation Safety Education and Training Programs, http://www.tdi.texas.gov/pubs/videoresource/stpwhbody.pdf

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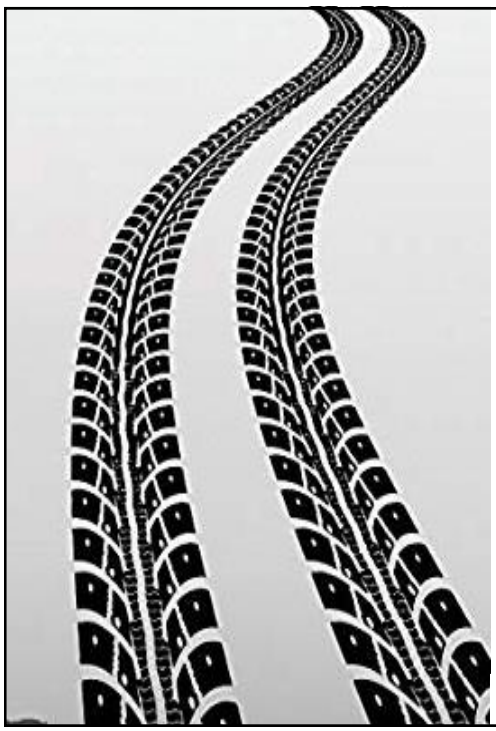
Position of the Person in the Wheelchair – Center of Gravity

Position of the Person in the Wheelchair – Center of Gravity



Tracking Technology – What is it?

A **feature** on the motors that interface with the control module so that the speed of the drive wheels can change in relation to one another to:

- Maintain a straight course of operation
- Compensate for discrepancies in terrain, transitions and thresholds
- Track independently over surfaces the consumer encounters in their home and community

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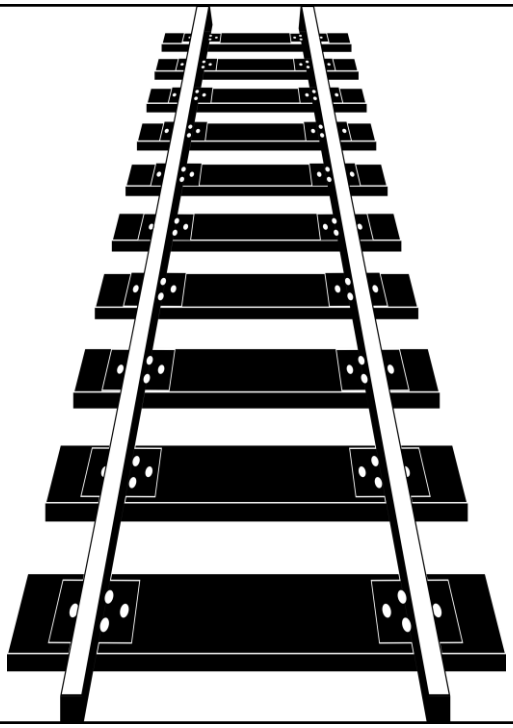

Tracking Technology – What does it do?

- Allows an individual to control their w/c without having to make continual adjustments due to unequal drive wheel revolutions
- Minimized the need for excessive movements of the (hand, head, neck, chin, foot or other body part) to stay on track
- Compensates for veering when using non-proportional (switch) type controls
- Promotes safe, accurate operation of the w/c

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Tracking Technology – Why is it Medically Necessary?

- Allows individuals with limited motor control, muscular fatigue, physiological fatigue, balance challenges and/or spasticity to compensate for their loss of function
- Increases length of time individuals can drive
- Minimizes the risk for accidents or an adverse occurrence

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Assessment/Training Strategies

- Traditional Training

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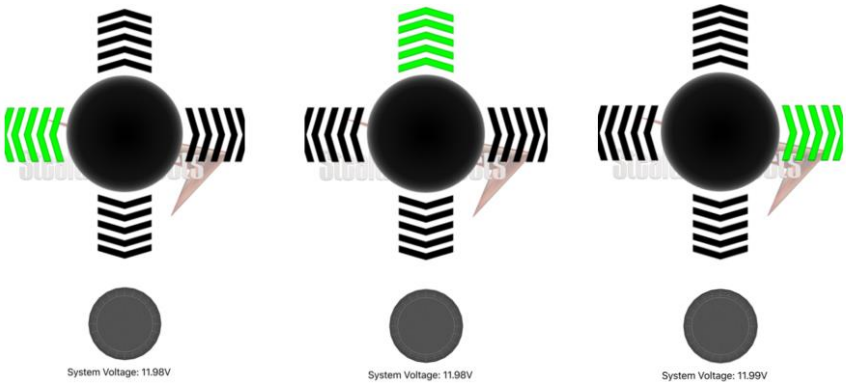
Assessment/Training Strategies

- Diagnostic Screen on Programming Station



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Assessment/Training Strategies

- Application Based Games - **LOONZ**

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Assessment/Training Strategies

- Virtual Reality (VR)

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Thinking Out Loud

- What are two things you learned and how can you relate it to your practice/job?
- How does this course relate to your practice/job setting?

- How will this course change your behavior in the future?

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Thank you for your time- any questions?

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