



Manual Wheelchair Selection and Configuration

.3 Ceu
Certified by University of Pittsburgh
Invacare CARES
Education and Training Department

What's Really Important



- 1.Design and ride quality (materials, flex)
- 2.Wheel and casters
- 3.Balance
- 4.Moving parts
- 5.Wheel access



Build Product Around User!



- Basketball
- Tennis
- Wheelchair Racing
- Cycling
- **Sport of Everyday Use!**





Balance Stability



Evaluation Steps to Optimal Fit and Function



- Client Goals/Expectations
- Seating Assessment
- Functional mobility
- Frame design
- Configuration options
- Components
- Fit/TRAINING!



Seating Assessment



- Current seating-what works, what doesn't
- Supine /Unsupported sitting
- Identify asymmetries
- Range of motion, flexibility, tone, reflexes
- Postural stability through the frame
- Match seating to frame design

Wheelchair Propulsion Mechanics



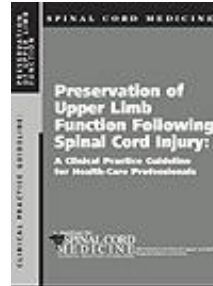
- Physiological capabilities of the user
- Biomechanics of the stroke,
- **Design of the wheelchair** and whether it is appropriate for the user.
- (Rory A. Cooper, Ph.D., Rick N. Robertson, Ph.D.)

Correct Configuration



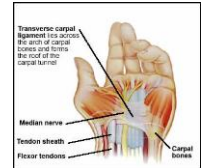
- Decreased roll resistance (Brubaker 1986)
- Handrim contact increased (Hughes 1992)
- Propulsion with less muscle effort, smoother joint patterns & lower stroke frequency (Masse 1992)
- Lower peak forces, less rapid loading of pushrim, fewer strokes, greater contact angles with handrim (Boninger 2000)
- Increased torque during shoulder propulsion increases shoulder pathology, Mercer et al 2006

Evidenced Based Practice



www.pva.org

- Use long smooth strokes
- Minimize frequency of repetitive limb tasks
- Minimize forces



How athletes make their product decisions

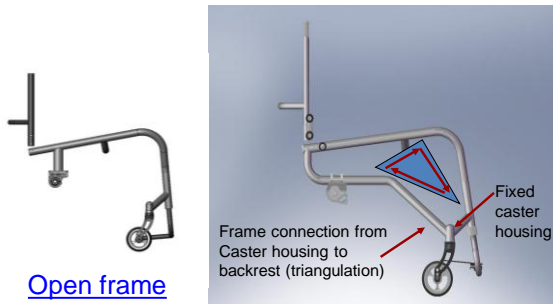
The key to successful configuration and design is rolling dynamics, or “rollability” over weight.

Materials



- In today's market with it's technologies in materials, the only way to take weight off a chair is by the components chosen, not the frame material
- Understand their properties, and how the design will enhance the ride quality.
 - Titanium
 - Aluminum
 - Steel

Rigid Frame Design



Adjustments/growth



- Are adjustments important?
- When making an adjustment, understand what else is affected.
- Build the chair to fit. Avoid “fudge factor” whenever possible.
- If you need growth, truly understand your options.

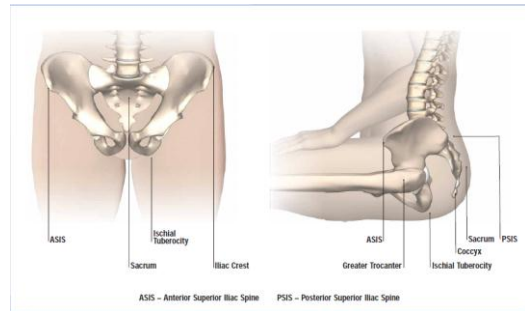
Concept of Rollability



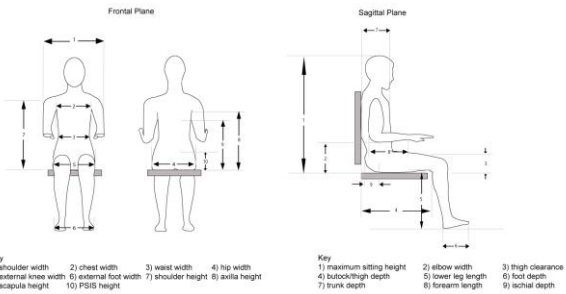
Where do we start?



Functional Anatomy



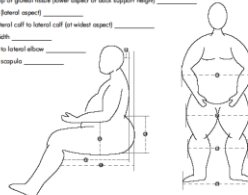
Basic Measurement



ADDITIONAL MEASUREMENTS FOR BARIATRIC CLIENTS

Current weight: _____ Weight history: _____

1. Back of knee/ calf to back of buttocks (seat pan depth)
2. Back of knee/calf to thoracic/lumbar trunk (for seat depth)
3. Seat pan to under femora (seat height)
4. Seat pan to top of gluteal tissue (lower aspect of back support height)
5. Width of knee (lateral aspect)
6. Width from lateral calf to lateral calf (or widest aspect)
7. Overall hip width
8. Lateral elbow to lateral elbow
9. Back of head occipute

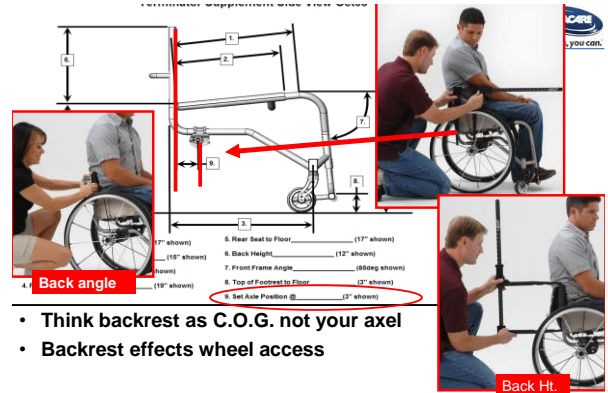


Effects changing the Front Frame Angle



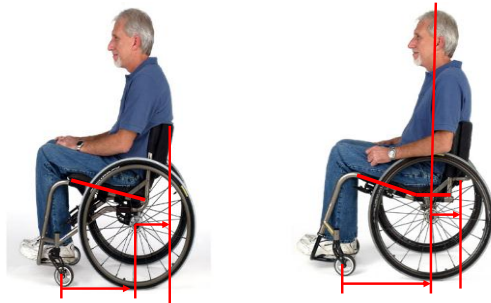
INPUTS

Front Seat Height	19	Front Frame Angle	90	85	80
Rear (TrueBalance)	3	Percent Weight on Front	18.8	17.2	15.8
Front (TrueBalance)	13	Front Load	32.8	30.0	27.7
Total Weight	175	Increase in Wheelbase	0.0	1.5	3.0



- Think backrest as C.O.G. not your axel
- Backrest effects wheel access

Backrest



Wheel Position

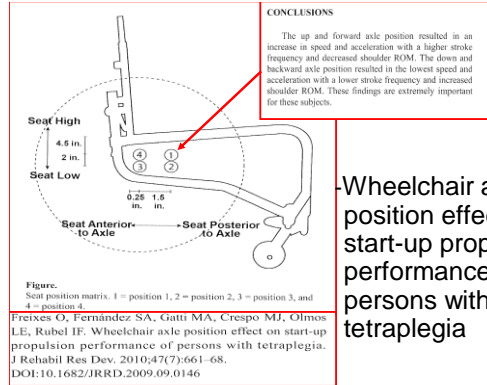


Wheel Back - original



Wheel forward 2 inches

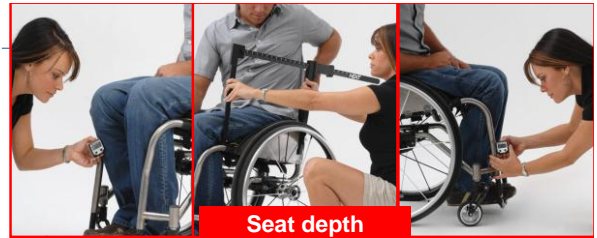




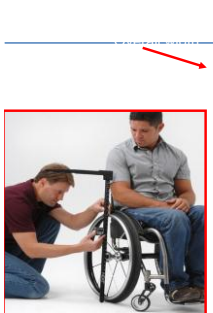
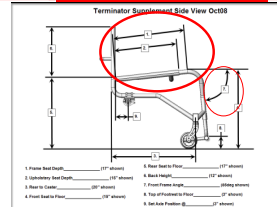
Wheelchair axle position effect on start-up propulsion performance of persons with tetraplegia



Rob



Seat depth

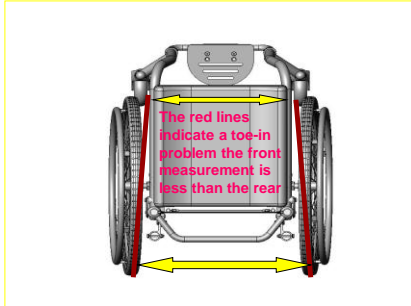


Camber

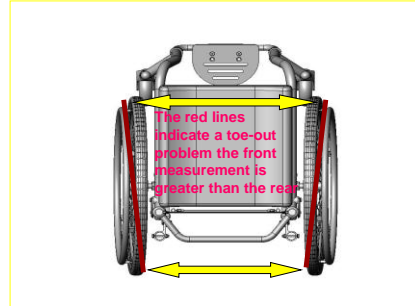


- Why camber is important
- Lateral stability
- Better pushing mechanics
- Know how to measure and adjust
- Understand the effects of a toeing problem

Toe-in



Toe-out

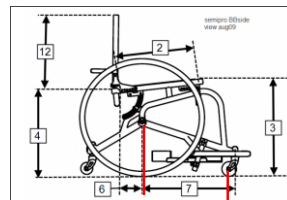


Adjustments/growth

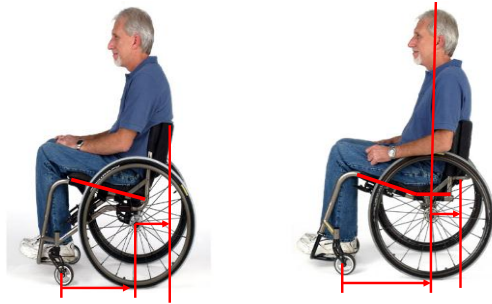
- Are adjustments important?
- When making an adjustment, understand what else is affected.
- Build the chair to fit. Avoid “fudge factor” whenever possible.
- If you need growth, truly understand your options.

Front Stability

- Balance the front of the chair
- All vehicle focus on front stability
- Use front casters and fork options
- Why athletes spend more time on the front of products



Front Stability

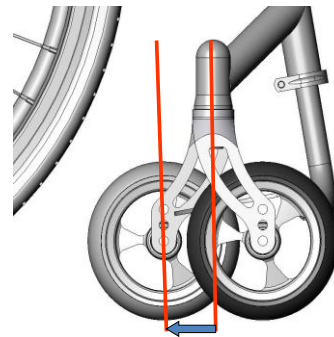
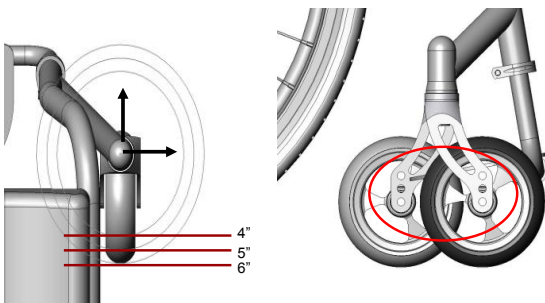


Front casters and forks

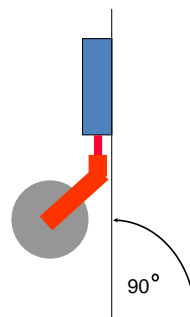


- Think front stability
- Does size matter?
- Lower COG
- Build into the frame
- Always use the shortest fork

Caster Trail



Housing Angle



- The caster housing must remain perpendicular to the floor
- Increasing or decreasing this angle impairs chair performance
- Placing a chair in Tilt by either smaller wheel size or axle placement will affect caster housing angle

Rear Wheel Options



Composite

- Poured Plastic
- When dries-shrinks
- "never" going to be true
- Limited handrim options
- Rigid ride
- Low maintenance

Spoke

- "old" perception of maintenance
- Increased durability
- Steel or aluminum spokes-lighter
- Take more tire types
- Can be "trued"
- Were bike wheels now WC wheels

Elite Spoke

- Spinergy
- Not alloy
- Fiber-1000 threads
- Increased durability, cost
- Strength, cost
- Approx ¼ lb. Less than traditional spoke (greater than savings of wt of titanium)
- SUN-aluminum spoke, high strength

Tire Type	Tire and Wheel	Per Wheel	Total Weight
Primo HP110 psi pneumatic (sport and everyday)	Primo with Spinergy	4 lbs	8 lbs
1 3/8" Grey Treaded pneumatic with flat free	1 3/8" with spoke	6 lbs	12 lbs
Schwalbe-light pneumatic hybrid w/ Kevlar wall (durable/puncture resistant) Long wear life Non-marking tire Good tread	Schwalbe w/spinergy	4 ¼ lbs	8 ½ lbs
Zipp 404-race tire (carbon fiber w/ metal spoke)		1 ½ lbs	3 lbs

Tire Characteristics



Flat Free

- 2.5# >High profile Pneumatic
- Most durable
- Cost least
- Ride quality least
- Maintenance least
- Active Consumer preference least

Urethane-KIK

- Less weight than flat free pneumatic but hard ride quality
- Durable
- Not compatible with all wheel types
- Low maintenance

Pneumatic

- More maintenance
- Better ride-shock dampening
- Lifetime cost increases
- Less impact on frame performance

High Pressure Pneumatic

- Least durable
- Most cost
- Most ride quality
- Most maintenance
- Most desired by active consumer

Wheelchair Training and Education



Propulsion-varied environments

- terrain-carpet, asphalt, grass, dirt, gravel, sidewalk
- inclines
- surface transitions-thresholds
- curbs
- steps
- stairs

Wheelchair Training and Education



- Turning
 - Left/Right-hand drag
- Door Management
- Transfers to/from WC-varied heights, surfaces, vehicles, floor
- Environmental modifications
- Travel and Leisure
- Exercise and Stretching

Wheelchair Training and Education



- Advanced Skills-wheelerie-rolling pop-up, thresholds, turns in wheelie, ramps, curbs, safe falls, stairs, assistance directed

• Changing propulsion style based on environmental and functional demand!

Propulsion Education



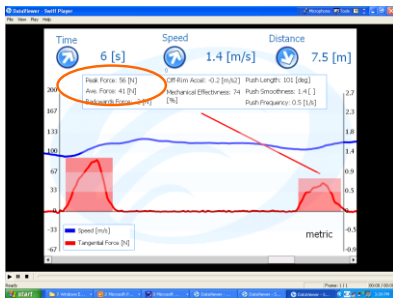
- Propulsion Phase
- Recovery Phase

- Long stroke
- Low repetition
- Low force

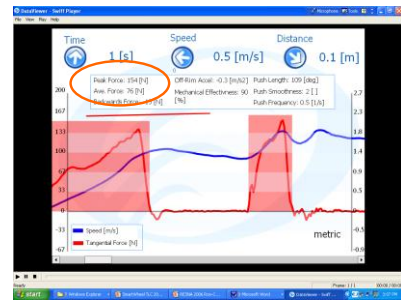


• Boninger et al, 2002

Lowered Forces . . .”



High Force Propulsion



Equipment Management and Maintenance

- Vehicle stow techniques for different style frames and abilities
- Rear wheel alignment
- Caster function-spin and swivel, housing alignment
- Equipment hygiene
- Equal camber
- Axle position
- Bent frame

Tire pressure!





Power Assist



- *Hands on – Wheel access*
- *COG*
- *Rear seat height*
- *Propulsion techniques*



Thank you!
Lois Brown, MPT, ATP
Rehab Clinical Education Specialist
Invacare Rehab Education
Lbrown@invacare.com

www.rstce.pitt.edu
For Position Papers