Adjustments to your manual wheelchair, power wheelchair or mobile shower commode

Preface
After taking delivery of a manual wheelchair, power wheelchair or mobile shower commode, several adjustments are often required to set the equipment up to fit the user and to obtain maximum benefit from use.

The following document uses a **suggested sequence of adjustments** starting with the footrest, then the seat and backrest, finishing with rear wheel position and balance of the chair. The sequence applies when considering the needs of the user.

FIRST set a seat height and angle for posture, transfers and shoulder to push rim relationship;

THEN move rear wheels forward / rearward to suit the stability needs of the user (Tomlinson 2000).

Often many of the seat adjustments have been decided when trialling the wheelchair, so these may be set up at the time of delivery by the supplier. Footrest height and back height often need adjustment at the time of delivery. Rear wheel position may be changed as the wheelchair user develops greater confidence or their needs change. Some **mechanical experience** is necessary to make most changes. The supplier, prescribing therapist or another person with suitable mechanical experience and access to tools may be able to assist.

The **product instruction manual** may have more detailed information on specific adjustments for equipment and should be referred to where available. This guide provides the rationale and aims for each adjustment, with instructions and product examples to give a general overview of adjustments for many different types of equipment.

A number of the adjustments discussed in this document will affect the overall stability of the wheelchair. As such it is important to carefully trial all changes to ensure the setup remains both functional and safe. In so doing consideration should be given to the environment of use with particular consideration of slopes and obstacles that are likely to be encountered.

Abbreviations Used	Manual wheelchair **MWC**	Power wheelchair **PWC**	Mobile shower commode **MSC**

Contents

Tools Required			
Allen keys (metric for most product except American where imperial sizes are required) Small shifting spanner	Small open ended/ring spanners (8, 9, 10, 11, 12 and 13mm or equivalent imperial sizes are most common) Flat tip and Phillips screwdrivers	For rear wheel position on MWCs: Large open ended spanners, 17, 19, 21, 22mm or 1", or 1&1/8" spanners and/or socket wrenches. May be possible using 1-2 x 300mm shifting spanners – refer pg 9	

Acknowledgements and Limitations

Sincere thanks to the many wheelchair users, carers, therapists, rehabilitation engineers, technicians, repairers, wheelchair suppliers and expert trainers who have contributed to the development of this document.

This guideline provides an overview of the subject area. More detailed information can often be found in product instruction manuals, or through consultation with the equipment supplier, therapists or technicians.

Correspondence

Clinical Education Officer
Medical Aids Subsidy Scheme Queensland Health
PO Box 281
Cannon Hill QLD 4170

Email: mass184@health.qld.gov.au

Disclaimer

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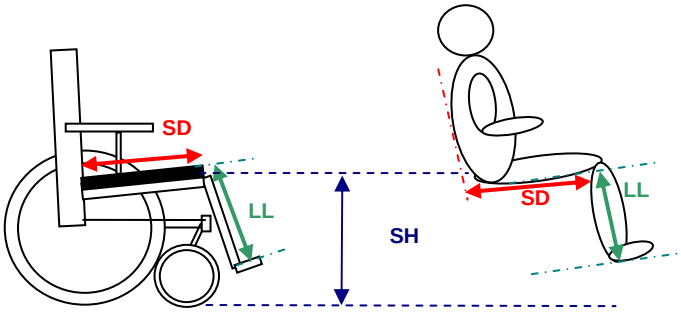
Footrest Height and Angle - set to accommodate leg length (**LL** below) and provide foot stability

Note: Changing footrest height is provided first in this guide as some wheelchairs are delivered by the supplier with the seat height and angle already set up. **If significant changes to seat height, seat angle, backrest height and seat to back angle are to be made, perform those adjustments first and set the footrest height last.** Changes to the seat and backrest will often change the distance between the seat and footplate.



1. Sit on the usual cushion. Wait until the user has settled into the cushion. With foam cushions this may take up to 10 minutes as they may react to body heat and the user sinks (or immerses) into the cushion further (Crawford 2005)

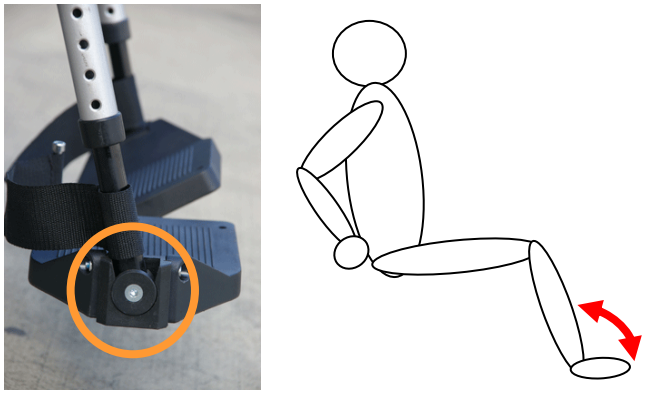
2. Loosen the footplate adjustment mechanism and move the footplate to a position where the feet are well supported on the footrest / footplates AND the thighs are well supported on the cushion / seat. This enhances stability and helps prevent pressure areas – refer below

   Various adjustment mechanisms exist:

   - Push button or hand wheel (tool-less)
   - Bolt
   - Allen key

Legrest adjustment mechanisms: Allen key (left) bolt (middle) push button with lever to lock in place (right)

3. If the footrest can be adjusted in angle, set the angle to achieve even pressure across the length of the foot. As a general rule, the angle should be as close to 90 degrees at the ankle as possible. Avoid large amounts of **plantar flexion** (i.e. angle between foot and shin greater than 90-95 degrees) since large amount of "foot drop" can set off muscle tone, causing lower limbs to extend forward and the pelvis to slide forward



Footrest angle adjustment mechanism

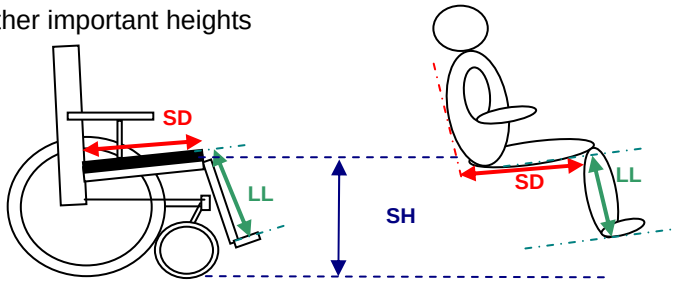
Step 2 above can be a difficult judgement if the wheelchair user has not moved for some time and has a lot of muscle wasting over the thighs and buttocks:

- Aim for the **middle of the thighs** to have more pressure than the soles of the feet – thighs are more tolerant of pressure and have good blood supply. Footrests need to be low enough so that some load is taken off the buttocks.
- Sufficient **contact with footplates** so feet do not slip off. Consider heel loops, calf straps, shin straps, angle adjustable or larger footplates to assist with retaining feet.
- For those without sensation in feet, always wear shoes in the wheelchair.
- For those with leg length discrepancies, adjust the height of each footplate individually or use a build up made from EVA foam or a similar water resistant material which is firm but does not risk injury to skin

Seat Height (SH below) is adjustable on many wheelchairs to allow:

- The user to propel the wheelchair most efficiently
- Seat to footplate dimension to fit the user AND provide clearance under the footrest
- For transfers in/out of the chair, to match bed/seat/other important heights
- Knees to fit under tables
- Head to clear under roof in vehicles.

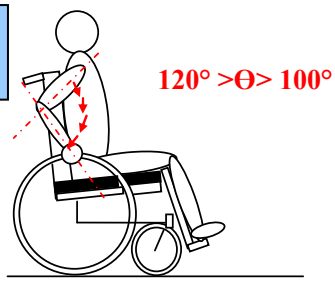
Many of these choices are made before taking delivery of the chair, and the seat height may be set before delivery. Small changes may be made after delivery to further refine the set up if required.



Seat height suited to propulsion

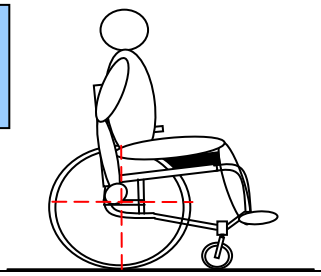
- Optimal **shoulder to push rim relationship**: Energy used to propel the chair is least when the elbow is at a 100-120 degree angle when grasping the push rim at its highest point (van der Woude 1989). This also helps prevent excessive elevation of the upper arm (humerus) when bringing the arm back to grasp the push rim. Repetitive elevation of the humerus is the main source of shoulder pain for long duration wheelchair users (Mulroy 2005)

1) Arm bent: 100-120 deg at elbow when grasp push rim at highest point



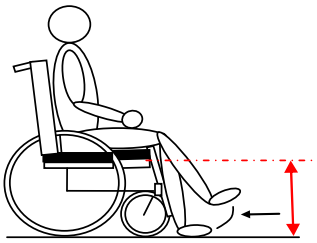
- Alternatively, drop the hand down to the side; the drive wheel axle should line up with fingers; axle between knuckles and finger tips

2) Arm straight: Axle between finger tips and knuckles when drop arm to the side of the axle



- Some wheelchair users propel with feet. Seat height at front should allow the heel to contact the floor for greatest efficiency and to prevent the user sliding forward in the seat when pulling the chair forwards with their foot. A low seat can be a compromise if the user is later pushed by someone – consider adding a higher cushion and replacing footrests when being pushed.

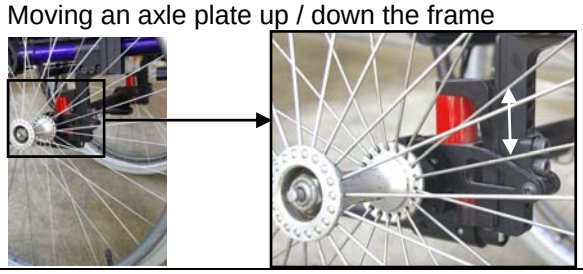
Seat height for strongest foot propulsion, heel making contact with floor



Rear seat height can be adjusted by

- Mounting axle to different locations on a bracket

- Moving an axle plate up / down the frame



- Moving rear wheels to different holes in the frame

Choosing different size rear wheels

Further information on changing rear wheels can be found on page 12 (i.e. bolt on wheels, wheel position)

Front seat height can be adjusted by

- Moving castors to different heights in the axle fork

- Choosing different size, castors, different length castor forks or castor fork spacers / longer bolt

*When changing castors, take care not to lose washers or axle spacers

Seat height on power wheelchairs can be adjusted by

- Mounting the seat at different heights on the seat mounting framework / posts

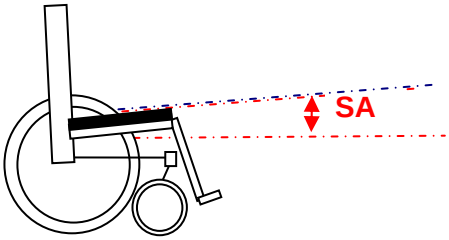
- Some chairs can be fitted with a seat elevator function for powered vertical seat raise / lower

- With many PWCs seat height is not easily adjusted due to the design or features fitted, particularly when powered seat tilt is fitted

Seat Angle: The angle between the seat and a horizontal line (from rear of seat to front of seat) can be expressed as a positive angle.

This is referred to as **seat angle** and can be very important for wheelchair users to:

- Have a positive seat angle (seat height front higher than seat height rear) to help with retaining the pelvis at the rear of the seat
- Have a more neutral / flat seat angle to move forward in the seat then stand to transfer out of the wheelchair, or transfer sideways into car, bed, or another chair



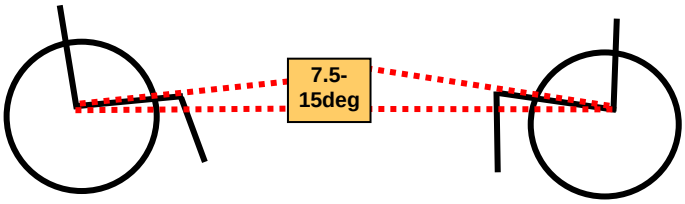
A positive seat angle (where the seat is higher at the front than rear) combined with support for the lower back, helps reduce the muscular effort involved in sitting with the trunk upright and can assist in compensating for limited or absent trunk muscle function.

Seat angle can be measured with an angle finder / level available from some seating suppliers, or some hardware or plumbing retailers.

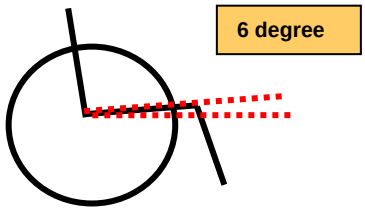
An angle finder indicating a 6 degree seat angle

Seat Angle: Changes to consider

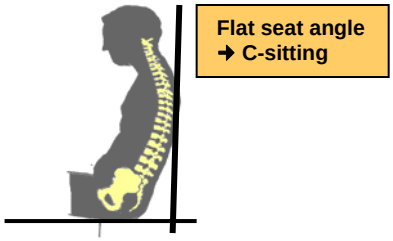
- 7.5 degrees or greater can assist with retaining the pelvis upright at rear of seat
- 15 degrees is a sensible upper limit. Provides strong stability but may impede independent transfers
- If the backrest is close to vertical, the wheelchair user must have sufficient hip flexion to sit with seat to back angle less than 90 degrees – if not, pelvis will move forward along the seat, tilting back, sitting on the tailbone (coccyx and sacrum), often called C-sitting or sacral sitting.



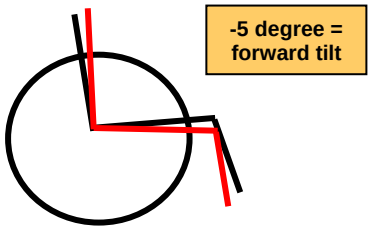
- Degrees may provide a balance between ease of transfers and stability. Dining / standard chairs use a similar angle.



- A flat/zero degree seat angle is not recommended, although some compromise may be required when the wheelchair user *must* transfer independently. The problem with a flat seat is the user must move the pelvis forward along the seat to compensate for weak trunk muscles. While a slouching posture (C-sitting or sacral sitting) is a common compensation that nearly all people use to have a rest in sitting, it can be a problem if people sit this way all or most of the time. The pelvis becomes fixed in rearward tilt and spine fixed in a C-curve. The user is often uncomfortable and unable to sit up straight again. There is also greater risk of pressure ulcers on the tailbone and further spinal deformities due to the limited support for the spine



- A forward tilted seat (e.g. minus 5 degrees) may assist with standing transfers, or to promote trunk muscle function and reach for short duration activities. Use a wheelchair with movable tilt in space so the seat can be returned to a resting position, as forward tilt cannot be maintained for long periods.

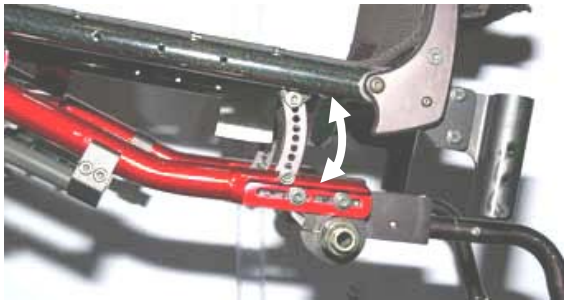


Limits to changing seat height and angle

Changing one component usually influences others (e.g. moving rear wheels up frame to get a better seat angle may compromise shoulder to push rim relationship). Few designs allow changes in seat angle without also making changes to rear wheel position.

- Decide on seating angles *prior to delivery*, at trial / order stage
- In summary, decide on a **seat height** to allow
  - shoulder to push rim, or, foot to floor
  - knees under tables + footplate clearance

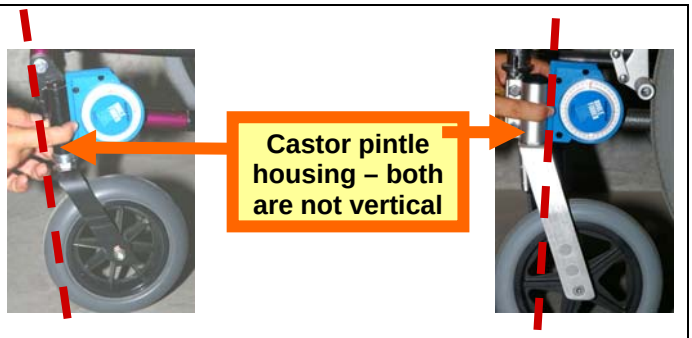
  and a **seat angle** to
  - keep pelvis upright at rear of seat
  - allow transfers from the seat when transfers *must* be independent / unassisted



On some rigid frame manual wheelchairs, seat height at rear and seat angle are adjustable without changing rear wheel position, or the position of the wheel locks, making adjustments much simpler.

After changing seat height, castor pintle adjustment

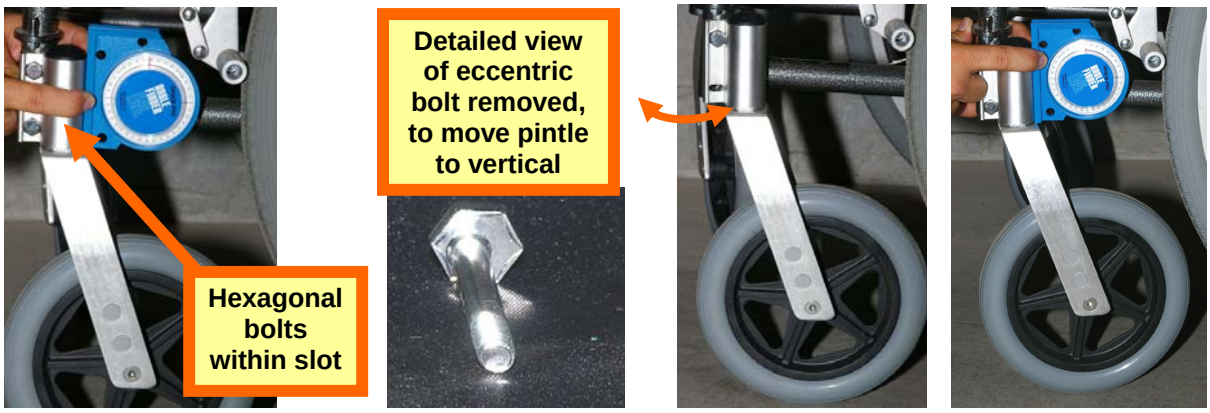
- Check if the castors will turn freely – they will not if the castor pintle housing is no longer vertical (i.e. as the castor fork rotates 360 degrees the frame at front will move up/down, meeting resistance when going up). Any *large* change in seat height will change the angle of the castor pintle housing
- Most wheelchairs that allow large changes in seat height will have an adjustable angle castor pintle



Setting castors back to vertical (see picture sequence below)

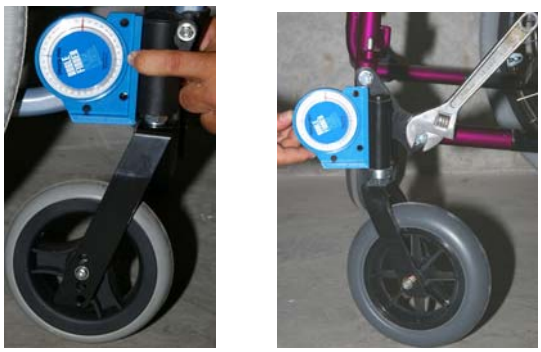
Example using castor pintle with 2 "eccentric" (off centre) bolts

- Use a single spanner to undo nuts on opposite side
- One of the eccentric bolts must be fully removed, the other part removed, so the hexagonal head is out of the slot. The castor pintle housing is then moved back to vertical.
- Both bolts must be inserted / rotated to a position in the slot where they lock the pintle housing in vertical alignment
- Secure nuts to thread end of bolt; fasten tightly



Setting castors back to vertical – design variations

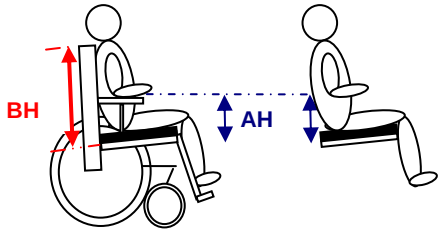
Two versions of a 2 bolt style of castor pintle adjustment are shown opposite. Spanners and/or allen keys may be required to make adjustments



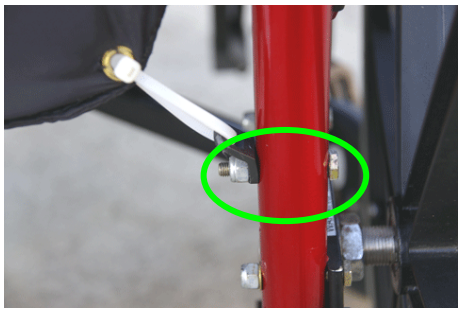
Finally, the **brakes/wheel locks** will often need to be moved along the frame slightly after changing seat height at rear. Take care to secure clamp on wheel locks very tightly to maintain alignment with the tyre.

Setting the Backrest Height

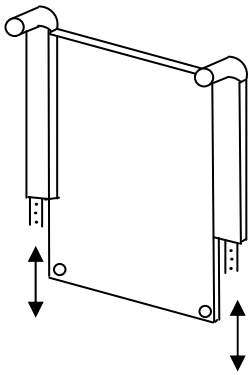
1. Locate hardware required to adjust the backrest height
   - bolts through the backrest uprights (back canes)
   - bottom of the upholstery may be secured to the frame with a tie / cable tie which is secured to the frame with a bolt

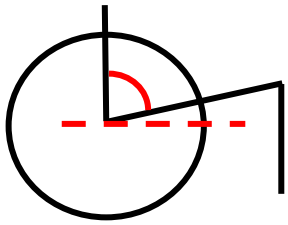


2. Loosen and remove bolts through back canes and remove ties if required. The backrest uprights and upholstery should then be free to move up / down



3. Move the backrest to a point where the seated wheelchair user is comfortable:
   - **Low Back Height**: Support up to the lowest ribs. Often used with a seat higher at front than at rear (a positive seat angle) to support the pelvis upright at rear of seat
   - **Regular Back Height**: For wheelchair users who relax, sitting for extended periods in the chair, back support is often provided to the base of the shoulder blades (scapula) to avoid restricting movement or rubbing when propelling the chair
   - **High Back**: When the trunk must be fully supported, support to top of shoulders
     - user who is not actively propelling
     - to provide a resting position if tilting the seat back or reclining the backrest
     - to provide a line of pull when using a chest harness





4. Replace the bolts and replace ties if required to secure the bottom of the backrest upholstery.

Step 3 above is more complicated for wheelchair users without active trunk muscles, e.g. spinal cord injury or those with neurological disease such as Multiple Sclerosis.

Seat angle considerations on page 6 above caution against having a flat/zero degree seat angle. Back height is arguably less important than seat angle for people without active trunk muscles. Setting up a high backrest height with a flat seat may do little to prevent pelvic and spinal deformities.

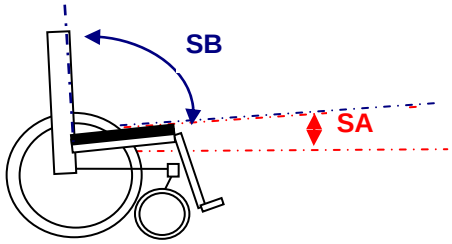
To prevent or delay deformity with a low back height requires:

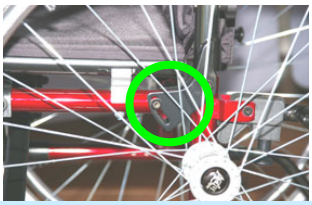
- Pelvis must remain upright, thighs well supported by a positive seat angle and a contoured or well conforming cushion. This resists the tendency of the pelvis to ride forward into posterior pelvic tilt
- Trunk supported vertical or as close to vertical as possible, up to height of lower ribs

This locks the pelvis at the rear of seat, encourages reach / function and weight bearing through middle thighs (Hastings 2003). The user needs sufficient hip flexion to use this posture – refer to the separate guide: **Deciding what seating support will be of most benefit**

Changing Seat to Back Angle (SB opposite)

Seat to back angle is considered together with backrest height and seat angle above. Some wheelchairs come as standard with an adjustable seat to back angle; others may have this as an option on the order form when first obtaining the wheelchair – examples below and right





4 mechanisms to change seat to back angle: bolt in slot (above left), pivot join in back cane (above right), eccentric bolt (below left), pin in slot (below right)

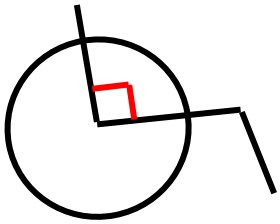
2 mechanisms to change seat to back angle on power wheelchairs: pivot join (left); hand wheel (below)

What seat to back angle will suit long duration sitting in a wheelchair?

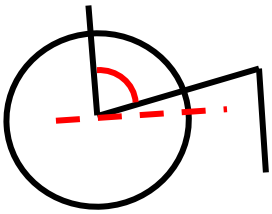
A seat to back angle of **90 degrees or less** may help inhibit strong muscle tone or spasm

- Check ability to tolerate this position
  - enough **hip flexibility** to avoid the pelvis sitting forward
  - user can keep chest and head upright for the duration of wheelchair use
- Better tolerated with low back heights or a positive seat angle of 7.5 degrees or more, to resist the pelvis sliding forward
- < 90 degrees has been advocated for wheelchair users with strong tone who cannot shuffle back to recover upright pelvis at the back of the seat, combined with a backrest as close to vertical as possible (Hastings 2003). Check footplates are low enough so the thighs are under load – if footrest is too high, this can increase the risk of pressure injury to skin over the buttocks / ischial tuberosities.

90 deg seat to back angle



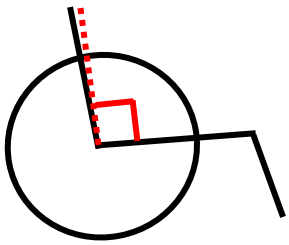
<90 deg seat to back angle, ~75 deg shown below



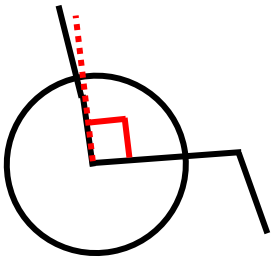
A seat to back angle of **95 degrees**

- provides an upright posture similar to a regular dining or office chair – may be better tolerated if the user relaxes, spends all day in wheelchair
- better suited to back heights up to the base of shoulder blades and above
- many designs feature backrest canes providing angles closer to 90 degrees at pelvic to mid back height, then with a “mid-height bend” providing an angle of 95 degrees or greater.

95 deg seat to back angle with straight back canes



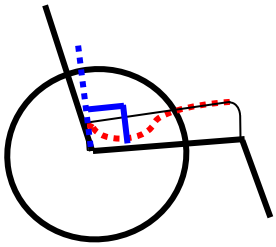
~95 deg seat to back angle with bent back canes



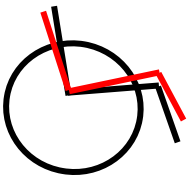
A seat to back angle of **100+degrees**

- may be required when the pelvis is fixed in rearward tilt (i.e. the user lacks hip flexion range)
- If fixed open hip/pelvic angles must be accommodated, a contoured seat or seat that conforms well under the pelvis, plus a pelvic strap is often needed to retain the pelvis at the back of seat

100+ deg seat to back angle with contoured or conforming cushion



- If the user continues to slide forward with a 100+ degree seat to back angle, it may be necessary to use a chair that allows the seat and backrest to tilt back. 15 degrees of rearward seat tilt is a sensible upper limit – gravity helps hold the user back in the seat. Too much rearward tilt forces the user to adopt a head forward posture to look ahead.



Avoid tilt > 15 degrees to hold the user back in seat. Head forward posture can result from the eyes horizontal head righting reflex ➔curved spine / kyphosis

Seat to back angle – using a different backrest style

Most standard folding frame manual wheelchairs do not come standard with adjustable seat to back angle but the angle can be changed using accessories:

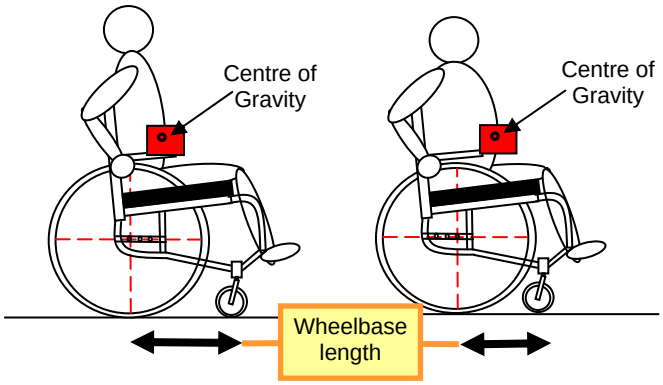
- **Adjustable tension backrest upholstery**: slacken off in the thoracic (rib cage) area and tighten in the lumbar area to promote normal spinal curves
- **Accessory backrest with angle adjustment** can often be set with up to 15 degrees of recline using mounting hardware supplied

After all changes to seat height and angle, backrest height and angle are complete, **check that the footrest height is correct** – refer page 3

Rear Wheel Position (MWCs) or Seat Position (some PWCs)

This adjustment influences the distribution of the user's weight between front castors and rear wheels:

- When most of the user's weight is distributed / carried by the rear wheels, the easier it is to push the chair – large wheels have less **rolling resistance** than small castors. Also, the shorter **wheelbase length** is easier to turn, being more manoeuvreable
- The **centre of gravity** of a wheelchair user can be calculated with mathematical models to be in a position close to the front of the abdomen / umbilicus. With a larger abdominal mass, the centre of gravity is further forward, placing more user weight on the front castors, making the chair harder to push. If the rear wheels are moved forward, the distance between the centre of gravity and rear wheel axle is shorter and the chair becomes easier to push
- BUT as centre of gravity gets closer to the rear wheel axle, then the chair is easier to tip over backwards. If rear wheels are too far forward for **balance skills** of the user, the chair is at risk of tipping over backwards when reaching overhead or going up a ramp / slope.



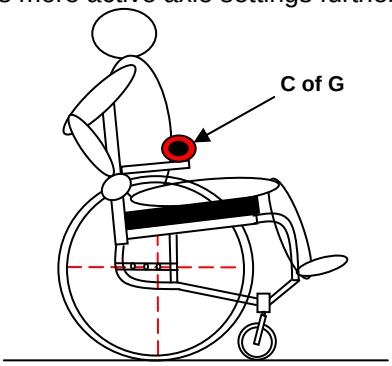
Aim:

- To adjust for the stability needs and balance skills of the user, aiming for maximum efficiency and manoeuvrability (i.e. for manual wheelchairs and some self propelled mobile shower commodes)
- To provide a stable safe power wheelchair that drives with minimal rocking or tipping

Balance Skills and Centre of Gravity (C of G)

Wheelchair users have different balance skills and needs, examples:

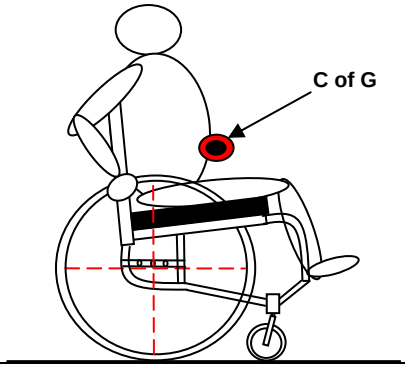
A. A wheelchair user with active abdominal muscles, can wheelie and lean forward if chair tips back – trials more active axle settings further forward



B. Double above knee amputee, inactive for long period prior to surgery – needs extra stability in manual wheelchair, amputee axle setting

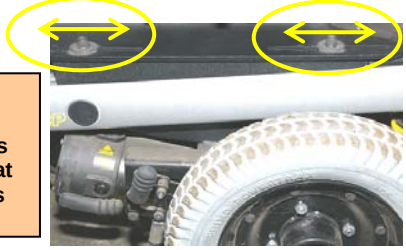
Example B: Amputee axle, behind rear frame uprights

C. 45yo with T6 complete spinal injury, slow to develop balance skills at first; starts with axle at rear; gains weight and develops wheelie skills over time, then moves axle forward



D. A power wheelchair user with both legs amputated well above knee level (i.e no weight on front of seat or legrests) has chair with heavy batteries at rear. Moves seat forward on wheelbase to stop tipping backwards on slopes

Example D PWC with adjustable seat position – 2 bolts each side to move seat forwards / backwards over wheelbase



Adjusting Rear Wheel Position – Manual Wheelchairs

1. Turn wheelchair upside down on a bench or table

2. Remove wheels, so that the axle mount tube and nuts are clear. If the wheels are bolted on, loosen the nuts on inside ends of both axles – you may need to hold the outside end of the axle with a socket wrench, or it may have a slotted screwdriver fitting or another way to stop the wheel turning so the nut can be loosened and removed

Bolt on axles: Spanner used to loosen nut inside end of axle

Bolt on axles: Socket wrench or slotted screwdriver used to hold outside end of axle

3. Once the wheels are removed, loosen nuts on axle mount tube. Two spanners may be necessary, or, if the axle mount tube is flat-sided (i.e. designed to not rotate in the slot), 1 spanner can be used

   - If the axle mount tube slides in a continuous slot, loosen and slide to the desired location. More recent products have an indexed axle plate, enabling small increments of adjustment and checking both sides are the same
   - If the axle mount tube must go into separate holes, remove the nuts and move to the desired hole
   - Secure the nuts on the axle mount tightly

4. Replace 1 wheel for a moment to check where the wheel locks should be approximately - often the wheel cannot be repositioned until wheel locks are moved. Loosen brakes and slide to new position

Flat sided axle tube, 1 spanner to loosen and adjust in slotted axle plate

Detailed view of indexed axle plate – small increments of adjustment possible

Axle mounting plate with separate holes

5. Replace wheels into the axle mount tubes. With bolt on wheels, tighten nuts on both rear wheel axles. Make sure the wheels spin freely – nuts are too tight if the wheel spins slowly or only briefly. Also check there is no side play by pulling and pushing on the hub / centre of the wheel – it is too loose if the wheel moves from side to side

Push / pull on centre of wheel hub to check for side play

6. Now position the brakes/wheel locks so they will stop the chair for transfers. Move the brake, align with centre of tyre then tighten at the new position. The amount of braking force required for transfers will vary for different wheelchair users:
   - e.g.1 very strong braking for a user with full paralysis of the lower body and some trunk muscle; does not stand to transfer
   - e.g.2 lighter braking force may be suitable for a user who can stand to transfer and has some standing balance
   - For a wheelchair user who has difficulty applying wheel locks with strong braking force but needs a very stable chair, consider wheel lock extension handles.

Wheel lock adjusted for strong braking force

Wheel lock extension handle, removable for transfers

Adjusting Rear Wheel Position – Mobile Shower Commode

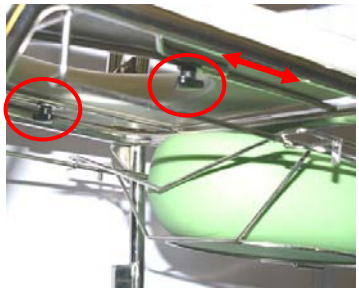
On some self propelled MSCs the rear wheel can be re-positioned for propulsion and / or to suit the balance needs of the user – refer to page 11 for further background information.

The process is similar to manual wheelchairs above, removing bolt on wheels, then mount in a new position.

- A hub cap may conceal the outside end of the axle. Pop this off to get a socket wrench to hold the end of the axle
- Avoid over-tightening the axle – the wheel should spin freely
- Avoid leaving the wheel too loose – there should be no side play when you pull / push on the centre of the wheel hub
- The brakes / wheel locks must be re-positioned to provide sufficient braking force to stop the chair when the user transfers.

Mobile Shower Commode Seat Position

On some models of MSC the seat can be moved along the frame to align the aperture in the seat with toilet, or to align the sit bones (ischial tuberosities) within the seat aperture. The latter may be an important pressure relief strategy to prevent pressure ulcers in people who sit for extended periods on the MSC



- Loosen hand wheels to allow seat to slide
- Move to position required
- Secure hand wheels tightly.

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