

1 The Smart Wheelchair: An Introduction

What is the Smart Wheelchair?

The Smart Wheelchair is an electric wheelchair with a computer-based controller and special sensors which help the wheelchair pilot in three different ways:

- Firstly, the Smart systems provide some safeguards for riders who cannot control the wheelchair completely independently. The special bumpers and sensors do not make the wheelchair completely safe though - responsibility for safety still lies with the pilot and his or her helpers and carers.
- Secondly, the Smarts can help the rider control the wheelchair by taking over some of the responsibility for steering and avoiding objects until he or she is ready to handle the job. The amount of work that the rider chooses to do, and how much control is taken by the chair is decided by the rider and his or her carers.

This division of labour can range from:

1. (at one extreme) total driver control of the wheelchair through the controls in the normal way, to
 2. (at the other extreme) allowing the wheelchair to decide where it is going, with the rider merely demanding when to move, and steering and stopping being controlled by the wheelchair.
- The wheelchair can also integrate with communication aids and computers; the pilot can use the same controls to drive the wheelchair and operate another assistive device, or even use the communication aid or computer to drive the wheelchair directly. This same system also allows you to put the control of the wheelchair into the care of smarter computers than the internal one it carries round with it, although we won't be describing this aspect in any detail here.

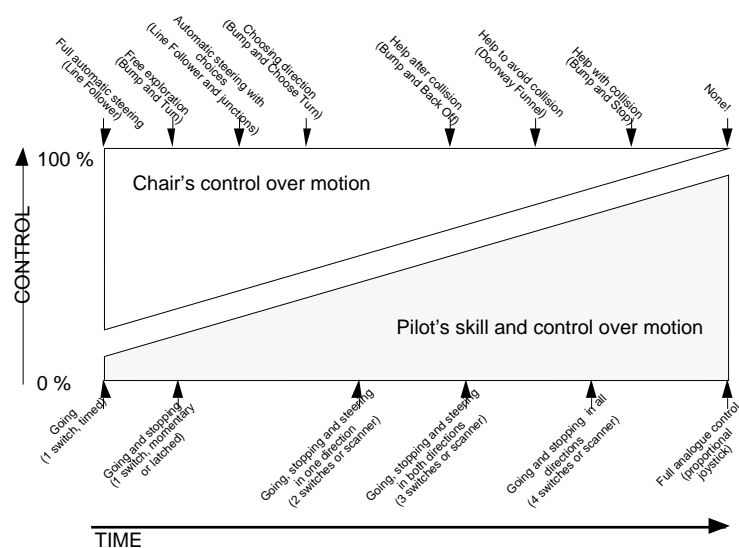
What the Wheelchair does

Mobility is fun, exciting and motivating. Being able to move opens up new opportunities for play and exploration. Mobile children and adults are more curious, active, assertive, and learn more effectively. People with very severe physical, communication, sensory or learning difficulties have even more to gain from powered mobility because they have very few other ways to demonstrate their individuality, and experience control. Yet controlling a powered wheelchair is hard for many people with severe disabilities. The Smart Wheelchair was therefore designed with several beliefs in mind:

- (1) When you are learning a new and difficult task, it helps to be able to share some of the load with someone or something else. In this case, your partner is the wheelchair.
- (2) Some skills which you might use for communication purposes (such as switching and tracking) shouldn't have to be relearned for mobility purposes, and vice versa.
- (3) It should be possible to progress gently from simpler to more complex tasks as your skill level increases.

You can think of the wheelchair as an assistant which can take some of the load from you whilst you are learning to drive or communicate and which makes it simpler to transfer skills from one task to another. *You and the wheelchair share the work.* How much each of you does is up to you: you can change your mind and take more control yourself, or decide to hand over more responsibility to the wheelchair at any time.

The diagram below shows how the pilot uses the chair's facilities to gradually develop better driving skills whilst reducing the amount of control taken by the chair itself.



Who's running this thing anyway

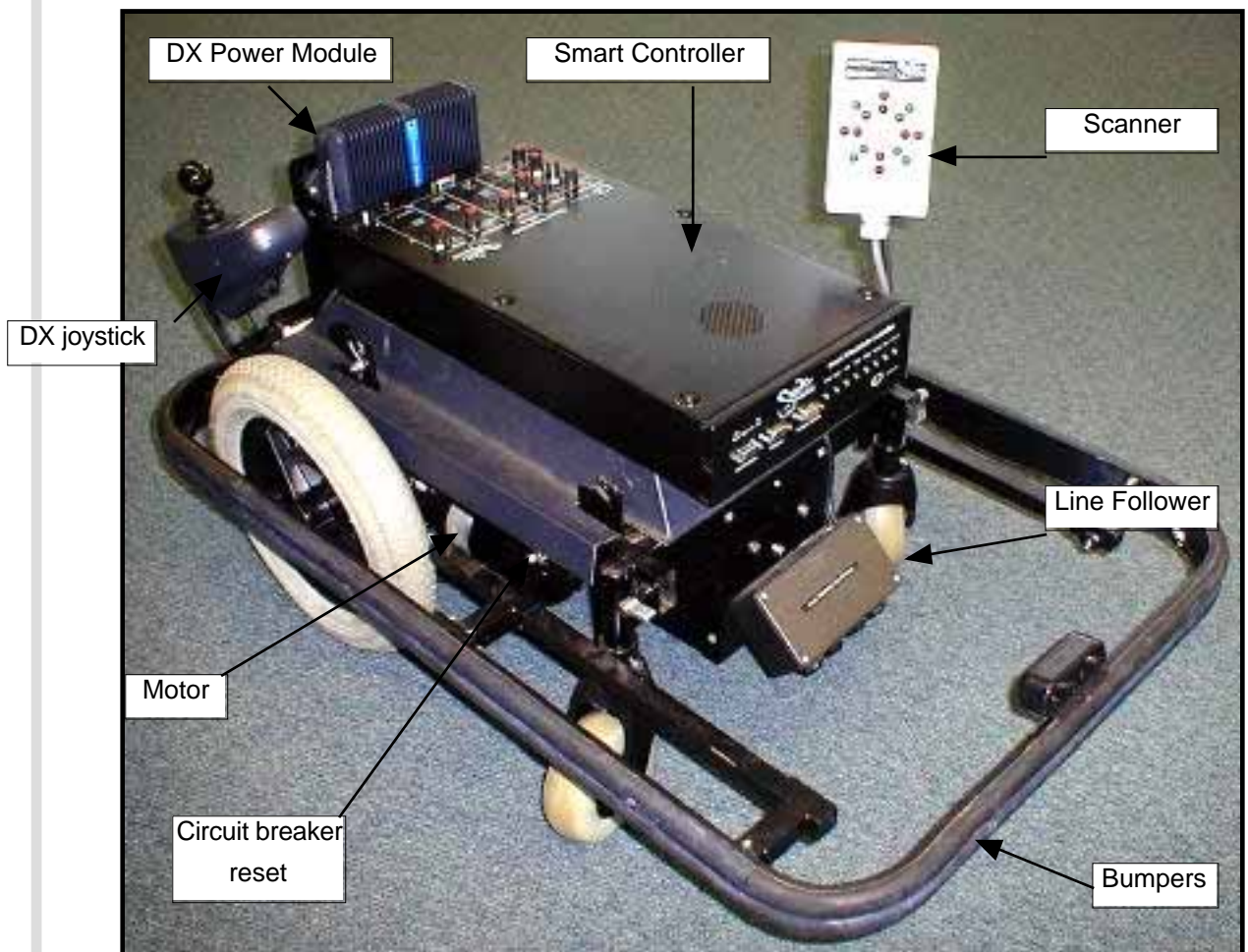
What sort of work might you share? When you're driving a powered wheelchair there are several decisions to be made and tasks to be performed. You have to decide *where* you want to go, and *what* sequence of movements must be made in order to get there. To actually make these movements, you must be able to *start*, *stop* and *steer* the wheelchair. You might also have to try to avoid unexpected obstacles or get out of trouble if you do collide with them. The wheelchair is able to help with some of the more simple tasks to do with moving or dealing with collisions. The central idea is that you can concentrate on learning and practising one task while the wheelchair takes care of another. For example, you might want the wheelchair to deal with bumps, or guide you from room to room, while you get on with the important things like deciding when to move.



2 The Smart Wheelchair: A Description

The Smart Wheelchair

Let's have a guided tour of the wheelchair chassis with the footplates removed:



The Smart Wheelchair consists of the:

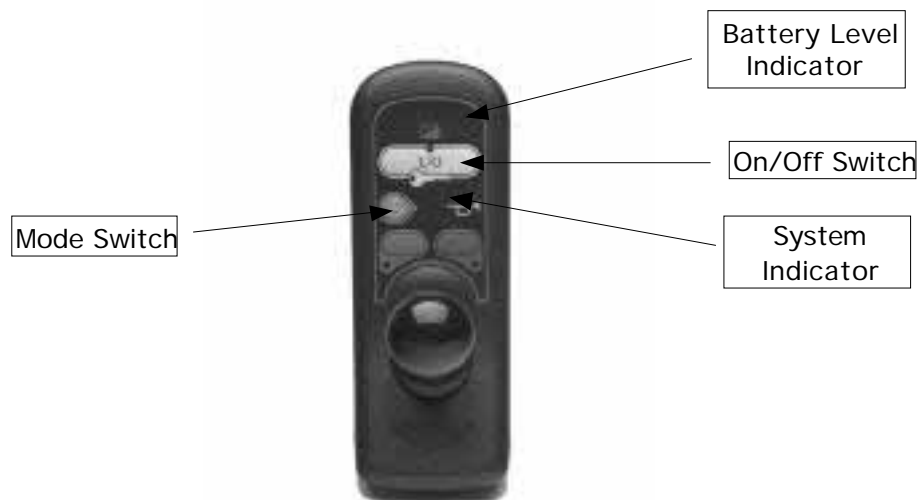
- wheelchair chassis
- 'DX Power Module', which drives the wheels
- 'DX joystick', which can be used by a helper to drive the chair
- Smart Wheelchair Controller, which contains the computer that controls the system
- Bumpers
- Line Follower
- Scanner

The Smart Controller, Power Module and Controls

Underneath the seat and on top of the battery box is the Smart Wheelchair Controller, and the Control Dynamics DX Power Module. There will also be a Control Dynamics joystick, which is usually mounted on the back of the user's seat. The joystick and the Smart Controller are both DX 'modules', that send signals along the 'DX bus' to the Power Module. The Power Module converts the signals into high current outputs for driving the two motors. The DX Power Module is fully programmable to cater for a wide range of chair types and user needs. Correct installation and programming are essential to ensure optimum performance and safety. The Power Module has been pre-programmed for the Smart Wheelchair chassis and electronics: these settings must not be changed. Any adjustments to speeds and other options must be made using the Smart Wheelchair programming options, described in Section 5.

The joystick allows the chair to be driven by a helper or attendant. The joystick and Smart Wheelchair Controller **MUST** be connected to the Power Module for correct operation of the Smart Wheelchair.

The main wheelchair off/on switch is the large white oblong pad towards the top of the joystick. You press it once to turn the chair on and then press it again to turn the chair off.



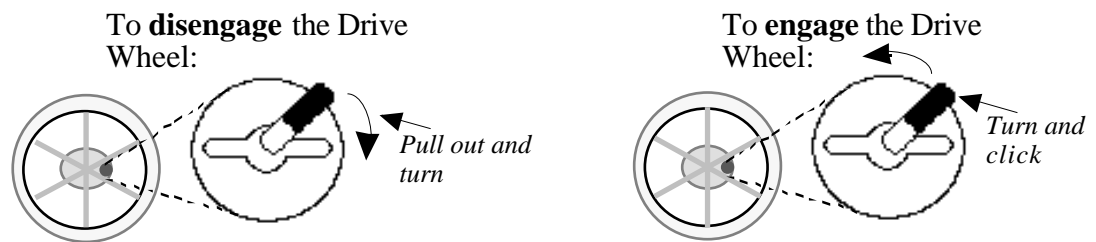
The blue Mode button switches control of the chair between the joystick and the Smart Controller. To drive the chair with the joystick press the mode button till the Mode indicator reads 2; to switch back to driving with the Smart Controller press the Mode button again so that the indicator reads 1.

NOTE: The Smart Wheelchair sensors and systems (Bumpers, Line Follower etc.) do not operate when the chair is driven with the joystick.

The Drive Wheels

The **Drive Wheels** must be engaged in order for the chair to be driven by the motors - similarly, disengaging the wheels enables the wheelchair to be pushed. To engage and disengage the wheels, pull out the red lever in the centre of the drive wheels.

The rear wheels have pneumatic tyres: keep those pumped up to the correct pressure.



Seating

The wheelchair seat can be removed by pressing down the two catches at the rear mounts, and tipping the seat forward and lifting it off. Putting it back is just the reverse. Make sure the rear seat latches lock the seat in position.

Battery Charging

The battery charge level is indicated by a set of six lights at the top of the joystick.

With a fully charged battery, all six lights light up. As the battery voltage drops, the green then yellow, then red lights go out. When the two red lights only are flashing, there is approximately 10% of battery capacity left and the battery should be charged.

If the chair is used all day, every day, charge the batteries overnight, every night.

If you use the chair for short periods every day, charge it once or twice a week.

Even if you don't use the chair for a while, you should charge the batteries at least once a month.

To charge the batteries, plug the charger into the socket on the front of the joystick, then plug the charger into the mains electricity socket. **Only use the charger supplied with the chair - using a different charger may damage the batteries and/or the charger.** The batteries should be charged in a well ventilated area as the batteries may emit gas. prevent flames and sparks.

Switch on the mains and the three lights on the charger will come on briefly while the charger tests itself. The Smart Wheelchair will also switch on - if you want you can switch it off with the on/off switch on the joystick and the batteries will still charge.

The red **Mains On** lamp on the charger will light, and the yellow **Charging** indicator will light to show the battery is connected correctly and being charged. When the battery is about 80% fully charged, the Charging light will start to flash; when the green **Float/Standby** indicator comes on, the battery is fully charged and ready for use. Switch off and unplug from the mains before disconnecting the charger from the joystick.

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Smart Wheelchair Controller

Smart Wheelchair Control Box

The Smart Wheelchair Controller is the large black unit which sits on top of the wheelchair chassis. The Control Dynamics DX Power Module (PM) that drives the motors sits underneath the Smart Controller at the rear. The Smart Wheelchair Controller contains the 'brains' of the wheelchair, together with the speech synthesiser, the switch and control connectors, and the 'ToolBox' for selecting the various wheelchair functions. A Dynamics joystick is also provided for attendant control (see section 2).

Switching On and Off

To switch the wheelchair on, press the power button on the Joystick and select Mode 1. If the system is functioning properly, the green indicator on the joystick will be on, and the green light on the Smart Wheelchair Controller will come on. If the speech is switched on, the wheelchair will also talk. Once this has happened the Smart Wheelchair is ready to drive.

If the green light on the Smart Wheelchair Controller starts to flash when you switch on, don't panic. If the light is flashing **once** a second this means the Smart Wheelchair is in programming mode - turn programming mode off with the *Program* switch on the ToolBox. Flashing **twice** a second indicates that a bumper is stuck on, which may mean the bumpers need adjustment (see bump tools section on bumper adjustment). If after adjusting the bumpers you still get a stuck indication contact Smile Rehab. In this condition the chair will still operate but you will not be able to use the Bump Tools and they should be turned off on the ToolBox. Both of the above conditions are reported by the Speech if you have it switched on.

If the green indicator on the Joystick starts to flash when you power on it means the DX Power Module has detected a fault in the system. See Section 12 for a description of what the DX 'flash codes' mean. If a DX fault is shown, first switch the chair off, wait five seconds, and then switch on again. If it still flashes go through the trouble-shooting in section 12 and if you cannot find the fault, contact Smile Rehab.

The chair switches itself off

The DX Power Module and joystick, and the Smart Controller are continually checking their own internal operation. If they discover anything wrong, they shut down the system, on the grounds that it is better to be safe than sorry. The red light on the Smart Wheelchair

Controller will come on and/or the green indicator on the attendant Joystick will start flashing. If this happens try switching the power on again as normal. If the chair immediately switches itself off again, go through the trouble-shooting procedure and if you cannot find the fault, contact Smile Rehab.

‘Ok, so what do I do now’

Setting up the Smart Wheelchair for your own particular tasks involves making some decisions. We think about tackling tasks using tools. Both of you (that is the wheelchair and you) has a bag of tools which you can choose to use for a particular task.

To make the wheelchair start, stop and change direction, the driver needs to be able to instruct and communicate with the chair - we’ve called the things to do this **User Tools** and they include switches, joysticks, computers, scanning displays, or communication aids. User tools are connected to the chair via the sockets on the front panel (for switches and Scanner), or via the ‘RS232’ socket at the back of the box.

The chair’s own sensing systems such as the bumpers and line follower are called **System Tools**. The Line Sensors plug into the front panel, while the Bumpers connect to the rear and both are set up with the switches on the **ToolBox**.

Let’s plug in a user tool first and see what happens.

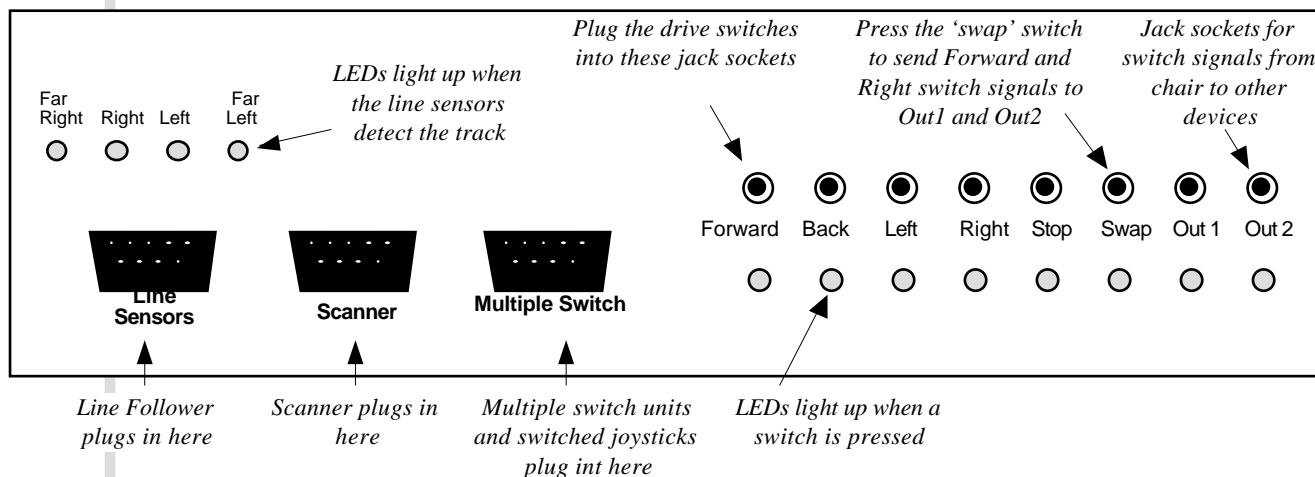
4 Driving the chair with switches

Types of switches

You can drive the Smart Wheelchair with almost any switch, provided it has a jack plug on the end. Switches can be operated by hand, head, finger, foot, elbow, tongue, breathing in and out, touch, sound. In most cases Smile Rehab or CALL will have recommended and supplied particular switches but as the driver's skills develop you may want to introduce new switches, or try different arrangements. This is particularly true where the Smart Wheelchair is being shared between several pilots. The chair has been specifically designed so that relatively 'non-technical' people can connect and try out different types of switches easily: to connect a switch, you simply plug it into the socket for the direction you want to move.

Connecting switches

Ordinary single switches plug into the 3.5mm 'jack' sockets on the SwitchBox at the front of the Smart Controller. Multiple switches or switched joysticks (e.g. TASH 5-way switch, Dudley Heavy Duty joystick) connect to the 'Multiple switch' plug.



The SwitchBox Front Panel

Select the driving tool you want and plug it in. The wheelchair immediately knows that you have chosen the tool and will attend to its demands. So, for example, we will suppose that you want to control the wheelchair using a simple 'Buddy Button' or 'Jelly Bean' switch as a forward control. Get the switch mounted on the wheelchair in a position that will allow you to

control it and plug it in to the *Forward* socket. The wheelchair now presumes that you want to control its starting and stopping and is ready to obey you immediately.

But say all you want to do is to make the chair go and leave the chair to look after the stopping itself. This is when you choose another set of user tools to do just that, called **Motion Tools**. These are to be found on a separate box called the **ToolBox**, which we'll look at in the next section.

Choosing switches

can be a hard, complex process. Don't expect to get it right first time. When assessing for controls for the Smart chair, we aim for a control scheme which is:

- *accurate*: ideally, the user should be able to start and stop motion accurately;
- *safe*: the switch should not be activated by accident;
- *extendible*: although you may start with only one switch, you will be hoping the user will develop use of several switches, or a scanning selector;
- *understandable*: there should be a clear link between the switch and the result, at least in the early stages. Some children with learning difficulties simply do not understand, even after lots of practice, how the small movements of a conventional proportional joystick can cause quite large movements of the chair. However, we have found that such children may learn how to drive using *separate* switches for forward, back, left or right, or using a gated, switched joystick, where the cause and effect is clearer.
- *accessible*: obviously, the control should be accessible to the driver. Less obviously, it should still be accessible when the wheelchair is moving and the driver shifting around in the seat, and ideally the rider should be able to operate the control without having to search for it.

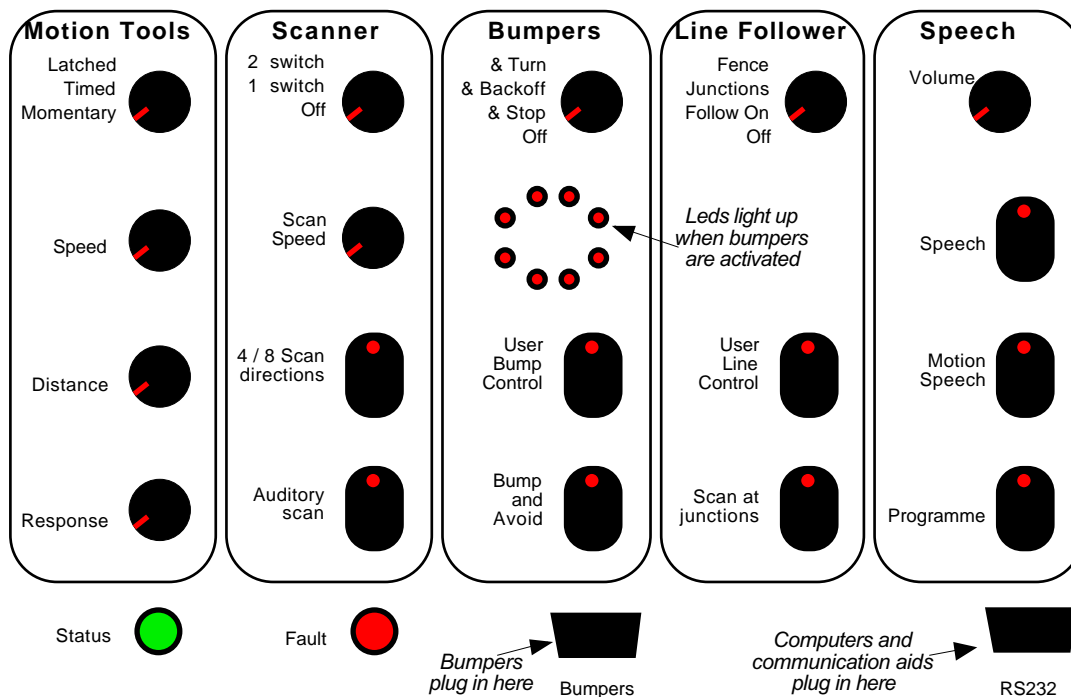
Switch Connectors

Single switches 3.5 mm jack sockets, Barrel 0v common, Tip signal

Multiple switch 9 pin 'D' plug	Pin	Action
	1	Forward
	2	Back
	3	Left
	4	Right
	5	Swap
	6	Stop
	7	Out 1
	8	0v common
	9	Out 2

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Smart Wheelchair ToolBox



The **ToolBox** is used to make Tool selections and adjustments to the Smart Wheelchair. The function of each tool is described in the later sections of the handbook.

Adjusting Speed

The Speed control sets the overall speeds for the Smart Wheelchair. It 'scales' all the other individual speeds (like forward/back, rotation, speed reversing from collisions etc etc). With the pointer in the middle the scale is 1, i.e. all speeds are unchanged. Fully anti-clockwise divides the speeds by 2, and fully clockwise multiplies by 2.

Adjusting Distance

The Distance control sets the overall distances moved by the Smart Wheelchair for Timed moves, and when backing off and turning away from an obstacle. Again, it 'scales' all the individual distances. With the pointer in the middle the scale is 1, i.e. all distances are as programmed. Fully anti-clockwise divides the distances by 2, and fully clockwise multiplies by 2.

Adjust

The Response knob controls acceleration and deceleration for the Smart Wheelchair. It also 'scales' the maximum forward/backward acceleration/deceleration, and turn acceleration/deceleration. To increase acceleration as programmed; turn it fully anti-clockwise to divide the response time to multiply by 2.

Using the programme switch on the ToolBox

The Smart Wheelchair 'Speed', 'Response' and 'Distance' knobs set overall values. If you want, you can set individual quantities (for example, forward/backward speed, bump reverse distance etc) separately using the 'Programme' switch on the ToolBox. After setting these individual values, the Speed, Response and Distance knobs 'scale' them up or down. Values are remembered after you switch the power off.

The overall procedure for programming is the same whatever is being adjusted:

1. Switch Programming on - the Observer will say 'Program mode on' and the green light will flash.
2. Set Motion Tools to *Momentary*, Bump, Line and Scan Tools *off*.
3. Select the tool whose settings you want to adjust, with the appropriate Tool switch(es).
4. Adjust the setting using the Speed, Distance or Response control.
5. Press and release the appropriate switch to fix the setting.
6. Switch Programming off - synthesiser will say 'Program mode off' and the green light will go back on.
7. Turn the Tool switches and Speed, Distance and Response controls knob back to where they were before you started programming.

The sections below describe how the various parameters can be set. Often you will never need to change the standard settings, but some individuals and environments may need special control or tool arrangements. To avoid having to repeat these instructions throughout the rest of the Manual, we'll use a table like the one below to show the setting to be adjusted, the Control knob which adjusts it, the Tool switches which define it, and the switch which sets the value.

The example below shows how to set individual straightline and rotation speeds. For example, to set straightline speed, you would:

1. Turn Programming On.
2. Select Momentary motion tool.
3. Adjust the Speed knob up or down as required
4. Press and release the forward switch to fix the setting.
5. Turn Programming Off.
6. Turn all controls and tool switches back to where they were before.

The parameter to be adjusted

Which of the three Control knobs - Speed, Response or Distance - are used to set the parameter

Parameter	User Switch	Control knob	Motion Tool	Bump Tool	Line Tool	Scan Tool
Straightline speed	Forward	Speed	Momentary	None	None	None
Rotation speed	Right	Speed	Momentary	None	None	None

Press and release this switch to fix the parameter to the value set by the Control knob

Tool switch setting

Summary table for programming Smart Wheelchair values

Programming Speeds

The Programming switch can be used to set straightline (forward and back) and rotation (turn left and right) speeds individually (see the table below).

Parameter	User Switch	Control knob	Motion Tool	Bump Tool	Line Tool	Scan Tool
Forward speed	Forward	Speed	Momentary	None	None	None
Back speed	Back	Speed	Momentary	None	None	None
Rotation speed	Right	Speed	Momentary	None	None	None

Programming Veer

One of the most common problems with electric wheelchairs, particularly when driving with switches, is getting them to go in a straight line. Sticky castors, uneven weight distribution, sloping surfaces, and unbalanced motors all cause the chair to veer to left or right instead of going straight forwards. You can adjust the Smart Controller to compensate for these imbalances by using the programming switch.

Parameter	User Switch	Control knob	Motion Tool	Bump Tool	Line Tool	Scan Tool
Adjust veer	Left	Speed	Momentary	None	None	None

For veer adjustment, the Speed control acts like a 'balance' knob - set it in the mid position (12 o'clock) for zero compensation, turn anti-clockwise to make the chair veer left, and

clockwise to veer right. Press and release the *Left* switch to set the value. Test the straightline accuracy by lining the chair up on flat ground, with the castors pointing forwards, then press a forward switch. If the chair veers off within a few metres, try adjusting the veer to compensate.

Programming Distance for 'Timed' motion

The overall Distance of the chair is set with the Distance control on the ToolBox. It scales all the individual distances by +/- 75%. Individual distances can be set using the programming switch as shown below. The maximum distance that can be set is 5m.

Parameter	User Switch	Control knob	Motion Tool	Bump Tool	Line Tool	Scan Tool
Forward distance	Forward	Distance	Timed	None	None	None
Back distance	Back	Distance	Timed	None	None	None
Rotation distance	Right	Distance	Timed	None	None	None

Programming chair response

The overall chair response is set with the Response control on the Smart Controller. It controls the acceleration and deceleration of the chair. Turn it anticlockwise to make the chair accelerate and decelerate faster. Turn it clockwise to make it slower. Again, it scales all the other factors, from a divide-by-2 to a multiply-by-2. Individual responses can be set using the programming switch as shown below.

Parameter	User Switch	Control knob	Motion Tool	Bump Tool	Line Tool	Scan Tool
Straightline acceleration	Forward	Response	Latched	None	None	None
Straightline deceleration	Back	Response	Latched	None	None	None
Rotational acceleration	Right	Response	Latched	None	None	None
Rotational deceleration	Left	Response	Latched	None	None	None

Programming switch response

Some people with tremor or other difficulties may hit the switch by mistake. The **input acceptance time** sets the minimum time that the switch must be held on, before the chair accepts it. Some people will hit the switch several times by mistake, after first operating it. These extra activations can be rejected by increasing the **post acceptance delay**.

Parameter	User Switch	Control knob	Motion Tool	Bump Tool	Line Tool	Scan Tool
Input acceptance time	Stop	Response	Momentary	None	None	None
Post acceptance delay	Stop	Response	Timed	None	None	None

Resetting default values

On delivery the Smart Wheelchair comes set up with default values for all the programmable parameters. If at any time you want to reset the chair back to these default settings: switch the chair off, plug switches into the *Back* and *Stop* sockets, hold them on, then turn the chair on. The Observer will report “Resetting tools and default values”.

Muting Tool speech feedback

You can stop the wheelchair reporting the tool selections when you make changes with the ToolBox. To do this, hold down the *Stop* switch when you turn the power on.

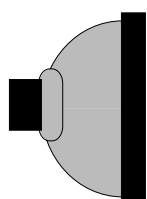
Software version

Like all computer-controlled equipment, the Smart Wheelchair software program is continually being improved and developed. When a new version is completed, Smile Rehab will contact you to arrange an upgrade. To find out which version you have, hold down the *Forward* and *Stop* switches while you power up, and the speech synthesiser will tell you (provided the speech is switched on).



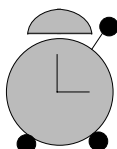
Motion Tools

The rotary switch on the ToolBox labelled **Motion Tools** is used to select the switch action:



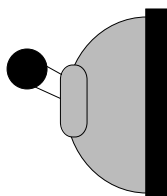
Momentary:

go whilst I press the button, and stop when I release it: like operating a doorbell,



Timed:

go when I press the button; and keep going for a fixed time - set by the *Distance* control



Latched:

go when I press the button, and stop when I press it a second time, or when I press the *Stop* switch - like turning on a house light

Characteristics and functions of Motion Tools

Momentary

Momentary control gives the majority of drivers most accurate control over starting and stopping. It also gives clear cause and effect when driving - the chair moves when the switch is pressed, and stops when the switch is released. However, momentary control does require the pilot to maintain the switch closure, and release it with good timing, so some children may find it difficult to manage, or fatiguing.

Timed

Timed Control is often useful when introducing children to the Smart chair for the first time, because the child just has to activate the switch, and the chair stops itself. It lets the child gain maximum mobility for minimum effort, and once the chair is moving, the child is free to experience the movement without having to worry about stopping the chair. The disadvantage of timed control is that the driver does not have control over stopping (unless a separate switch is used, plugged into the *Stop* socket).

Latched

Latched control is for drivers who can accurately activate a switch, but cannot hold the switch on. Cause and effect of latched control is slightly more complex, since the switch has two opposite effects. We have found that few drivers use Latched turning, so we recommend that the rotation Motion Tool is re-programmed to be timed or momentary (see next section).

Selecting separate go and turn Motion Tools

Usually, all switches use the same Motion Tool. However, it is possible to set up different motion tools for turning, than for going forward and back. For example, a useful arrangement for pilots who can only operate one switch at a time is *Latched Forward* motion, and *Momentary steering* - the driver can press the Forward switch to start moving, and then briefly press each turn switch to adjust the direction as he or she drives along.

Once the Motion Tool for turning is programmed, it stays that way until you program it to a different tool, or 'de-program' it. The Motion Tool switch then acts only on Forward/Back motion - if you program turning to be Momentary say, then it stays Momentary whether you then select Momentary, Timed, or Latched for the Forward/Back motion. If you want the Motion Tool switch to control rotational motion again, you must 'de-program' the turn Motion Tool.

Use the Programming Switch to set the turning motion tool: flick the Bump Control switch down, to *User*, hold down the *Right* switch, select the Motion Tool with the Motion Tool switch, and then release the *Right* switch.

To 'de-program' the rotation Motion Tool, switch Programming ON, set Bump Control to *User*, then press and release the *Left* switch.

(We know that setting the Bump Control switch to *User* does not make much sense, for selecting motion tools, but we have run out of options! If you have any suggestions which make more sense, please tell us!)

Parameter	Tool Switch	User Switch	Control knob	Motion Tool	Bump Tool	Line Tool	Scan Tool
Program Rotation motion tool	Bump Control set to USER	Right	-	Select Momentary, timed or latched	None	None	None
'De-program' Rotation Motion Tool	Bump Control set to USER	Left	-	-	None	None	None

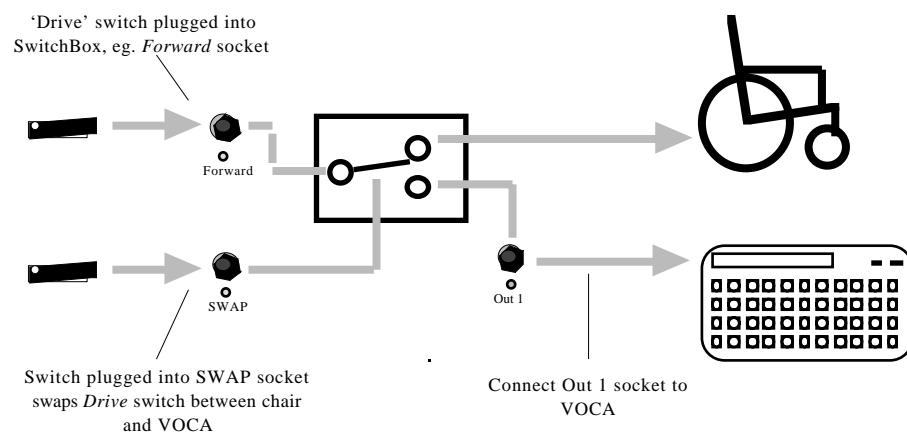
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Integrating a computer or communication device to the chair

There are two ways in which you can control and integrate a laptop computer or communication aid with the Smart Wheelchair. Either you can connect the computer or VOCA to the 'RS232' socket, and drive the chair from the VOCA; or you can use the separate 'Switch output sockets' on the SwitchBox to send the switch signals to the chair, or to the VOCA.

Using the switch output sockets

By adding an extra 'Swap' switch you can swap the signals from the *Forward* and *Right* input switches between the Smart chair, and a switch-operated computer or VOCA.



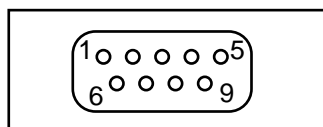
Using a Swap switch to control the chair and VOCA with the same switch

Plug your 'Swap' switch (the one you are going to use to swap the switch signals between the chair and the VOCA) into the *Swap* socket on the SwitchBox. Then plug lead(s) from the *Out 1* and/or *Out 2* sockets into the VOCA. When you press and release the *Swap* switch, the *Forward* and *Right* switches will be connected to the VOCA and operate it; when you press and release the *Swap* switch again, they will drive the chair as normal.

On pressing the *Swap* switch the speech synthesiser will report that you are using the *Out* sockets and if the Scanner is connected all the Red lights will come on. When you operate the *Swap* switch again (to drive the chair) the speech synthesiser will report this and the Scanner lights will go off.

Driving the chair with a computer or communication aid

You can connect a laptop computer or communication aid to the Smart Controller, via the RS232 socket. This is wired up like a PC 'COM' connector as shown below, so you should be able to use a standard RS232 serial cable to connect your computer/VOCA to the chair.



9 way D type plug

Pin 2: Rx (Input to chair)
Pin 3: Tx (Output from chair)
Pin 5: GND

The chair transmits and receives RS232 data at:

9600 baud, 8 data bits, 1 stop bit, no parity, with XON/XOFF handshaking.

Sending commands to the chair

The table below gives the current set of commands which you can use to drive the Smart chair. The commands consist of letters followed by a full stop: to make the chair move forward, for example, you would send '!f.'; to stop '!s.'; and so on. We are currently adding new commands which will let you use your computer or communication aid to programme the chair to move a set distance, switch Tools on and off, and programme speeds and distances.

Command	Action
!f	move Forward
!b	move Back
!l	move Left
!r	move Right
!fl	move Forward and Right
!fr	move Forward and left
!bl	move Back and right
!br	move Back and left
!s	stop

If you want more information about driving the chair from a particular computer or communication aid, contact the CALL Centre. We can provide information on driving the chair using *Clicker* and other switch access programs on PC; using speech recognition programs; and using communication aids such as the *DynaVox*.



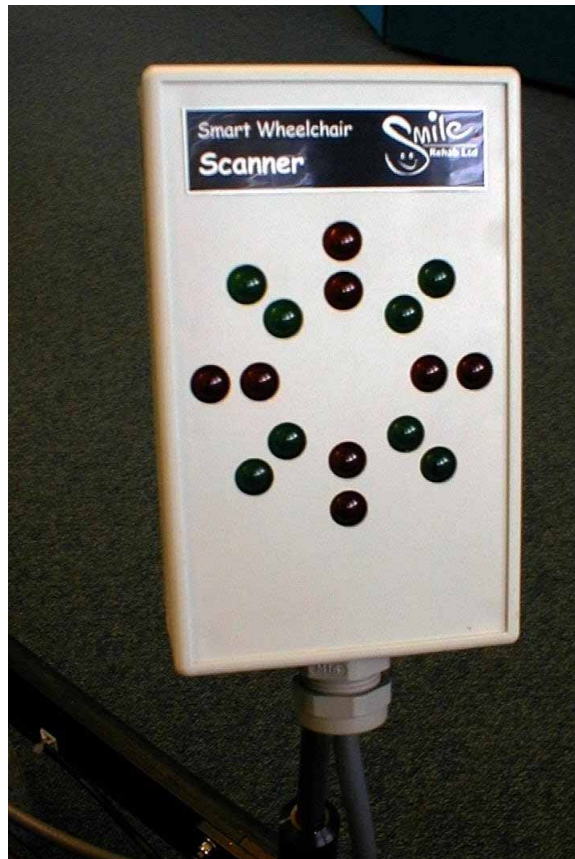


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Driving with the Scanner

The Scanner box

The Scanner is a small unit with 8 pairs of Leds which correspond to each of the 8 directions the chair moves.



Smart Wheelchair Scanner

The Scanner must obviously be mounted so that the wheelchair driver can see it. The Scanner is supplied with a bracket for attaching it to a wheelchair tray, or it can be positioned using a proprietary mounting systems such as the Universal Switch Mount, Mighty Mount, the Slim Armstrong, the QED 'Mobilia' or Techess 'Daessy' system. Smile Rehab can supply clamps and poles if necessary. The Scanner plugs into the Scanner socket on the SwitchBox.

Function of the Scanner and Scan LEDs

The Scanner and Scan Leds (Led stands for 'light emitting diode') do three things:

1. They can give visual confirmation of the direction the chair is currently moving (a visual 'Observer'): for example, if "forward" is selected the "forward" Led lights up. See Section 11.4 for a description of this visual feedback.
2. They can present choices of possible direction at Track Junctions, or after collisions. This is done in two ways:

For children using several switches to drive the chair directly, the available directions (say, forward and left at a line junction) light up, and the pilot presses the appropriate switch (in this example, the left or forward switch) to make a choice. Section 11.4 describes this further.

For children using one or two switches and scanning, the available choices are illuminated one at a time - and the child presses a switch when the one they want is lit. See 11.5 for how to switch on this 'Scanning Control'.

3. The Scanner can give full control over all directions of motion, for children who can only operate one or two switches. Each of the 8 directions (forward, back, left, right, and those in between - forward-right, back-left, etc) light up in turn, and the pilot selects the direction by pressing a switch. Driving with the Scanner is described in 11.5.

Scan LEDs

Some children may find the Scanner lights too abstract for giving feedback or choices: they may have difficulty relating the forward direction, say, to the top lights on the Scanner box. The Scan Leds are separate lights which can be connected in place of the ordinary scanner. Then the lights are positioned far apart, perhaps inside large coloured cardboard arrows, so that the relationship between the light and direction is clearer.

Similarly, children using switches to drive the chair directly might find it easier to understand if the Scan Led is positioned beside, or actually inside, each control switch. Instead of the scanner, you can plug in up to eight separate Leds for each of the eight directions. In practice, you might just want to plug in four Leds and attach them to separate switches.

Separate Leds are available from Smile Rehab, or you can make up your own, according to the instructions given below.

Scanner 9 pin 'D' socket	Pin	Direction		
	1	Right		<p>One or two LEDs can be connected.</p> <p>The LEDs are driven by a +12v source, via a 470R resistor inside the Smart Controller.</p> <p>There is no need to use another resistor unless you want to use low current LEDs.</p>
	2	Back/right		
	3	Back		
	4	Back/left		
	5	Left		
	6	Forward/left		
	7	Forward		
	8	0v common		
	9	Forward/right		

Many children will have difficulty with the concept of left and right etc, so it can be helpful to colour code the switches and Leds, and attach meaningful symbols to them. You might use:

- Green switch for GO Forward
- Red switch for RIGHT turn
- Yellow switch for LEFT turn
- Blue switch for BACK

Green, red and yellow Leds are readily available in sizes from 3mm to 20 mm (the ones in the Scanner are 10mm). Blue Leds are less common and are only available in 3 or 5mm sizes. You can buy Leds from electronic suppliers like MPS or CPC (see Section 13).

Visual feedback using the Scanner and Scan LEDs

Motion indication

When the chair moves, the appropriate Led direction indicator lights up. This can be especially useful with Latched Control.

Choices at Line Junctions

With Bump and Choose turn, when the chair hits an obstacle to the front, it stops, and will not let you go forward again - only

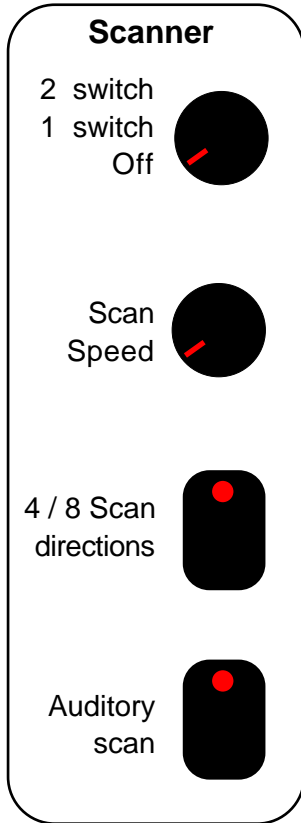
The Scanner or Scan Leds indicate the left, right, or back Leds. The pilot uses the switches to drive off in any of these directions. Similarly, choices to turn with Bump and Choose turn are given using the Scanner/Scan Leds.

Choices at Line Junctions

If the chair finds a line junction, say to the left, it stops and lights up the left and forward Leds to indicate these are the possible choices. The driver presses the left or the forward switch to choose the track to follow.

Note: here, we are talking about using the Leds to reinforce choices, for children using *several* switches to drive the chair *directly*. If you want these choices to be *scanned*, see below.

Scanner Tools



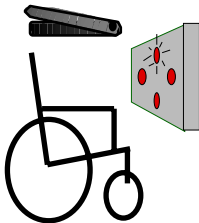
Use the Scan Tools controls on the ToolBox to select scanning control and either one or two switch scan.

The Scan speed can be altered with the speed control.

The scanner can either scan through 4 or 8 directions.

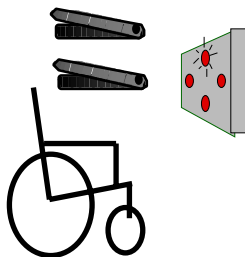
And choices can be offered using speech, as well as with the Scanner lights.

One switch scan



Plug your 'Drive' switch into the *Forward* socket. Press and release the switch to start the scan, then press the switch when the required direction lights. The chosen direction will stay on while the chair is moving (according to the motion tool chosen). When the chair stops, press the switch to start the Scanner again at the beginning. If no direction is selected after 3 cycles round, the scanner stops until the switch is pressed again. The Scan Speed and number of scan cycles are adjustable (see below).

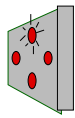
Two switch scan



Plug the 'Drive' switch into the *Forward* socket, and the 'Scan' switch into the *Right* socket. Press and release the Scan switch to light up each direction in turn until you get the one you want, then press the Drive switch to move in that direction. If the Scan switch is held down, the Scanner scans at the speed set by the Scan Speed control. Movement is controlled with the selected Motion Tool.

4 / 8 direction scan

8



4

You can scan either 4 or 8 directions.

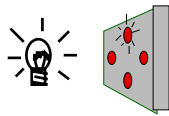
4 directions

Pilots who need a slow scan speed may choose to select from 4 rather than 8 directions.

8 directions

Driving with 8 directions is much easier than with only 4, provided the pilot can control the Scanner accurately.

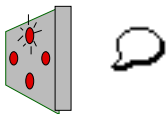
Smart Scan



This scanning approach is for good scanning users and gives them better control of the chair as they are driving.

With both the Latched and Timed modes, moving forward or back the driver is offered momentary control. The nudge left/right are on momentary control and stops when you release the switch.

Auditory scan



With auditory scan, the speech synthesiser will speak out the choices as they are offered. This can be helpful for visually impaired pilots, or to help teach driving direction vocabulary.

Setting Scan speed

The scan speed is set by turning the Scan speed knob on the Toolbox.

Setting number of scan cycles

This setting controls the number of times the scanner cycles round, before it stops and waits for another switch press. Use the Programming Switch, set Single Switch Scan, turn the Scan Speed knob to select the number of Scan Cycles, then press and release the *Right* switch.

Parameter	User Switch	Control knob	Motion Tool	Bump Tool	Line Tool	Scan Tool
Number of scan cycles	Right	-	-	None	None	Single Switch Scan and set cycles with Scan Speed control

Three-switch scan

Three switch scan operates like two-switch, except that a third switch plugged into *Left* lets the driver scan anti-clockwise as well as clockwise.

Three Switch Smart scan

With three switch Smart Scan, the two turn switches act like momentary turn switches if the chair is moving but if it is stopped, they scan the display. It's a lot more intuitive than it sounds and control. To turn Three Switch Smart Scan on or off, use the Programming Double Switch scan and set Smart Scan ON, press and release the *Forward* or the *Back* Switch to turn it off, then switch Programming off.

Parameter	User Switch	Control knob	Tool	Line Tool	Scan Tool
3 switch Smart Scan ON	Forward	-	-	None	Double Switch and Smart Scan ON
3 switch Smart Scan OFF	Back	-	-	None	Double Switch and Smart Scan ON