

## **Chapter 9**

# **Switches**

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## 9.1 Introduction

### What is a switch?

A switch is a device for making an electrical connection between two contacts. With some switches (such as keys on a keyboard), you press the switch and it is *on* until you release the switch: these are called *momentary* switches. Other switches (such as push-buttons on audio equipment) ‘latch’ or ‘toggle’ from *off* to *on*, and then from *on* to *off*, each time you press and release the switch.

### How do I plug a switch into the computer to scan?

To plug a switch into the computer you need an interface box. Different programs and computers use different types of interfaces: see Chapter 11 and Chapter 12 for more information on switch interfaces.

### What kinds of switches are there?

There are many different types of switches available and popular switches from a range of manufacturers and distributors are listed throughout this chapter. The tables are not a firm recommendation to buy these particular items but rather a starting point for comparing prices and specifications. You should get catalogues from the suppliers in Table 9-1 below and others from the manufacturers listed in Chapter 11 and Chapter 12.

**Table 9-1 Suppliers of switches**

SUPPLIERS OF SWITCHES	
QED	A huge range of switches, mountings, interfaces, communication aids and mobility aids, including the popular TASH range, Mobilia mounts, and the CALL Smart Wheelchair.
CAC (Cambridge Adaptive Communication)	CAC sell the Chameleon PC-based communication aids and distribute switches made by TASH and Ken Ketteridge.
TFH	The Fun & Achievement catalogue lists a good range of contact and non-contact switches, together with interfaces and battery powered adapted toys.
Liberator	UK and European distributors of the PRC (Minspeak) communication aids and the Ablenet range of switches and interfaces.
Inclusive Technology	Software and alternative keyboards and pointing devices for children with special educational needs; also Ablenet distributors.
SEMERC	Software and alternative keyboards and pointing devices for children with special educational needs; also Ablenet distributors.
Don Johnston	Distributors of Don Johnston software (Discover, etc.), as well as Ablenet and their own range of switches.

There are several comprehensive references about switches. *Communication and Access to Computer Technology* (Barrett & Herriotts, 1995) has an up-to-date section on switches currently available in the UK. The *Handbook of Adaptive Switches and Augmentative Communication Devices* (George & Lacefield, 1994) is a comprehensive guide which contains technical data (dimensions, operating force and travel etc) although it only covers North American devices and manufacturers such as TASH and Ablenet.

## 9.2 Contact, Hit and Target Switches

Contact switches need the user to make physical contact with the switch – by touching, pressing, squeezing etc. Contact switches are the most common type of switches because they are easy to manufacture and use. Most contact switches are *target* switches (see below) where the user has to reach and touch or press the switch to operate it. You can also have contact switches where you don't have to move or reach to target it – like a *grasp* switch, which you squeeze with your hand, for example.

Figure 9-1 *Big Red, Jelly Bean, Specs, Buddy Button and Ultimate switches*



Most contact switches give *feedback* when they have been operated – perhaps an audible click or a beep. This feedback can make the switch easier to use because the user (and teacher or therapist) can tell when the switch is being activated.

Many mechanical switches also have a spring inside which gives some 'feel' when the user presses on it (like the accelerator pedal on a car), and this can help the operator find and use the switch. People with cerebral palsy often have poor proprioception (i.e. they cannot tell easily what their limbs are doing, or where they are, without looking at them): good tactile and audible feedback can help the user know when the switch operates without having to look at it.

Contact switches can be operated by head, hand, arm, knee, foot, leg, shoulder, etc. – whichever part of the body can be controlled most accurately. Relevant factors to think about when choosing contact switches are:

- size
- pressure needed to operate the switch
- travel i.e. how much (if at all) the switch moves before it operates
- feedback whether the switch moves, by how much, does it give a click, can you feel the switch as it activates

All of these affect how well a particular contact switch works for a particular individual. A pupil with very limited power might be best with a switch which needs only a light touch and pushed a small distance, while another with poor proprioception might be helped with a very clunky switch with lots of travel and feedback.

### Hitting the Target

The majority of switches available are mounted on a tray or table or with a mounting pole (see 9.7 *How is the Switch Mounted?*) and are then pressed, kicked, butted etc. – the user must 'hit the target' to make them work. (Some target switches are non-contact proximity switches, i.e. you still have to target on something, but you may not need to actually touch it). To use them the pupil must be able to hit the target consistently and accurately, with good timing. Choosing a suitable switch is a compromise: if the target is too small the user cannot hit it; if it's too big, it may get hit accidentally.

Some pupils have a lot of difficulty lifting their hand up and then lowering it to hit the switch. They may be better with a switch mounted vertically on a table, so that they can slide their hands sideways

along the table to press the switch. Or a flat switch mounted flush with the table surface (e.g. a touch switch) may let them use small wrist rotation movements to activate the switch without gross movements. A joystick switch might be better for those who tend to ‘scrabble’ but have good control once they are grasping (see 9.4 *Joystick Switches*).

Table 9-2 A selection of target/hit switches

A SELECTION OF TARGET/HIT SWITCHES	Description	Price Guide	Supplier
QED lever switches	Rectangular switches with good tactile and audible feedback. Micro, mini, standard and heavy duty sizes. Operating pressures from 30g to 350g.	£ 25	QED
TASH Buddy Button	Robust round switches in a range of colours, 65mm, 200g force.	£29	CAC, QED
TASH Big Buddy	Bigger robust round switches in a range of colours, 115 mm, 150 g force.	£29	CAC, QED
Ablenet Specs switch	Small round 35mm diameter switch, suitable for mounting on tray or head rest.	£35	Semerc, Liberator. Inclusive.
Ablenet Jelly Bean	Robust, round plastic switches, 65mm, 90 g. force. Range of colours.	£35	Semerc, Liberator. Inclusive.
Ablenet Big Red Switch	Also Big Yellow, Big Blue, etc. Bigger robust switches, 130mm, 150 g. force.	£35	Liberator
TFH Mini switch	Small wooden switch with very light touch.	£ 19.50	TFH
Adaptech Taction pads (plus Linkswitch)	Touch sensitive, flexible switches; can be stuck to all sorts of surfaces eg. trays, cups, toys etc. Require linkswitch adapter.	£14 (£68)	QED
Adaptech Pal Pad	Very light touch flat switches. 34g force.	£30	QED
Ultimate Switch	Useful switch suitable for head/arm/elbow use; flexible and light touch, mounted on gooseneck.	~ £50	Enabling Devices

## 9.3 Non-contact Switches

Non-contact switches work by detecting movements (e.g. tilting arm or head, making a sound, breaking a beam of light) or proximity of body parts, so there is no target to aim for (and miss). Often, these switches are attached to the user’s body: when the user’s body part moves, so does the switch.

Non-contact switches can detect gross movements (e.g. a flailing arm, which has little hope of hitting a contact target switch accurately), or very small movements (such as eye-blinking). So a *squeeze* switch might be useful for a person with good hand grasp but poor gross arm control which precludes a target switch. A *mercury switch* could detect when the child’s arm or head is raised; a *sound switch* can respond to a sound or voice; a *piezo switch* detects very small muscle movements; a *sip-puff* switch responds to breath.

Non-contact switches can be technically more difficult to set up, more obtrusive (since they are usually attached to the body), and can be less intuitive, than contact switches. Once a person has learned the movement which operates the switch, though, they can be faster to operate because the user does not need to look for the target to operate it. Because there may be no obvious reference or tactile feedback when the switch is on or off, there may be a bigger cognitive, perceptual and physical load. If the switch doesn’t beep or indicate when it’s on, adding an extra feedback box can help confirm when the switch activates.

Table 9-3 Popular non-contact switches and feedback boxes

POPULAR NON-CONTACT SWITCHES	Description	Price Guide	Supplier
Suck-puff switch	Switch operated by mouth or breath, by sipping and puffing	£150	QED
Mercury tilt switch	Small switch which can be worn on headbands, etc. to detect arm, leg, head being raised	£22	QED
Sound-operated switch	Switch activated by sound or speech	£98	TFH
Magic Eye beam-break switch	Switch which detects the light from a torch – break the beam to activate the switch	£80	TFH
Toby Churchill Eye-Blink switch	Switch mounted on spectacle frame which operates by blinking the eye	£276	QED
TASH Grasp switch	Switch which is held in the hand and squeezed to operate	£85	CAC, QED
Audible Feedback Unit	Provides an audible click when the switch is activated – with lead to connect onto toys/computers	£38	QED
Switch Reaction Tester	Gives visual and audible indication of switch activation – for assessment only as it has no output lead to connect to other equipment	£38	QED

## 9.4 Joystick Switches

Switched joysticks can be useful for some children with athetoid cerebral palsy who have difficulty targeting on hit switches. They may be able to grasp and lock on to the handle of the joystick, and then, once stabilised, use arm movement to push or pull the joystick. Switched joysticks are available as single switches (e.g. push only), double switches (e.g. push and pull), three-way or four-way switches (push forward, pull back, left and right).

Table 9-4 Some joystick switches

SOME JOYSTICK SWITCHES	Description	Price Guide	Supplier
Push-pull switch	Large wooden lever switch	£45	TFH
Special-Ed joystick	Popular and robust 4-way joystick for use with Acorn computers	£94	QED
TASH Mini joystick	Miniature un-gated joystick switch; light operation and flexible shaft	£192	QED

## 9.5 Switch Connections

Most switches have a cable with a jack plug on the end, and most toys and interfaces have corresponding jack sockets into which you plug the switch. There are two sizes: quarter inch (0.25) big jacks and 3.5 mm (half the size of quarter inch) small jacks. Quarter-inch were common on UK equipment for many years but increasingly switches are being supplied with the smaller 3.5 mm size. If you want to plug a big jack into a small socket, or vice versa, you can buy wee adapters (QED £2, MPS 60p., Tandy £1.49). Over time, as plugs are pushed in and out, we have found the connections with these adapters becomes unreliable, so we recommend adapters with short cables and a plug at one end and a socket at the other. Only Ablenet provide such adapters, but you can improvise by making your own or buying and adapting extension leads.

Table 9-5 Switch adapters

SWITCH ADAPTERS	Description	Price Guide	Supplier
0.25" jack socket to 3.5mm jack plug	Converts from large to small jacks	60p - £2	MPS, Tandy, QED
3.5mm jack socket to 0.25" jack plug	Converts from small to large jacks	60p - £2	MPS, Tandy, QED
Pigtailable adapters	Jack adapter cables	£7	Liberator

## 9.6 'Release-to-select' Switches

Some children find it easier to lift their hand *off* a switch to operate it, than target and press *onto* the switch. Most switches are *off* until you press or activate them, and then they turn *on*. Release to select switches work the opposite way: with a target switch, you rest on the switch and take your hand *off* to operate it; with a squeeze switch, you *release* the switch to turn it on.

If you need this sort of control for a scanner the best way is to select *UserScan*, where the switch is pressed and held down to scan, and then released to make the selection. There are also a few release to select switches available or you can use a switch inverter box to convert the signal of an ordinary switch, which you can use with an *AutoScan* scanning method.

Table 9-6 'Press for off' switches

'RELEASE TO SELECT' SWITCHES	Description	Price Guide	Supplier
QED 'normally on' lever switches	'Normally on' versions of standard QED lever switches	from £25	QED
Inverter module	Inverts the signal from any switch	about £20	Enabling Devices

## 9.7 How is the Switch Mounted?

Target/contact switches need to be placed in a reliable position so that the child can hit them. Non-target switches can be more straightforward to mount since they are often attached to the user's body by velcro, straps etc. Ideally, the position of any switch should not change so that with practice, the user no longer needs to look to see where the switch is in order to hit it. Switches can be mounted on a wheelchair tray, a table, or in a specific location using a specially designed mounting arm.

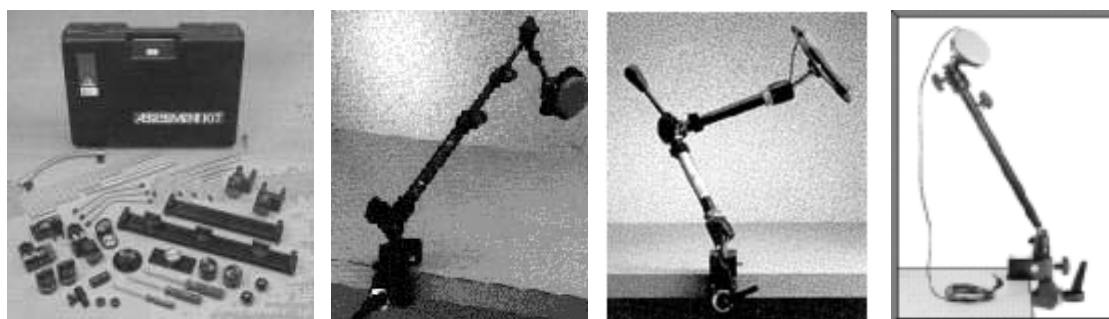
Some switches have screw holes or flanges for bolting the switch to the table or tray. Rolls of self-adhesive Velcro loops and hooks are available from distributors such as QED and electronic component suppliers such as RS Components and MPS. A particularly useful assessment tool is to glue sheets of Velcro loop (available from makers of custom display board) on the tray so that switches can be located in different positions easily. Or you can buy a ready-made *Maxess* tray with velcro covering and mounts to position switches at different angles from SEMERC. Different types of heavy duty velcro-type fixings are also available from QED and Liberator, for pupils with less controlled movements who can dislodge standard velcro mounts.

If you want to locate switches in space to be operated by head, chin, knee, foot, arm or other body part you need some sort of adjustable mounting. The *Magic Arm*, *Slim Armstrong*, *Mighty Mount* and *Daedelus* devices are clamps with adjustable poles which you can use to mount switches in precise positions. These are useful for assessment purposes but they are relatively expensive. The *Mobilia* range of clamps, poles, joints and mounting brackets can be used to position switches, cameras, communications aids, cups and other items. Setting up a switch with *Mobilia* equipment can be slightly more complicated than using a single adjustable pole because of the variety of different clamps, poles and joints, but the end result is usually cheaper. *Toys for Special Children* have a large range of inexpensive and effective poles and clamps: they do not have a UK distributor but you can

order and pay by credit card. CAC and FCD are closer to hand and will make up custom clamps and poles to your specification.

You can also make up your own switch mounts from wood or uPVC piping – the *AAC Assessment Resource* (Goosens & Crain 1986) has instructions and diagrams on building home-made switch mounts.

**Figure 9-2 Mobilia, Slim Armstrong, Universal and Mighty Mount switch mountings**



Once you have used an adjustable mounting system to establish the best switch position, it can be helpful to take a note of exactly how the set-up works, for the benefit of others. Photographs and checklists attached to the pupil's wheelchair are practical methods for making sure that the switch is in the right place and that it is attached to the technology with the correct interfaces.

**Table 9-7 Switch mounting systems**

SWITCH MOUNTS	Description	Price Guide	Supplier
Mobilia system	Very flexible mounting kit, with clamps, poles, goosenecks, switch, cup holders, etc. Various kits for wheelchair/table mounting	e.g. £79 for switch mount; £42 for clamp	QED
Mighty Mount	Extendable mount for switches, clamp for wheelchairs or tables	£99	CAC, QED
Slim Armstrong system	Extendable, rotating mounting arm for switches, wheelchair or table clamp. Range of mounting plates.	£153 complete; £30 for clamp	Liberator
Ablenet Universal mounting system	Quick and easy adjustable mounting arm, wheelchair, or table clamp. Different mounting plates for different devices.	£185 complete, £30 for clamp	Liberator, Semerc, Inclusive Tech.
TASH switch mountings	Range of clamps and tubes for switch mounting	e.g. £45 for clamp & tube	CAC
FCD Switch mountings	FCD can make up switch mountings to order	POA	FCD
TSC Switch mounting hardware	Wide range of inexpensive but effective clamps, poles, goosenecks, switch mounting plates, adapters	e.g. £16 for clamp; £7 for 12" gooseneck	Enabling Devices
Maxess tray	52 x 27.5cm tray with loop Velcro covering. Mounting blocks enable switches to be mounted at 45° or 90°	£30 for tray; £14 - £19 for mounts	SEMERC
Velcro hook & loop	1m lengths of self-adhesive velcro hooks and loops	£1.10 per m	MPS

## 9.8 Choosing Switches and Switch Sites

Sometimes it's obvious which switch and switch site is best, but more often it's not at all clear. With many pupils, their skills change dramatically after they start with a switch because using it develops motor patterns which they have never had to use before. So they get good at it very quickly, and this means the switch may be changed: as accuracy improves a smaller one can be used; or it can be placed closer to the body; or more switches can be added to give more control options. The user's muscle tone may change from day to day, or from hour to hour, so the position of the switch may need to be altered to compensate.

When we consider switches and switch sites, we bear several things in mind.

- **Speed, accuracy and timing.** We want switches which the user can operate quickly, when they want to, consistently, and reliably.
- **Fatigue.** If the user is liable to tire easily, the switches should be physically easy to operate: this may mean it's easy to hit (see accuracy, above), has a light touch (small operating pressure), or is close to the body part which operates it so the user can make minimal movements.

### Case Box

Susie is 6 years of age and has mixed athetoid/spastic cerebral palsy. She has low tone, but can raise and lower both hands. She could not exert sufficient pressure to operate either a Jelly Bean or Buddy Button (operating force 150 - 200g.) whereas she could activate a QED sub-miniature lever switch (operating force 40g). The lever design also meant she could rest her hand on the hinge end, and use wrist flexion to press the switch.

- **Function.** Choice of switch depends on function. A switch used with an *Auto Scan* system (where the highlighter is moved along automatically) will not be activated a lot but it must be hit at exactly the right time otherwise the wrong thing gets selected. With a two switch *User Scan*, the user presses and holds one switch to scan along, releases it to stop the scan, then hits a second switch to select. So the pupil needs to press the Scan switch more often and release it at the right time, but there can be less tension and stress since the scan is controlled by the pupil. A switch used for Morse Code will be activated quickly and repeatedly and so must be very easy to activate and involve minimal effort.
- **Understanding.** Target switches with lots of feedback are easier to understand for a pupil with learning difficulties. The number of switches and type of scan can also be important. Some switches have dead areas where the switch does not operate and these may be confusing for users with learning difficulties. A 'lever' switch, for example, has a hinge at one end and the micro-switch is at the other end so pressing on the hinge will not activate the micro-switch
- **Switch characteristics.** Other factors about the switch to bear in mind are:
  - size and shape;
  - operating pressure (how much force is required to press it);
  - travel (how far it must be moved – if at all – before it activates);
  - feedback (e.g. 'click' when operated, travel, operating pressure) to let the user know when the switch has been activated successfully.

## 9.9 Switch Evaluation Procedure

Assessing for switches and controls is a complex process and only the basics are covered here: see the references for more information. Caroline Gray's *Helping Switch Users to Access Technology* (Gray, 1997) is an interactive CD-ROM training resource which gives a particularly useful illustration of the issues and techniques involved with switch evaluation and provision.

### Consider other options

Make sure that scanning or encoding is really what you want and that you have considered other potential access methods which may be easier or faster – see *Chapter 2 Assessment for Special Access*, *Chapter 3 Accessing the Keyboard* and the point and click access section in *Chapter 7 Introducing On-screen Keyboards*.

### Get help from other professionals

Advice from an occupational therapist, physiotherapist and experienced rehabilitation technician or engineer is helpful when considering switches, not only when deciding on which body part or movement to use, but also to ensure that the user is seated and positioned well to operate the switch.

### Ensure functional seating and positioning

Before looking at switches or controls ensure that the pupil is seated and stabilized properly: it is really hard to hit a switch at exactly the right time if your limbs are flying around and you are having to concentrate on stopping falling out of your seat.

### Identify potential switch sites and movements

Then consider which parts of the body offer the best possibilities for reliable control. There is a more or less generally agreed order of priority for investigating switch sites (Fraser et al, 1994, Beukelman & Mirenda, 1992) beginning with the hands and ending with the foot. *Figure 9-3 Switch Evaluation chart* gives the body sites in order of priority.

If you are new to switches and assessment, it may be appropriate to test every possible switch site in the table to ensure that you cover all the possibilities (*maximal* assessment – see Chapter 2). As you gain experience you will probably adopt a pragmatic approach – if satisfactory switch control is achieved using the hand, for example, there may be little point in looking at knee or foot control (*decision-tree* assessment).

Often there are several switch movements and sites which might work. How do we compare or evaluate them? In Chapter 9 we noted that different scanning and encoding methods demand different control skills so it can be helpful to compile a short-list of potential sites and assess the level of control for each movement. Once we have an idea of how each site and switch performs, we can choose the most suitable access method to match the switch site(s).

Beukelman & Mirenda (1992) identify six skill components of switch control:

- **waiting** the user must wait for the right time to operate the switch
- **activating** the user must activate the switch or switches
- **holding** the switch must be held down
- **releasing** the switch must be released
- **waiting** the user must wait again
- **reactivating** and then activate the switch once more

## Evaluate Potential Switch Sites and Movements

If you are trying to find a set-up for a particular individual, it is not particularly sensible to try and measure each of these skills in isolation (i.e. without a switch or something controlled by the switch).

One approach is to use a scanning or encoding program which you know well, contains interesting and motivating activities, and which has a wide range of quick and easy scan methods and adjustments. You may choose to create an activity using a scanning on-screen keyboard program to operate games or other programs, or you can use a program with scanning built in: fun, switch-operated programs are available from suppliers such as Inclusive Technology, SEMERC, Wigit Software, Don Johnston, Crick Computing, and others.

If you do not have access to a computer, Beukelman & Mirenda recommend a practical technique (which also has the advantage of being cheap, quick and portable) which uses the switch to operate a tape recorder or battery-powered toy. Switch skills are tested for each potential switch site simply by asking the user to operate the device in different ways: “*Don't play yet...okay, play it now...stop...play it again..*” Most tape recorders have a REM (remote) socket: plug the switch into the REM socket (you may need an adapter to convert the switch jack plug to a smaller 2.5mm plug for the REM socket), press *Play*, and when the switch is pressed the recorder will operate.

Whichever method you use, it is important to evaluate the effort and relative accuracy of each switch site (on a scale from 0 to 5, say, where 0 is ‘impossible’ and 5 is ‘consistent’).

As you test each site record the results on a chart such as the one in Figure 9-3 (modified from Cook & Hussey (1995, p. 358) and Beukelman & Mirenda (1992, p. 128).

Figure 9-3 Switch Evaluation chart

Switch site	Switch type & position	Wait	Activate	Release	Re-activate	Physical Effort	Sensory demands	Cognitive demands
Fingers (Left/right)								
Hand (Left/right)								
Arm (Left/right)								
Shoulder (Left/right)								
Head turn (Left/right)								
Head								
Head lower/chin								
Other head motion								
Knee (Left/right)								
Foot (Left/right)								
Suck-puff								
Sound								

## Evaluating finger control

Some people have low muscle tone and low power (as a result of spastic cerebral palsy or muscular dystrophy, for example), such that they have some finger movements but little hand or arm movement. Small, light touch switches such as the *Specs*, *QED micro-lever* and various TASH switches are worth trying, with wrist rests to support the user's hand. Some people may find it easier to rest a finger on the switch and then raise the finger off it to operate it ('release to select'), rather than the more usual 'press to select' operation. There are a few **Release to Select** switches available; many programs and devices have built-in switch 'inverter' facilities; or there are adapters which can convert the signal (see '*Release to Select*' earlier in this chapter). With an ordinary switch and scanning system, use a '*Userscan*' method where the switch is released to stop the scan and select an item.

Some users have uncontrolled gross arm movements, but fine finger control. Target switches mounted on a tray or mount are unlikely to be successful, but it may be possible to position a switch on the hand or wrist so that it is activated by finger movement, regardless of the position of the hand in space, for example by using:

- a TASH thumb switch is grasped in the hand and operated by thumb
- another method is to use plasizote or a similar material to mould a wrist splint with extension over a controlled finger and then locate a microswitch, or a touch-sensitive switch such as a Taction Pad so that it is activated when the finger is extended.

## Evaluating hand control

There are a large number of switches that can be accessed by hand, and a range of different physical movements which may be employed. Ideally, the movement should involve minimal arm movement to reduce fatigue and the chances of missing the target – if the user has to employ a wild athetoid movement to hit the switch, think again because it is unlikely that the movement and switch site will be suitable for scanning or encoding. Again, using wrist rests, splints or grab bars to stabilize the wrist and arm may improve function. Some athetoid users will extend when raising an arm to target a switch and may find it easier to *slide* the hand across the tray to activate a vertically mounted switch, or a switch mounted flush in the tray. Wrist movements (raise, lower, rotation and sideways movement) may give better control than movements which involve moving the forearm or entire limb – strapping the forearm down can help, although is not usually desirable or recommended.

Experiment with different positions when evaluating switches and movements: try bringing the switch close to the user so that it is operated using a flexed arm; or locate it at arm's length if the pupil has better arm control when extended. Try different heights, and moving the switch from left to right, to the midline. Some users have great difficulty targeting a switch, but can grasp a joystick and use gross arm movements to control the stick. Grasp or squeeze switches may be suitable for people with severe athetosis but good hand control.

For this sort of evaluation, a tray with velcro loop covering or a large programmable overlay keyboard which can be programmed with only a few active keys is invaluable.

## Evaluating arm and shoulder movements

Often arm and shoulder movements are used to operate a hand switch, but it is also possible to operate switches using an elbow, forearm or shoulder directly. Some people with high spinal lesions, for example, have very limited upper or lower limb control but can move their shoulders. There are many switches which can be used for such movements – the main difficulty is mounting them for functional control, comfort and to permit transfer in and out of the seat. See *How is the Switch Mounted?* p. 156 for methods of switch positioning.

## Evaluating head control

Many users, particularly those with athetoid cerebral palsy or spinal injury, find that head control can be very effective. It is important to mount the head switches carefully so that they do not obscure vision or interfere with natural head movements. They can be attached to head rests and covered with fabric, or mounted on lightweight supports.

Stable seating and positioning is vital if head switches are to be used effectively. Head rotation, elevation or head tilt, or a combination of movements can be used to operate switches. If head *rotation* is to be used it is preferable to locate the switches so that they are towards the back of the head: they are less obtrusive and a headrest may be available for mounting the switch(es). Because the user cannot see the switch it is important that the switch is always mounted in the same position relative to the user. Initially, it may be necessary to use a large single switch some distance from the head but with practice, the switch can be made smaller and brought closer, and a second switch introduced, if necessary.

Adjustable mounting arms like the *Magic Arm*, *Slim Armstrong* or *Might Mount* are useful for evaluating and experimenting with different head positions while *TASH* and *Dudley Controls* also sell good purpose-built adjustable head switch mountings. Switches should be chosen with care: a switch with a lot of travel and a loud click may be uncomfortably noisy when operated next to the ear. Switches with a soft surface can be more comfortable than hard plastic items, although you can obviously add soft covers to such switches or insert them into covered head rests.

In some situations it is also important that the switch and mounting are compliant so that they move if the user head-butts them violently: most of the adjustable mounts have some compliance for this reason. It is tempting to use a flexible 'gooseneck' mount but these have several disadvantages: they gradually weaken over time as they are flexed; and it can be difficult to achieve a consistently repeatable switch position, especially if the switch is being moved or taken off and on for transfers in and out of the seat.

For some people, chin switches have advantages over head switches. They are usually mounted on a collar or bib so that their position is more constant regardless of whether the user is sitting upright, to one side, or slides down in the seat: some people find the chin movement more comfortable than turning or moving the head backwards. Mounting chin switches can be problematic, however. Chailey Heritage Rehabilitation Engineering Services sell a good range of chin switches and chest mounts in different sizes: sometimes head supports like the *QED HeadMaster* can be used; or you can try fabricating your own (Goosens & Crain, 1986 has some instructions).

## Evaluating knee & foot control

If hand, arm and head are not viable or effective switch sites, knee and foot can be worth investigating. Knee switches can be mounted on the inside, or more commonly (given the common use of a pommel) on the outside of the knee.

Feet can often provide a very good control and switch site: foot artists; writers such as Christy Browne; toe-typists; and people who drive powered wheelchairs using foot-controlled joysticks or foot-pedals all bear testament to the dexterity of feet and toes. Feet are not often used for fine control, however, and so effective switch and control use will take time and practice: consider how long it takes for an average car driver to learn to co-ordinate foot control with clutch and accelerator pedal. Many standard switches can be used as foot switches although it is usually advisable to choose robust items such as the *QED heavy-duty lever*, *Ablenet* or *Buddy Button* switches, or switches designed for foot control. MPS sell an inexpensive foot switch for tape recorders, for example. Two-way 'see-saw' switches or multiple switch foot pedals can provide extra control options for foot switch users.

There are several methods and orientations of mounting foot switches: horizontally, to be operated by foot press and release; or vertically, to be kicked or back-heeled. Function can often be improved by resting the heel on a stable surface, so that the foot can rotate or move up and down around the ankle joint. If target switches cannot be used, less accurate foot and leg movements may be sensed with 'pull' switches (elastic string attached to a switch) or 'beam-break' switches (where a leg movement breaks a beam or light to operate a switch).

## Evaluating other switch sites

There are many other movements and functions which can be used to control a switch: breath ('sip-puff'); tongue; sound; small muscle movements; eye-movement; eye-blink; and so on – see *Non-contact Switches* p. 154. Since these movements are often hard to measure or observe, the best way to evaluate their potential is to obtain a suitable switch and try it.

With such a variety of possible switch sites and controls, some sort of systematic approach is required to evaluation. Very often, many of the switch sites and movements will be usable, but only a few or even one will be good enough for efficient scanning or encoding.

This type of assessment, whether performed with a computer, tape recorder or other device, is a screening test rather than a conclusive evaluation: there are several things that can influence the results. Does the user understand the instructions? Is he or she motivated by the task? Does he or she like the music on the tape (if a tape recorder is the controlled device)? Do the user's physical abilities change from day to day, and if so, will these results of the test be valid tomorrow? Even if there is no change in tone, it is almost certain that the user's control over the switch will improve with practice, so progress and controls must be reviewed.

Nevertheless, the advantage of this sort of screening test is that it ensures that the potential switch control sites have been considered in a reasonably systematic way, and if nothing else, should provide a reasonably valid method of comparing them. It also provides a procedure for observation which can be referred to at a later date.

## 9.10 Further Information

### Web Sites

**Don Johnston** - <http://www.donjohnston.com/> Information and resources for Discover, Ke:nx and other Don Johnston software, switches and products.

**Widgit**. <http://www.widgit.com/index.htm> Excellent site with lots of information about symbols, switch software and techniques for introducing switches and scanning.

**TASH**, <http://www.valleyweb.com/tash/index.html#1> TASH web site: keyboards and switches.

**Ablenet** <http://www.ablenetinc.com/index.html> Ideas and resources, plus information about the Ablenet range of switches and devices (eg. Jelly Bean switches, Big Macks).

**Enabling Devices** <http://www.enablingdevices.com/> North American firm manufacturing a wide range of switches, interfaces and mounting systems.

**QED** <http://www.qedltd.uk.com/> Switches, mountings, communication aids and wheelchairs.

### Suppliers

**ACE Centre**, Waynflete Road, Headington, Oxford, OX3 8DD. Tel. 01865 63508.

**CAC**, The Mount, Toft, Cambridge CB3 7RL. Tel. 01223 264244.

**Crick Computing**, 123 The Drive, Northampton, NN1 4SW. Tel. 01604 713686.

**Don Johnston Special Needs Ltd.**, 18 Clarendon Court, Calver Road, Winwick Quay, Warrington, WA2 8QP. Tel. 01925 241642.

**Dudley Controls Ltd**, 10 Granby Industrial Estate, Granby Court, Bletchley, Milton Keynes, Bucks. MK1 1NE. Tel. 01908 640777.

**Enabling Devices / Toys for Special Children** 385 Warburton Avenue, Hastings-on-Hudson, NY 10706, USA. Tel. 00 1 914 478 0960

**FCD (Foundation for Communication for the Disabled)**, Beacon House, Pyford Road, West Byfleet KT14 6LD. Tel. 01932 336512

**Liberator**, Whitegates, Swinstead, Lincs. NG33 4PA. Tel. 01476 84391.

**MPS Electronics**, PO Box 777, Rayleigh, Essex SS6 8LU. Tel. 01702 554171.

**Possum Controls Ltd**, Middlegreen Road, Langley, Slough, Berks. SL3 6DF. Tel. 01753 579234.

**QED**, Ability House, 242 Gosport Road, Fareham, Hampshire PO16 0SS. Tel. 01329 828444.

**SEMERC**, 1 Broadbent Road, Watersheddings, Oldham, OL1 4LB. Tel. 0161 627 4469.

**Tandy Education Supplies & Services**, Intertan UK Ltd, Tandy Centre, Leamore Lane, Walsall WS2 7PS. Tel. 01922 434047.

**TFH**, 76 Barracks Road, Sandy Lane Industrial Estate, Stourport-on-Severn, Worcestershire, DY13 9QB. Tel. 01299 827820.

**Toby Churchill Ltd**, 20 Panton Street, Cambridge CB2 1HP. (Tel. 01223 316117)

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