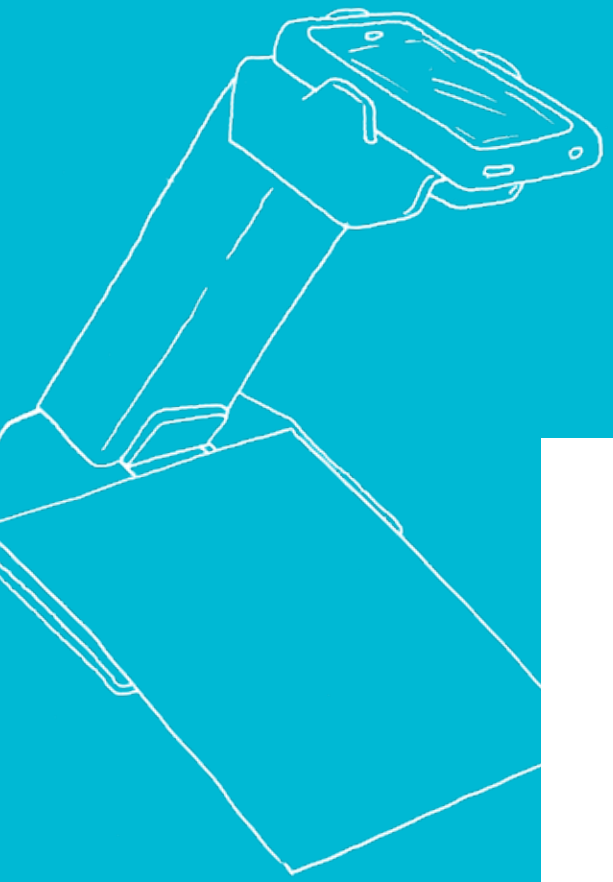

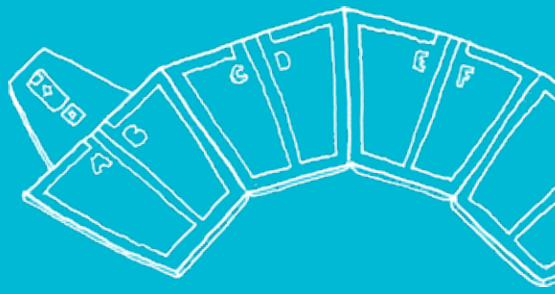

enabling technology *n.*

1. any digital technology which empowers disabled people to live more independently

by Sam Jewell and Ross Atkin

September 2013

Supported by

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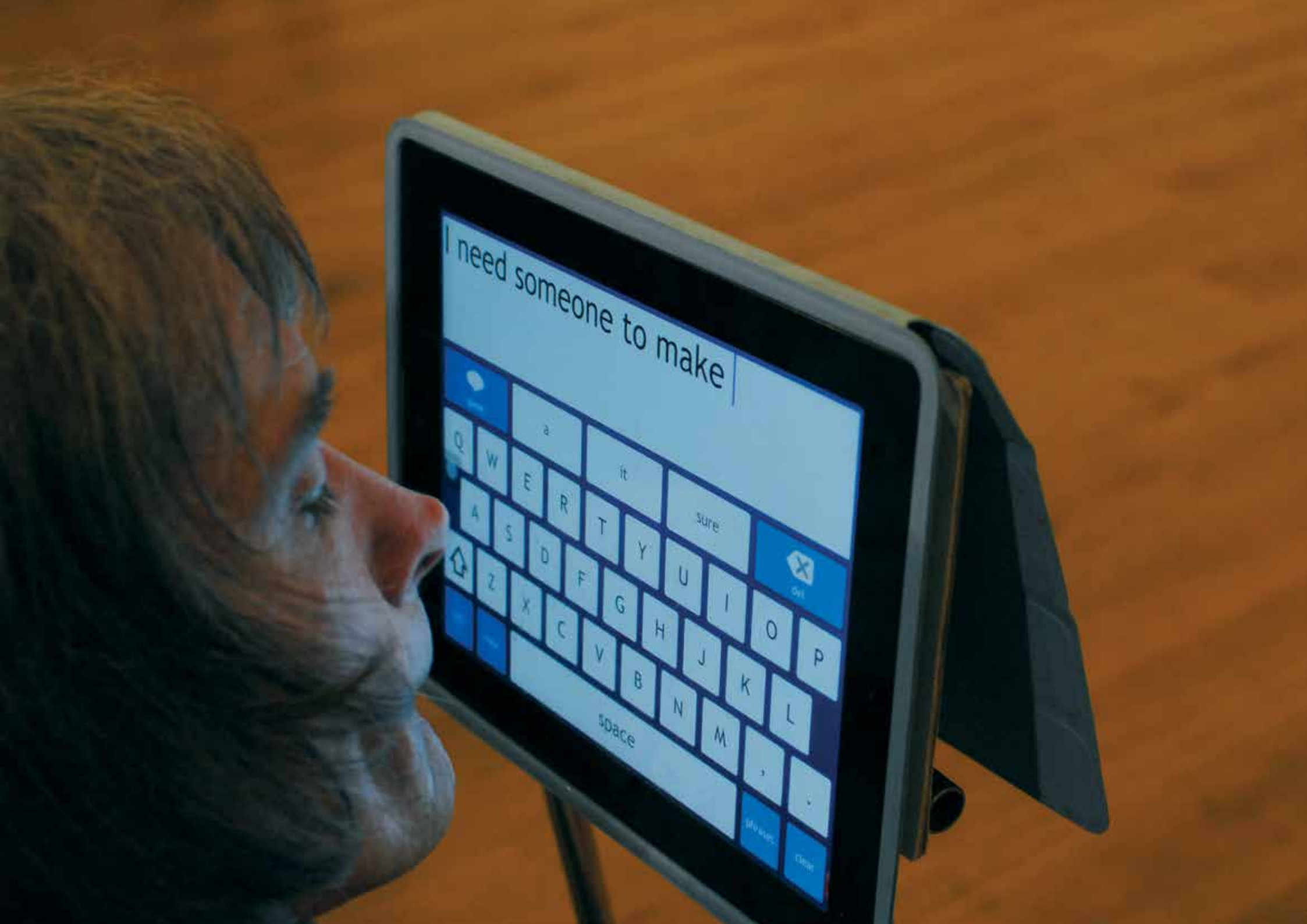
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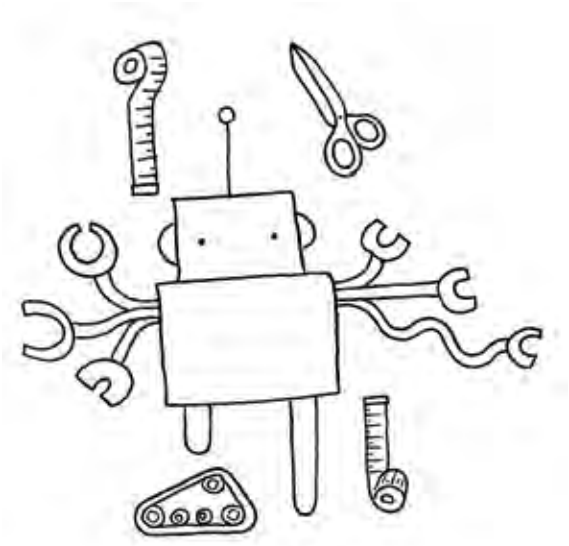
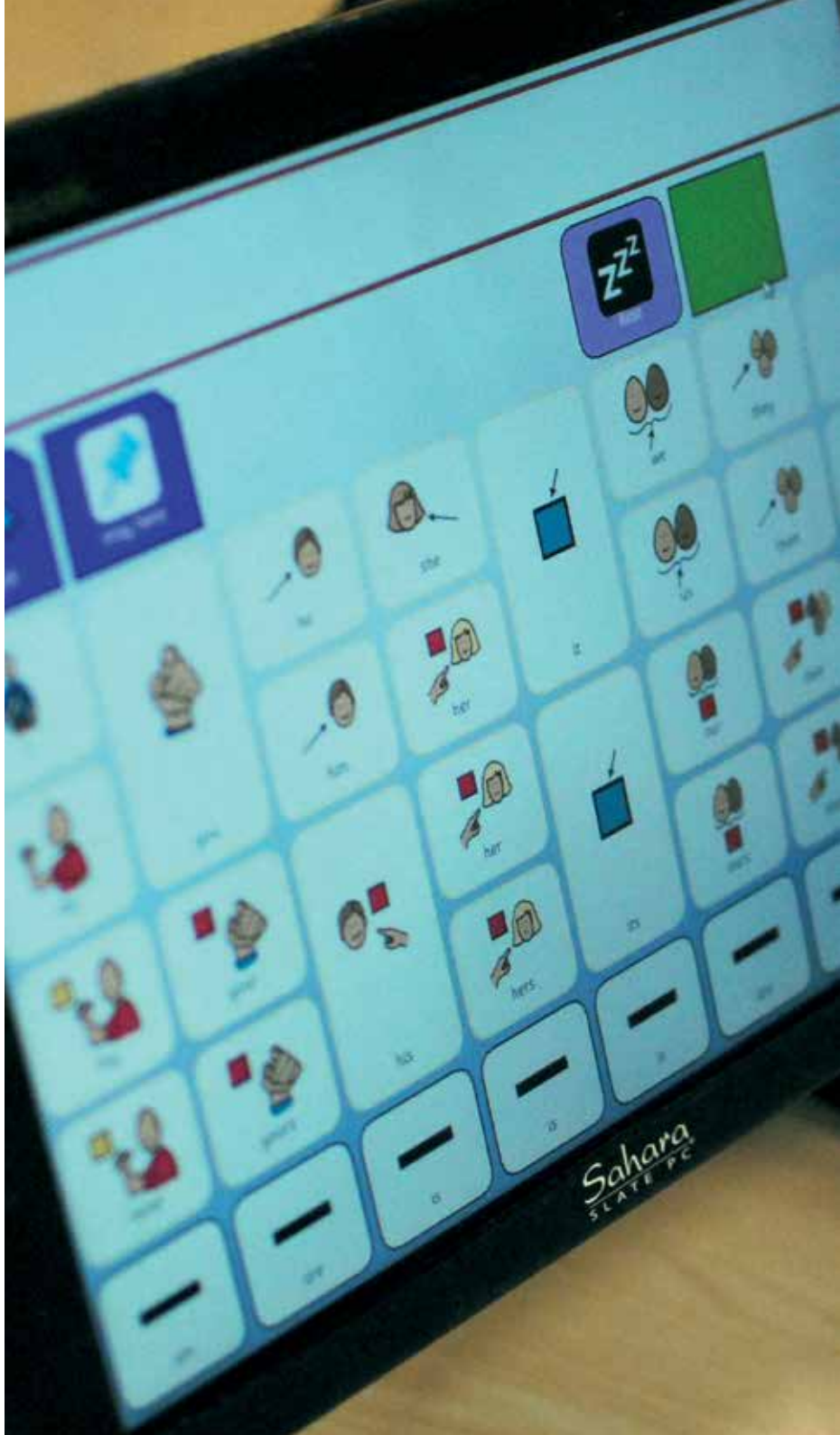




Executive summary

Digital technology can be incredibly enabling for many disabled people. But for others, obtaining affordable devices that meet their needs and accessing essential digital services can be difficult or impossible.

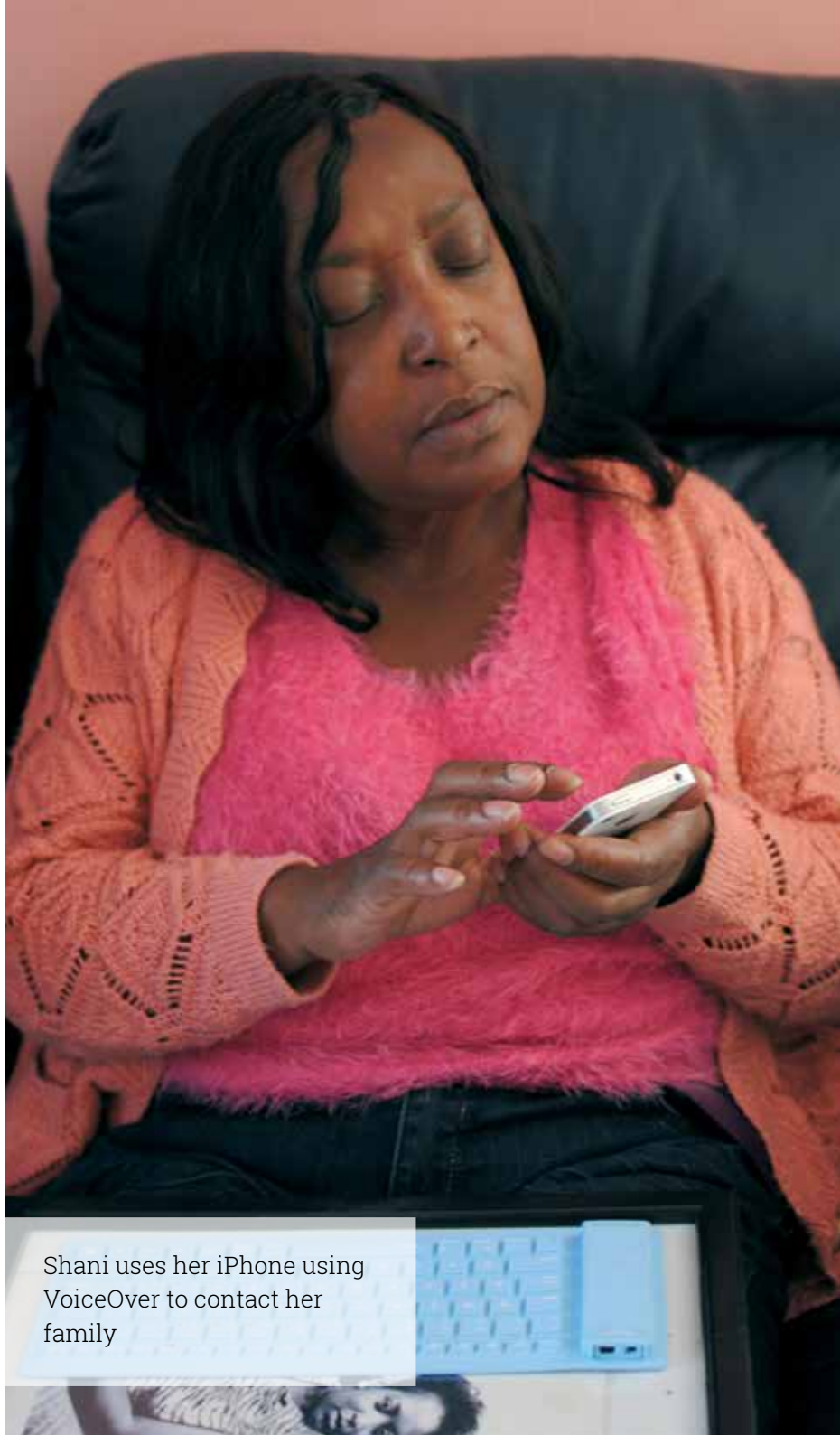
This report is an output of a 15 month design research project carried out by the Helen Hamlyn Centre for Design at the Royal College of Art, in partnership with BT and Scope as part of the BT Better Future Program. It looks at steps that can be taken by commissioners and producers of enabling technology, as well as providers of key digital services, to maximise the enabling potential of digital technology for the 11 million disabled people in the UK. It emphasises the importance of flexibility in the creation of technology used by disabled people, whether hardware, devices or digital services.

Key recommendations for commissioners and makers of enabling technology devices:

A1 Adapt the mainstream - Use adapted mainstream technology as much as possible to create enabling devices rather than developing dedicated devices from scratch.

A2 Use open, flexible technology - Base enabling technology on adaptable or open source technology to maximise flexibility, forward compatibility and security of supply.

A3 Tailor it - Create enabling technology that can be simply and easily tailored to the individual who will be using it, minimising the gap between the person and the device.



Shani uses her iPhone using VoiceOver to contact her family

Key recommendations for providers of essential digital services such as banks, supermarkets, utilities, local and national government:

B1 Allow the experience to be customised - Digital technology allows a single service to present different faces to different users. Build services that can do this by being themselves adaptable, and open to adaptation by third parties

B2 Use timed task completion to measure accessibility - As well as compliance with abstract accessibility requirements, use the time it takes for different disabled people to accomplish tasks as a measure of the accessibility of a service

B3 Consider the experience before and after web - Think about the whole chain of delivery of a service and the best way to make every link accessible. This may mean substituting steps that are currently physical with digital ones, or offering alternative routes to steps that are already digital.

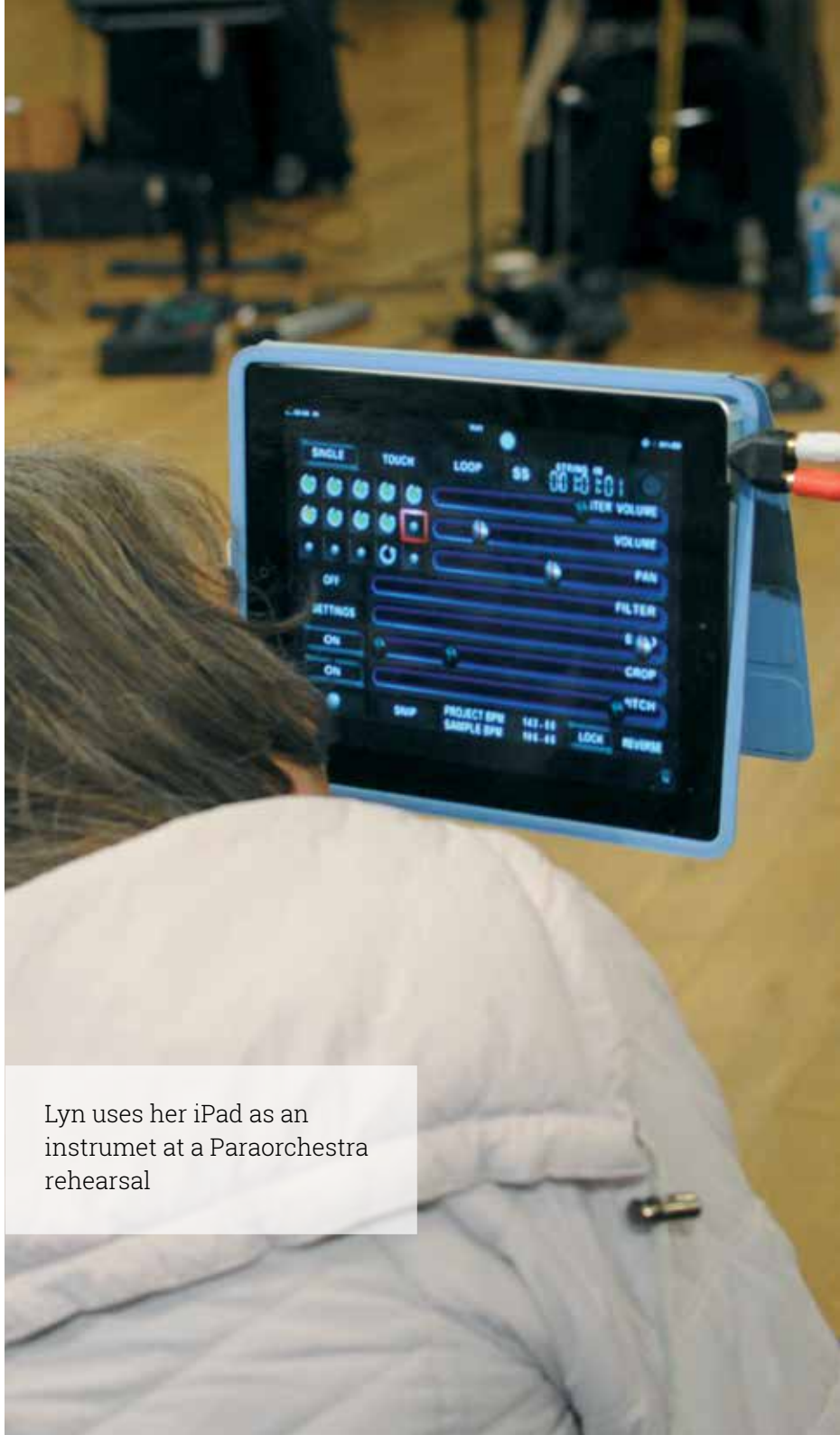
B4 Include switch users - Use native interface elements, simplify layout and navigation and support keyboard shortcuts. Consider building a scan-and-select input option for digital services. Case studies of successful embodiments of these principles are provided as illustrations. The Pop-up Reader and Tailored Touch products have been specifically developed as part of the project.

Possible Opportunities for future developments

C1 Remote personal assistants - A way to augment current support services to increase independence and participation through remote support using digital technology.

C2 Enabling technology awareness - A way to help disabled people remain aware of the latest enabling technologies and how to make them work for them.

This project builds on five years of a pioneering partnership at Beaumont College between BT and Scope. It has sought to apply the lessons learned through the resulting 'Wheeltop' and 'Connect to control' projects to a wider context. Recommendations are based on detailed analysis of the technology landscape, in depth qualitative research with disabled people, expert interviews and user testing.



Lyn uses her iPad as an instrumet at a Paraorchestra rehearsal

Introduction & background

Digital technology can allow disabled people to access services as well as participate in the digital world on more equal terms. In this way, technology has the potential to dramatically enhance their lives.

However in practice this becomes the exception rather than the rule. Disabled people face barriers to participation at every step. Devices and software can be inaccessible or difficult to customise. Digital services can have limited coverage for disabled people. Support services have rarely made the transition to the digital world. Because of these barriers disabled people are amongst the groups least likely to use the internet, 20% less likely to be online than their peers.

"I love technology, it's a big part of my life, and it can be very enabling when it can be used properly." Paul

"I feel pretty privileged to have it, if it wasn't for certain aspects of technology I would really be in a lot of trouble... The simple miracle of the web itself allows me to access a lot of stuff from my living room." Gus

"I love the fact that I can access a lot more than I ever did. That was one of the worries when I first lost my sight, that I wouldn't be able to do so much, that I wouldn't be able to read to my son. Now with things like the computer I don't have to worry about it." Shani

Introduction & background

Between July 2012 and September 2013, two design researchers (Ross Atkin and Sam Jewell) at the Helen Hamlyn Centre for Design (HHCD) at London's Royal College of Art have carried out a detailed research project to explore how disabled people can be supported to live more independently through technology.

Through detailed analysis of the technology landscape, consultation with disabled people, expert interviews and user testing, the HHCD researchers have developed an in-depth understanding of how the digital divide is affecting disabled people, and how it can be resolved.

This 15 month project builds upon a five year partnership between BT and Scope at Beaumont College in Lancaster as part of BT's Better Future programme.

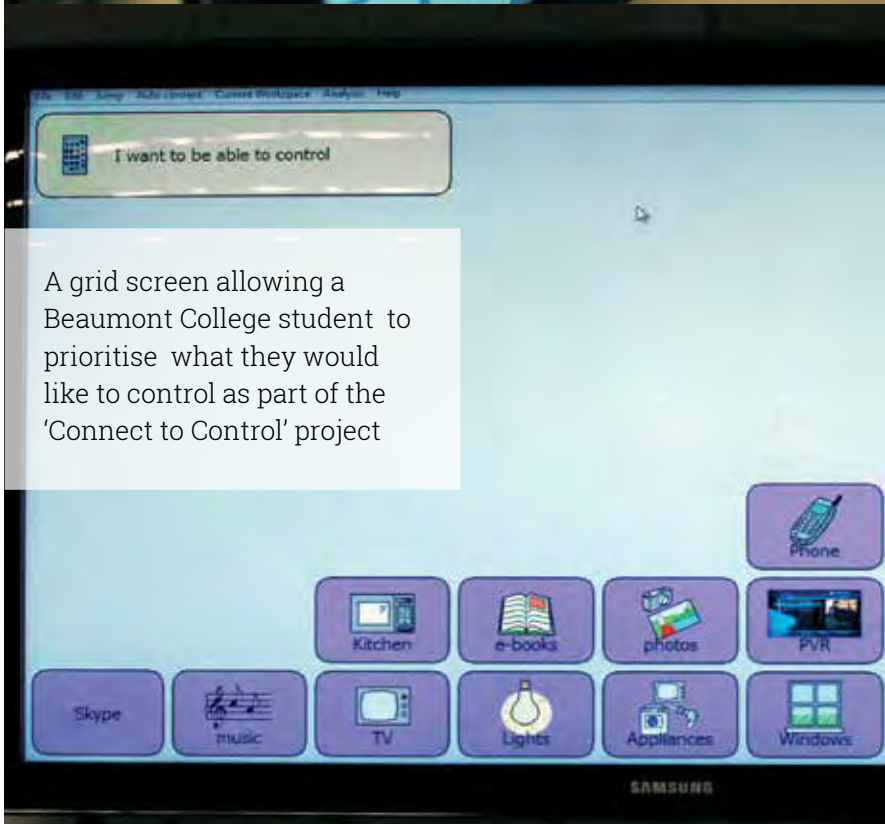
During the first three years of collaboration, BT and Scope developed the 'Wheeltop' - named as a short version of wheelchair mounted laptop. Specifically the project took mainstream hardware and adapted it to make a powerful, versatile and good-value piece of assistive technology.

Communication aids were integrated using Windows tablet computers, which were built into housings with much bigger batteries, speakers, and adapted for other input devices such as input switches. These have been widely and effectively used by many students in Beaumont College, Lancaster, Scope's residential college for students with the most severe and complex needs.

The second three year period of collaboration saw the development of 'Connect to control', which began by asking each student to choose the things they each most wanted to connect with and control, from music and the TV to lights, curtains, to opening and locking their doors. Students were set up with hardware or software prioritising their particular needs and desires. Environmental controls were deployed around the college, giving students (among other things) the ability to open and close their own doors, and exercise the fundamental right to privacy that brings.

This project has aimed to take the knowledge from the Beaumont College projects and apply it more widely outside, for all disabled people. It has sought to maximise the positive impact that digital technology can have in disabled people's lives, harnessing and adapting powerful, cheap, mainstream devices wherever possible.

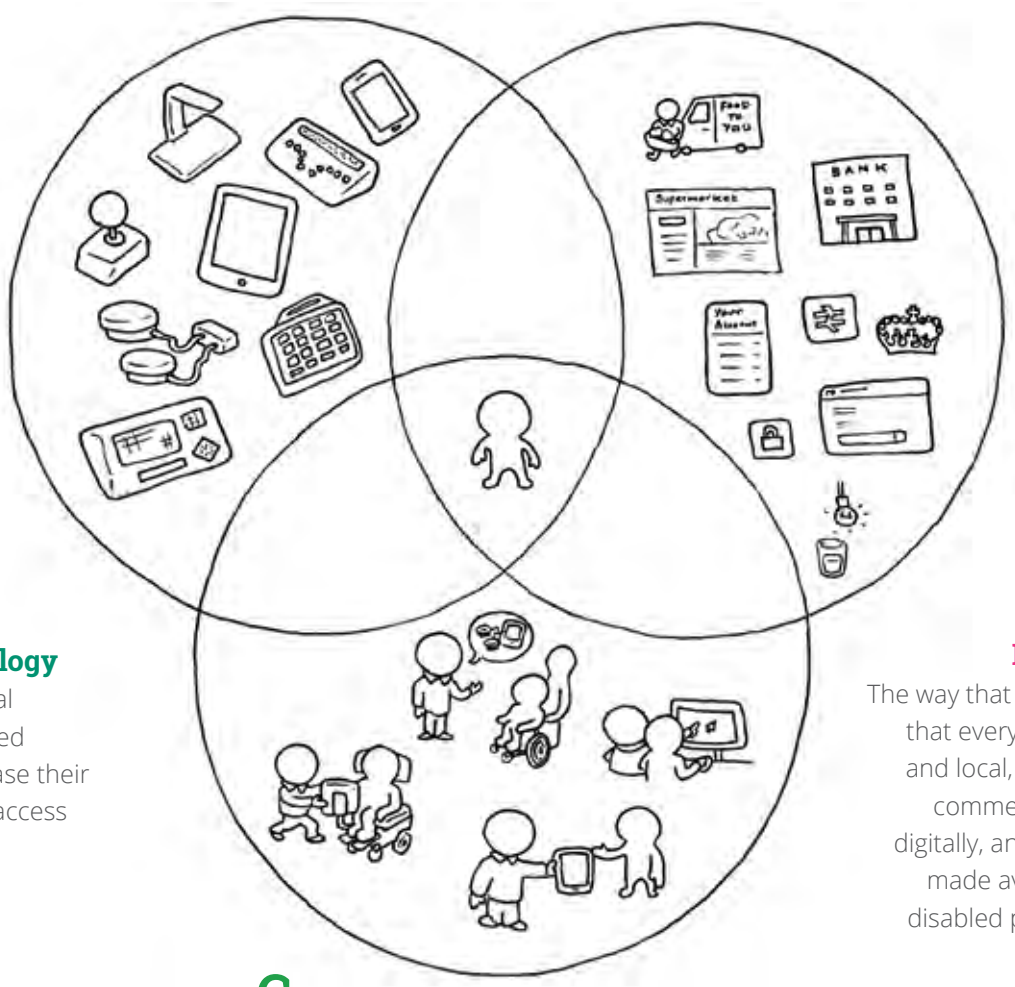
A 'Wheeltop' device at Beaumont College



A grid screen allowing a Beaumont College student to prioritise what they would like to control as part of the 'Connect to Control' project

About this report

The starting point of our approach is the experience of disabled people using digital technology. This means in practice a radical focus on all of the systems that affect the way disabled people interact with digital technology and use it to live their lives. We all use technology to access digital experiences that are delivered by increasingly overlapping relationships between devices, software and internet-based services, all working within a wider support network. The solutions we present in this report all aim to unite these systems to provide the most enabling experience possible. Three key areas are covered:



A
Enabling technology
The devices and local software that disabled people use to increase their independence and access digital services.

B
Digital services
The way that key digital services that everyone uses (national and local, governmental and commercial) are accessed digitally, and how they can be made available to as many disabled people as possible.

C
Future options for support
The way digital technology is made available to disabled people and how they are supported to use it to maximise their independence.

A
Enabling technology

This section focuses on the actual devices and local (non-internet based) software which runs on them. It looks at the gap between mainstream and assistive devices, and at potential ways to narrow it, delivering cheaper and more capable devices which do not compromise on their suitability to different disabled people.

Traditionally there has been a significant gap between the worlds of mainstream and assistive technology. Mainstream technology has addressed the needs of typically young, non-disabled users whilst for many disabled people the most enabling options have been myriad specialised assistive technologies, such as dedicated communication aids or spoken interface systems.

These dedicated assistive devices have typically been extremely expensive, because manufacturing set-up and development costs need to be spread across relatively small numbers of devices. Indeed the smaller the group of people that would be served by a device, such as one particularly suited to a specific set of needs, the more expensive it would tend to be (see Fig 1). This has led to disabled people paying a lot of money for enabling devices which often offer quite limited functionality.

The emergence over the last few years of inexpensive, adaptable touch-screen devices, together with significant improvements in their accessibility features, has begun to present mainstream devices as genuine alternatives to assistive ones for many disabled people. Lyn, for example, has got rid of her dedicated communication aid.

"I used to use a Lightwriter that cost three and a half grand, now I use an iPad [costing £350] and it's better. I still use the Lightwriter's stand, which I've modified to hold my iPad"

Lyn also uses her iPad to control her lights, tv, stereo and fan, to perform music live (including with Coldplay at the 2012 Paralympics closing ceremony), to take photos, to access email and Facebook and even to get her laptop back when it was stolen.

"Someone stole my Mac but I got it back [with the remote desktop]. We took a picture of the person who stole it. Then I put some anti-theft software on the computer while they were using it which told me where the computer was."

Shani has also made a similar jump from having to fight for a specialist piece of technology to using a more adaptable mainstream device.

"The first phone I ever had I had to send off to get the speech package put onto it. I had to argue my case; that I'm paying them but it's not fit for purpose and why should I lose out. So I argued, and they said OK we'll put the package on for you. Well NOW I went to upgrade, and on my new phone I can go into accessibility and get the speech package happening. That for me is fantastic".

The challenge presented by this shift is that with a mainstream device there is often still a gap between the device and the person being able to use it. Even in Lyn's situation, her iPad would be useless to her without the stand which allows her to operate the touchscreen with her nose. An academic assistive technology expert expressed his concerns about this.

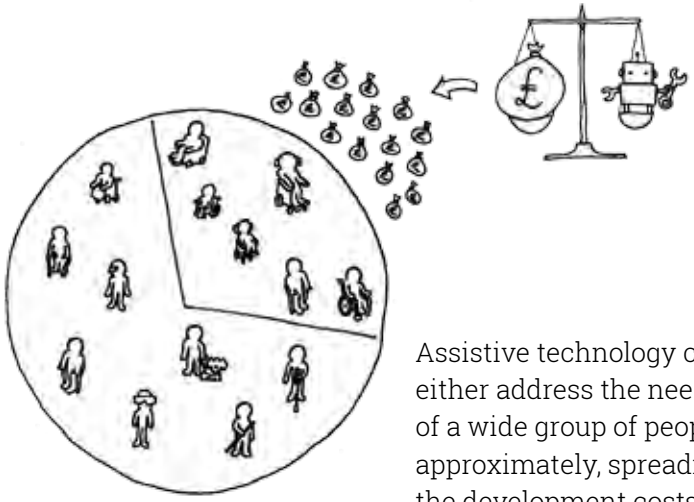
"I think we'll get 'lowest common denominator devices', that's my concern. A mainstream device that looks cool, but doesn't really meet our needs. The teenagers will love it, but it won't give them the degree of control that they have with a tailor-made device."

The Wheeltop and Connect to control projects at Beaumont College have demonstrated the potential to bridge this gap by using modified mainstream tablet computers to replace more expensive dedicated communication aids, whilst giving students access to a wider range of digital services such as social networks and environmental controls (for controlling devices around the home).

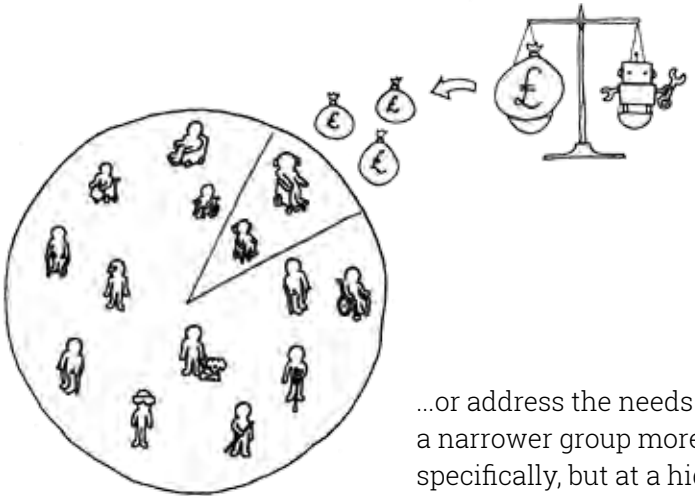
The emergence of the 'assistive technologist' (a specialist in the deployment of assistive technology) as a dedicated profession at Beaumont College has also extended the way that an enabling set-up can be 'fitted' to a particular individual providing a much greater degree of control.

This section will outline ways this gap can be bridged for disabled people more widely, to create affordable enabling technology which meets the needs of as many people as possible.

Fig 1.
The economics of Assistive Technology



Assistive technology can either address the needs of a wide group of people approximately, spreading the development costs over many units...



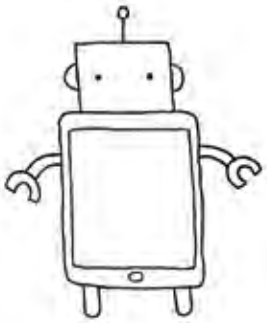
...or address the needs of a narrower group more specifically, but at a higher cost per unit.

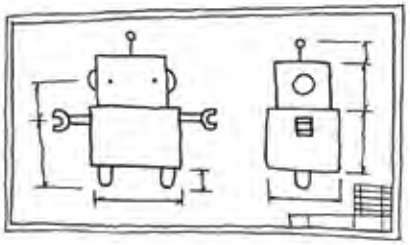
Enabling devices recommendations

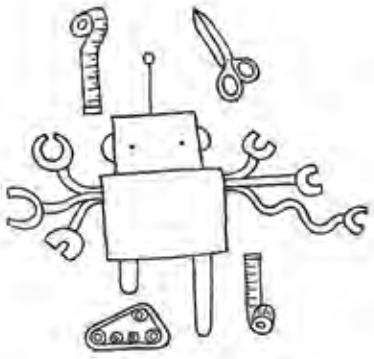
A1 Adapt the mainstream - Use adapted mainstream technology wherever possible to create enabling devices rather than developing dedicated devices from scratch.

A2 Use open, flexible technology - Base enabling technology on adaptable or open source technology to maximise flexibility, forward compatibility and security of supply.

A3 Tailor it - Create enabling technology that can be simply and easily tailored to the individual that will be using it, minimising the gap between the person and the device.







These steps can be implemented by those who either purchase or develop enabling technology. This includes:

commissioners and budget holders
practitioners such as assistive technologists
researchers and research commissioners

They can both lower the cost and increase the usefulness of technology for disabled people by bridging the gap between mainstream and assistive technology to create enabling technology.

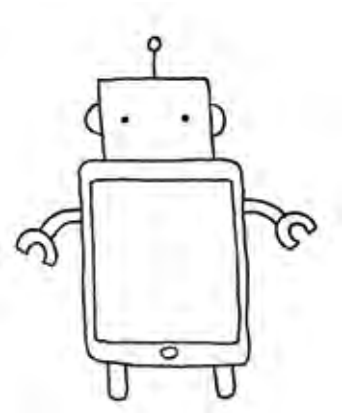
A1 Adapt the mainstream

Using as much mainstream technology as possible (devices, components and software) for any enabling technology set-up can minimise costs and maximise capability/versatility. For example a communication device made through modification of a mainstream tablet computer may be both cheaper and more powerful than a dedicated specialist device.

The cost saving is achieved because the development and production cost of the mainstream components do not need to be divided across the small number of assistive devices. They will already have been spread across the hundreds of thousands or potentially millions of mainstream devices produced. It must be acknowledged however that in many situations, such as the communication device context, very significant adaptations will be required which may end up costing significantly more that the mainstream tablet itself.

The capability increase results from the power, flexibility and multi functionality which is built into modern digital web-connected devices, allowing an almost limitless number of applications.

- Commissioners/purchasers of enabling technology should ensure that funds may be used to buy adapted mainstream devices and software, and not limited to dedicated AT equipment.
- Those developing new enabling products should consider developing software, and accessories for mainstream devices rather than creating new assistive devices from scratch.



Case Study: Pop-up Reader

The Pop-up Reader is an adaptation to the iPhone (produced in partnership with Shani) which allows a person with a visual impairment to read a paper letter or other document using Optical Character Recognition (OCR) apps. It uses mainstream hardware (any iPhone 3GS or later) and apps together with VoiceOver. It replaces a dedicated piece of assistive technology costing between £500 and £2,000. The Letter Reader itself can be made at home for £2, or produced cheaply using a laser-cutter. More information on the Pop-up reader, an output of this project, can be found on the project page of the Scope website.

Case Study: Smartbox Communication Aid

Smartbox produce communication devices based on a Windows tablet computers with adaptations such as additional batteries, speakers, control inputs and casings. They are supplied with a communication package called Grid 2 which will run on any Windows machine. These devices are cheaper than dedicated communication aids and allow their users to access additional functions such as music, environmental controls and web-based services.

A2 Use open, flexible technology

Both the pace of technological change and the level of customisation that disabled people need from technology mean there are considerable advantages in basing enabling technology on platforms which are more easily adapted, modified and hacked. Such technologies can be described as 'open'.

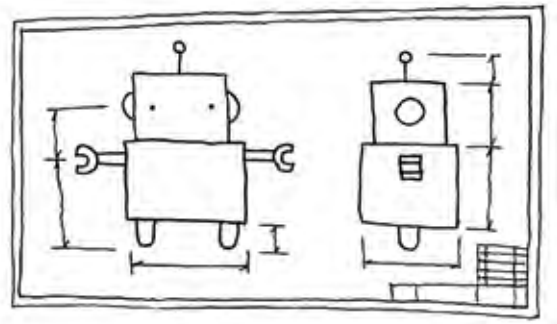
These include, at the most open end of the spectrum, open source software such as Linux, Ubuntu and Android.

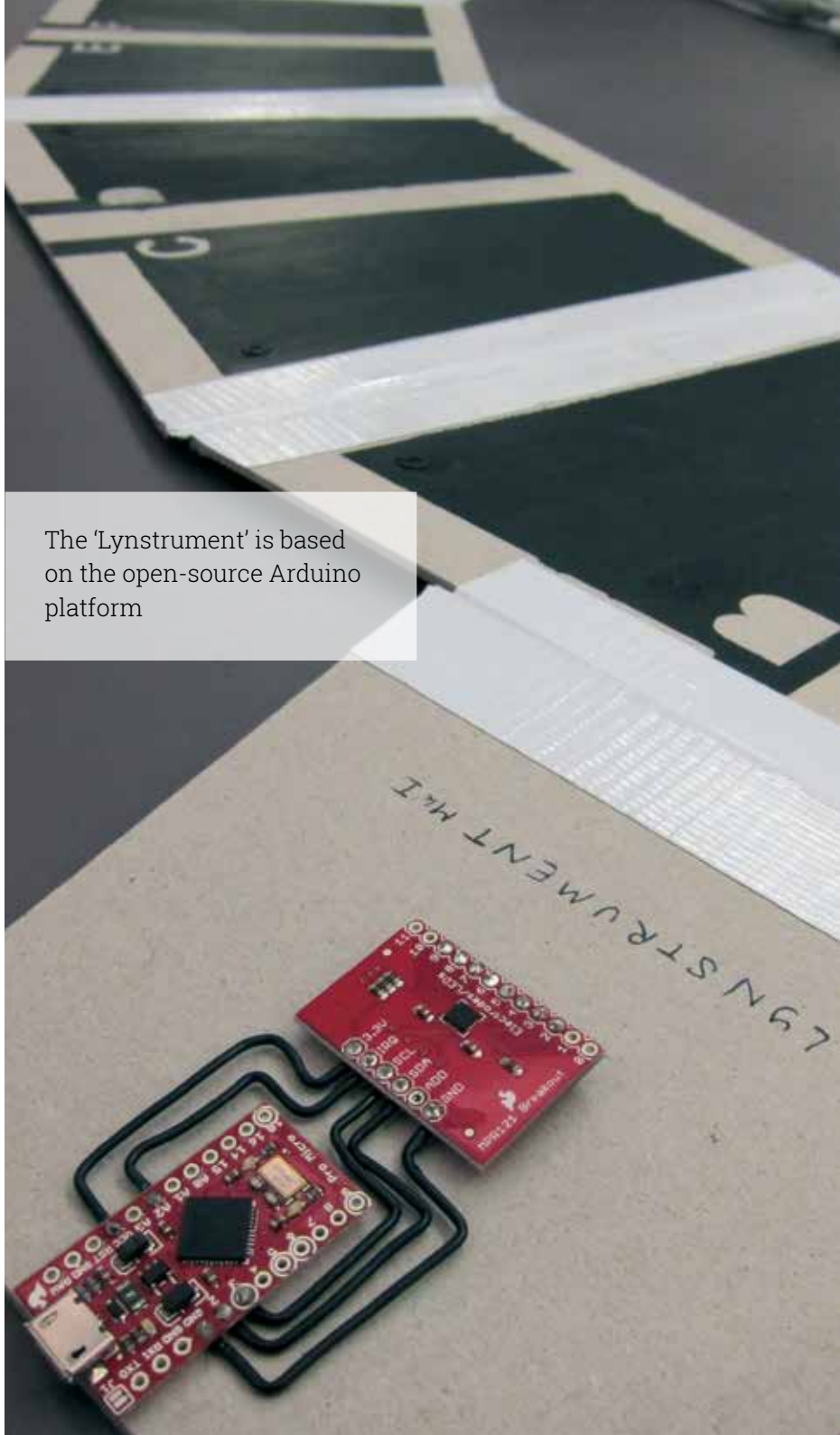
There is also an emerging movement towards 'open source hardware' spearheaded by the Arduino family of microcontrollers and the Rasberry Pi computer. The rise of distributed digital manufacturing technologies such as 3D printing and laser-cutting is making the modification and local production of 'open-source' physical products a reality. Publishing services like Instructables, 3D Warehouse and Thingiverse make the sharing of digital design data and manufacturing instructions easy.

The relatively more open 'curated ecosystems' such as the iOS operating system (including the iPhone and iPad), the Apple App store, the Google Play store and the iOS accessory platform are less open than the platforms outlined above but still allow an enormous versatility and customisation for disabled people. This is true especially in comparison to traditional AT devices, which are usually built for one thing and only one thing.

Using open technology is a way to future-proof an enabling technology, as it allows others at all levels (from manufacturers to end users) to work with the technology, and reapply it in new ways.

Fig 2 (on the next page) lists the relative advantages and disadvantages of different degrees of openness.

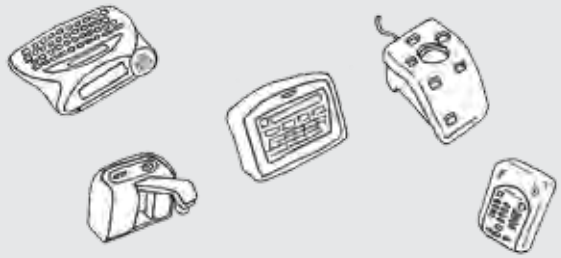




The 'Lynstrument' is based on the open-source Arduino platform

Fig 2. Types of 'openess'

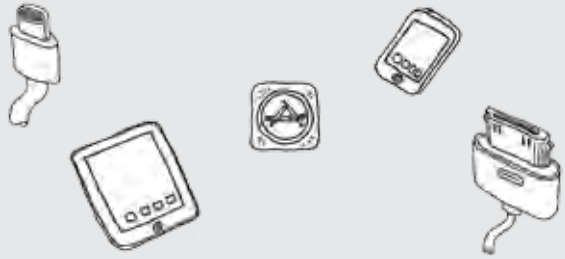
Dedicated AT Devices



Advantages
Perform a specific task 'out of the box' often with minimal set-up and configuration. Levels of support available from some assistive technology suppliers is excellent.

Disadvantages
May be expensive. May offer limited opportunity for customisation to different people's needs. Offer very limited functions beyond core purpose.

Curated Ecosystems



Advantages
Popular ecosystems ensure a wide variety of apps and peripherals are available 'out of the box', making many adaptations simple, easy and cheap. App markets (like the iOS App Store) make wide distribution of new apps easy.

Disadvantages
Approval is required for both apps and peripherals ultimately limiting flexibility and often increasing cost. If the curators of the ecosystem disappear or stop supporting it (such as Nokia with the Symbian platform) technology based on it may stop working.

Open Source

Advantages
Offers the ultimate overall flexibility. Offers security of supply because if one supplier disappears others can still make, support and develop the technology.

Disadvantages
Much time and expertise is often required for initial setup. Without revenue from commercial sales, development can be difficult so some technologies are not well resolved. There may be a limited choice available, particularly of soloutions which work 'out of the box'.

Not Open ⟵ ⟶ Totally Open

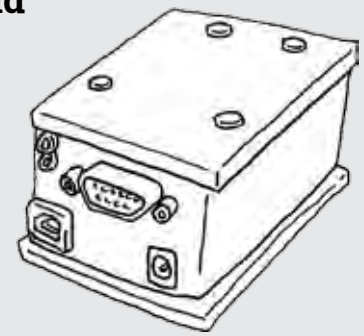
When creating new enabling technology, open source can eliminate the need for a manufacturer, investment or both. These otherwise often prevent good new enabling technologies from reaching potential users. In addition it can ensure security of supply because, if a manufacturer disappears, designs that are in the public domain can be manufactured by others.

By publishing openly, and integrating other open source elements, users, or the people around them may be able to manufacture devices themselves, removing the need for a manufacturer to be involved at all. In practice many people will face significant barriers to doing this so will always prefer to buy a product that works 'straight out of the box' but open source does not preclude this as illustrated by all of the open source hardware that is commercially available.

- Researchers and assistive technologists developing new enabling products should consider publishing their designs openly (to Github, Instructables or Google Warehouse) as a potentially quicker and more flexible route to users. They should also consider basing their designs themselves on existing open-source frameworks such as Arduino, Android and Linux, and optimising the design of physical elements for local one-off production using 3D printers or laser-cutters.

- By favouring more open over closed technology (be that curated ecosystems or open source) commissioners can maximise flexibility, forward compatibility and security of supply whilst often minimising costs (though potentially significantly complicating the procurement and commissioning process).

Case Study: Tecla Shield



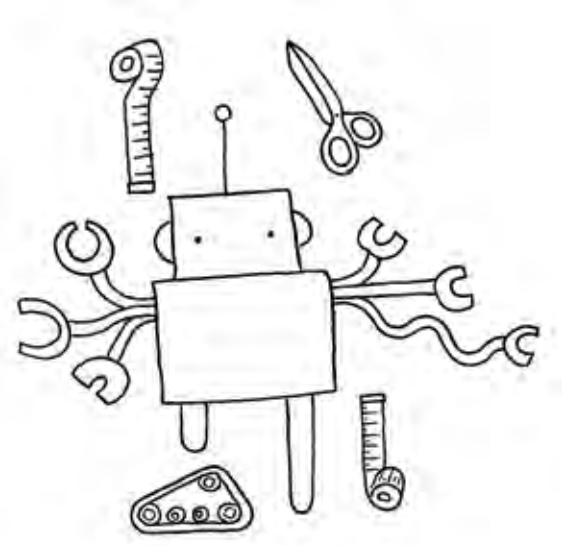
The Tecla Shield is a piece of hardware that allows a person with limited motor control to use access switches, joysticks or wheelchair controls as alternative inputs for iOS and Android devices, via Bluetooth. It is based on the open-source Arduino platform and all the source-code and design resources required to make one are available on the open source collaboration platform GitHub. In addition to being itself open-source and being based on an open-source platform, the Tecla Shield also makes the devices it works with more open by allowing them to work with a wider range of peripherals. Despite being open-source, Tecla Shields are still available commercially from Komodo Open Lab for people who are unable to make their own.

A3 Tailor it

Devices and software that can be tailored to individual requirements have a much greater capability to meet the needs of a diverse population of disabled people. They also have the potential to significantly lower the cost of enabling technology, because the development and production costs can be spread over a larger number of products, without sacrificing their fit to particular individuals' needs.

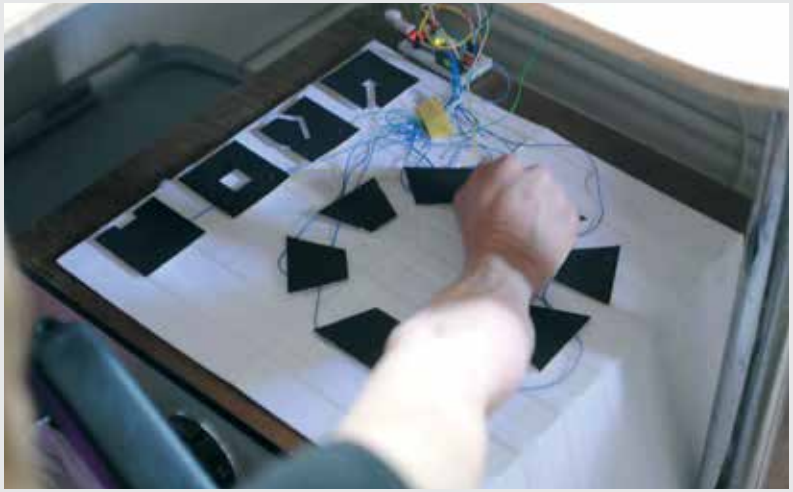
The easier it is to tailor a product, the more people will be able to do the tailoring. This increases its accessibility to disabled people and the people immediately around them, meaning more people can have a set-up that works really well for them.

- Researchers and assistive technologists developing new enabling products should aim to make tailoring those products to an individual's needs as easy as possible.
- Commissioners should aim to buy products that can be easily tailored, maximising their effectiveness and flexibility.



Case Study: Tailored Touch

Tailored Touch is a new approach to creating computer access solutions for people with limited motor control (developed in partnership with Lyn as part of this project). Instead of creating a solution using pre-manufactured switches mounted around a person, tailored interfaces are made up of touch-sensitive pads which can be applied to almost any surface, in any size and any position. They are made using open-source tools and can be created by anybody. Individual interfaces produced so far are a musical instrument for Lyn, a member of the Paraorchestra, and a mouse substitute for individuals at Beaumont College.



B
Digital Services

Full command of a digital device is of limited use without the ability to access internet based services. This section addresses the key internet-based services disabled people need to access to live independently. It shows how these can be made as useful as possible to users of enabling technology.

Many of these digital services represent gateways to access services, such as banking, grocery shopping, transportation, utilities and government transactions that everyone needs to live independently. Being able to access these services digitally has the potential to be hugely enabling for many disabled people. Paul articulated the importance of online shopping for him:

"For me, going to a supermarket, loading up a trolley with seventy quid of shopping and carrying that home just isn't an option. So to have someone who is able to bring it to you is brilliant and it also means that I don't have to take anyone else's time to come with me or help me, which is great."

Unfortunately decisions made during the architecture of these services are limiting their enabling potential, making them far less useful to disabled people than they should be.

As the lines between service, website, browser, app, operating system and device are increasingly blurred, service architecture becomes of paramount importance, whilst the consequences of decisions relating to that architecture may become less obvious.

For example, a single service may be accessible through mobile and desktop websites, native apps which are specific to up to four or more platforms (iOS, Android etc) as well as any number of third-party software products or services via the Application Programming Interfaces (APIs) which are ways for a computer programs to exchange information with other programs. Equally it could be provided exclusively through a single, responsive website. Fig 3 (on the next page) illustrates this difference for two digital services.

The delivery of a digital service like banking or entertainment may require a particular physical item, such as a card reader or set-top box. How effectively disabled people are able to use these services depends on design and decision making at every level, from initial architecture, editorial, design and engineering.

The situation is further complicated when a third party is involved in helping a disabled person access a service.

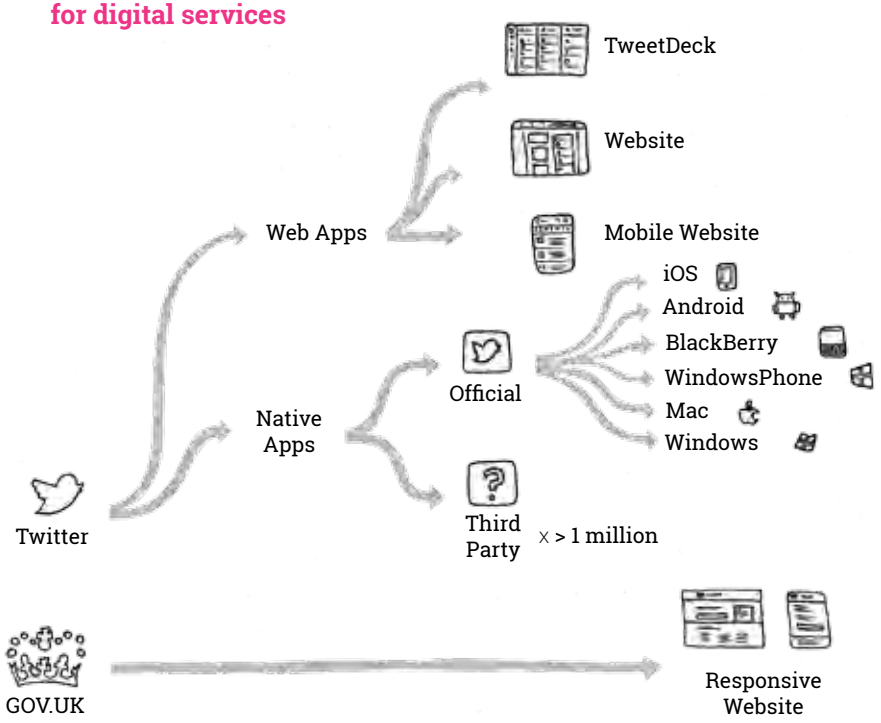
This third party could be an app developer, developing a portal to a popular service better suited to a certain group, using an API provided by the service. The availability of a variety of different Twitter clients optimised for different use contexts is a good example of this.

At the other end of the spectrum the third party could be an assistive technologist developing an enabling technology setup to allow a particular individual to use a service.

Looking forward the 'Assisted Digital' component of the government's 'Digital by Default' agenda introduces another class of third party who will help disabled people access digital government services. This program will fill all of the gaps where disabled people (and others who may not be online or have access) find they cannot access the digital service.

In this context a standards-based approach is often not enough to deliver the most inclusive services. If the decisions made in the creation of essential digital services, including shopping, banking, utilities and government transactions, are not made with the full awareness of the context in which they will be used, opportunities for dramatically increasing their usefulness to disabled people, and therefore those people's independence, will be missed. This section identifies some of these opportunities.

Fig 3.
Contrasting delivery methods for digital services



Digital services recommendations

B1 Allow the experience to be customised

Digital technology allows a single service to present different faces to different users, so build services that can do this by being themselves adaptable, and open to adaptation by third parties.

B2 Use timed task completion to measure accessability

As well as compliance with abstract accessibility requirements, use the time it takes for different disabled people to accomplish tasks as a measure of the accessibility of a service.

B3 Consider the experience before and after web

Think about the whole chain of delivery of a service and the best way to make every link accessible. This may mean substituting steps that are currently physical with digital ones, or offering alternative routes to steps that are already digital.

B4 Include switch users

Use native interface elements, simplify layout and navigation and support keyboard shortcuts. Consider building a scan-and-select input option for digital services.

These recommendations can be implemented by the providers of the key day-to-day digital services which everyone needs to live independently. These include:

banks
supermarkets
transport providers
utilities
government services

They explore the ways these services can be made as usable as possible by the widest possible number of disabled people, both through a direct connection between the person and the service provider, or one mediated by a third party. In this way they allow the services to maximise their enabling potential.

B1 Allow the experience to be customised

We all have different abilities and preferences in the way we like to do things. Amongst disabled people the spread of these abilities and preferences can be especially wide. Inclusive design emphasises the creation of things that work for everybody.

In the physical world we are limited by space and resources, so to include as many people as possible we must create buildings, public spaces and transport infrastructure which are the best compromise between different people's needs.

In the digital world we are far less limited. A single service may present many different faces to different people, depending on their needs and preferences. In this context the most inclusive solution may not be a single website or app which is a compromise between different people's needs, but actually multiple user interfaces that are each more optimised for their users and that together include more people in total. Paul articulated the advantages this approach offers him when using his Android phone:

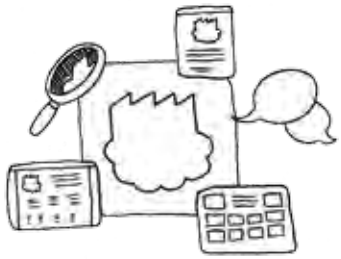
"I know full well that if there's a process or app in here that is tricky there'll be another one out there that makes it easier"

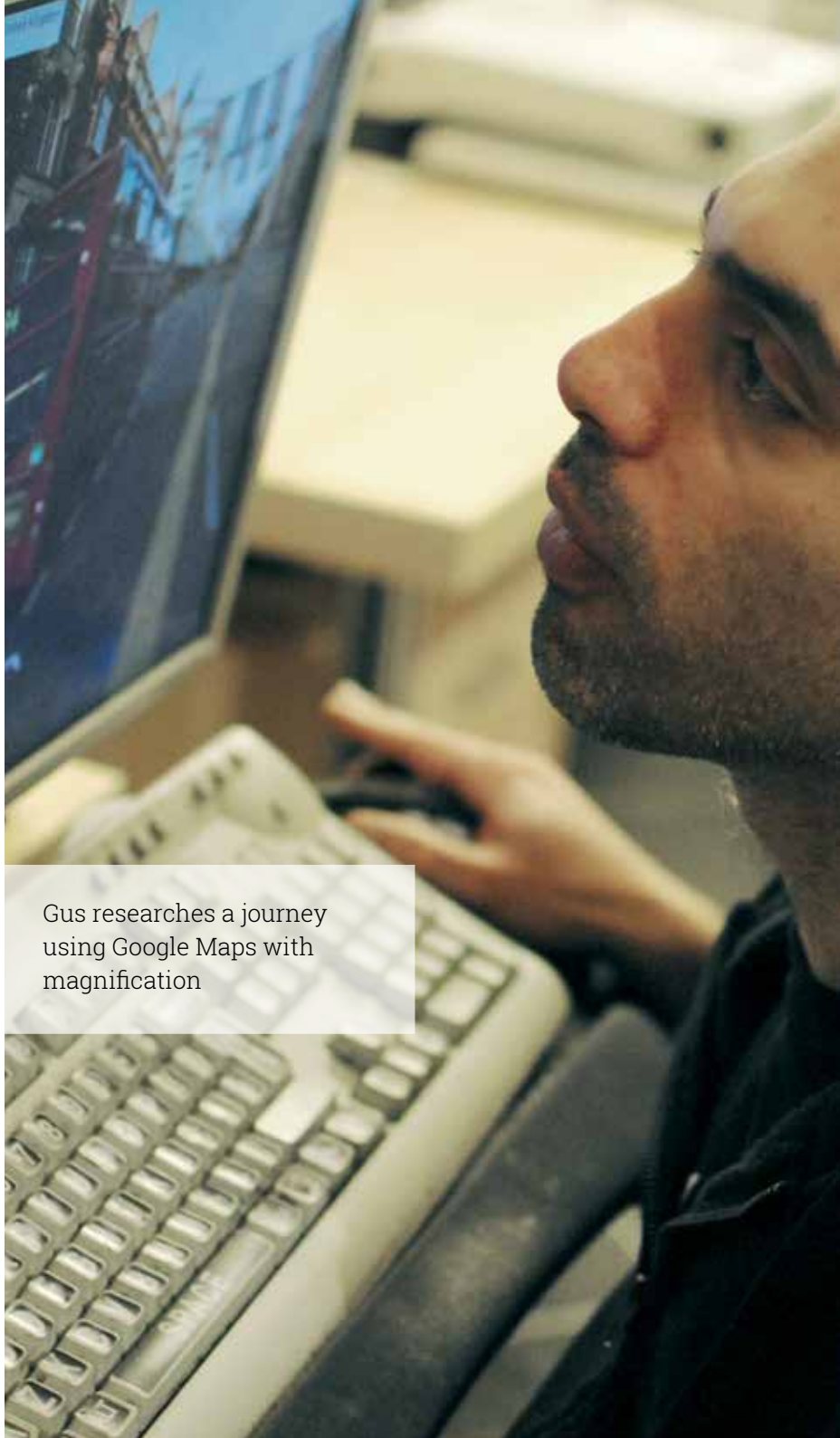
Whilst Gus cannot use an output designed for a fully-sighted person, he pointed out that the usable sight he has means he does not want to use an output designed for a person with no sight at all, ie speech only.

"They say 'If you're a low vision user but you can hear all right why can't you just use speech output? [If] a blind person can use it, you can use it.'

But if you think about it there are massive advantages to referencing information with sight over sound. [So magnification is much more useful]"

In some cases third parties, such as assistive technology producers or individual assistive technologists, may be in a position to create some of these interfaces and so provision of an API can potentially be of considerable benefit. However provision of the API itself does not include anyone; people are only included when the interfaces themselves are made available.





Gus researches a journey using Google Maps with magnification

Where a physical device, such as a card reader, set-top box or smart energy meter is part of the delivery of a service, providing ways for other enabling technologies to access these devices is often the easiest way to make them accessible to many disabled people. Paul explained the problem for him with card readers:

"One of the things that has made things very difficult are those poxy card readers that you have to use. They make life so much more difficult for me because they are cheap and fiddly and the buttons are tiny."

- Aim to ensure the service can be delivered multi-modal and multi-sensory. This means making services which can be accessed to people with sight or hearing impairments, so they can be accessed no matter what the impairment. Ideally each input should be compatible with each and every output type, so that the individual can choose the best input and output methods to suit their needs. Abilitynet provide a complete list of inclusive design fundamentals in their 'Mind the digital gap report'.
- Consider providing multiple front ends for a web service as a way of including more people and giving each a better optimised experience.
- Consider providing APIs so that third parties can create front ends that may work even better for certain people.
- Build in keyboard shortcuts into websites and apps. Try to maintain consistency with existing widely-used combinations such as those found in Windows or Google Docs.
- Where a piece of hardware is involved in delivering a service make it as easy as possible for other devices to communicate with it. Useful provisions include USB, Bluetooth, Infra-red and mini audio jack (useful as an input for switch users and output for people using headphones).

Case Study: TweetCaster

TweetCaster is a third party Twitter client which uses a Twitter API to provide a slightly different front-end, or user interface, for its users. It is a more inclusive option for Paul, as it requires fewer button presses for each step, meaning everything is quicker, easier, and less likely to go wrong.

Case Study: Grid 2

Grid 2 is switch-accessible, grid based software for Windows. It can be used as a communication aid, and for many web activities such as emailing, browsing, and social networking (twitter and facebook), as it makes everything available through scan & select. It is highly customisable, as bespoke configurations (gridsets) can be easily created, edited, and shared online, for example by assistive technologists.

B2 Use timed task completion to measure accessability

We usually go online to complete a particular task or perform a transaction. Accessibility has traditionally been measured by comparison of hardware or software with the accessibility guidelines or standards, such as the Web Content Accessibility Guidelines (WCAG) maintained by the World Wide Web Consortium (W3C). Whilst this does measure if a task or transaction can be performed in principle, it does not actually check that it can be completed, end to end, quickly and easily.

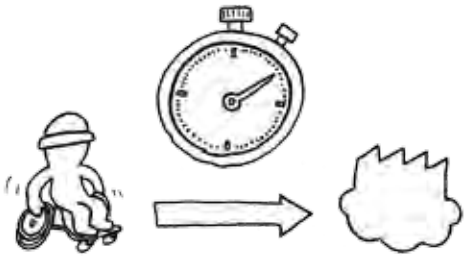
Sandi Wassmer, who runs a web agency and is blind, points out:

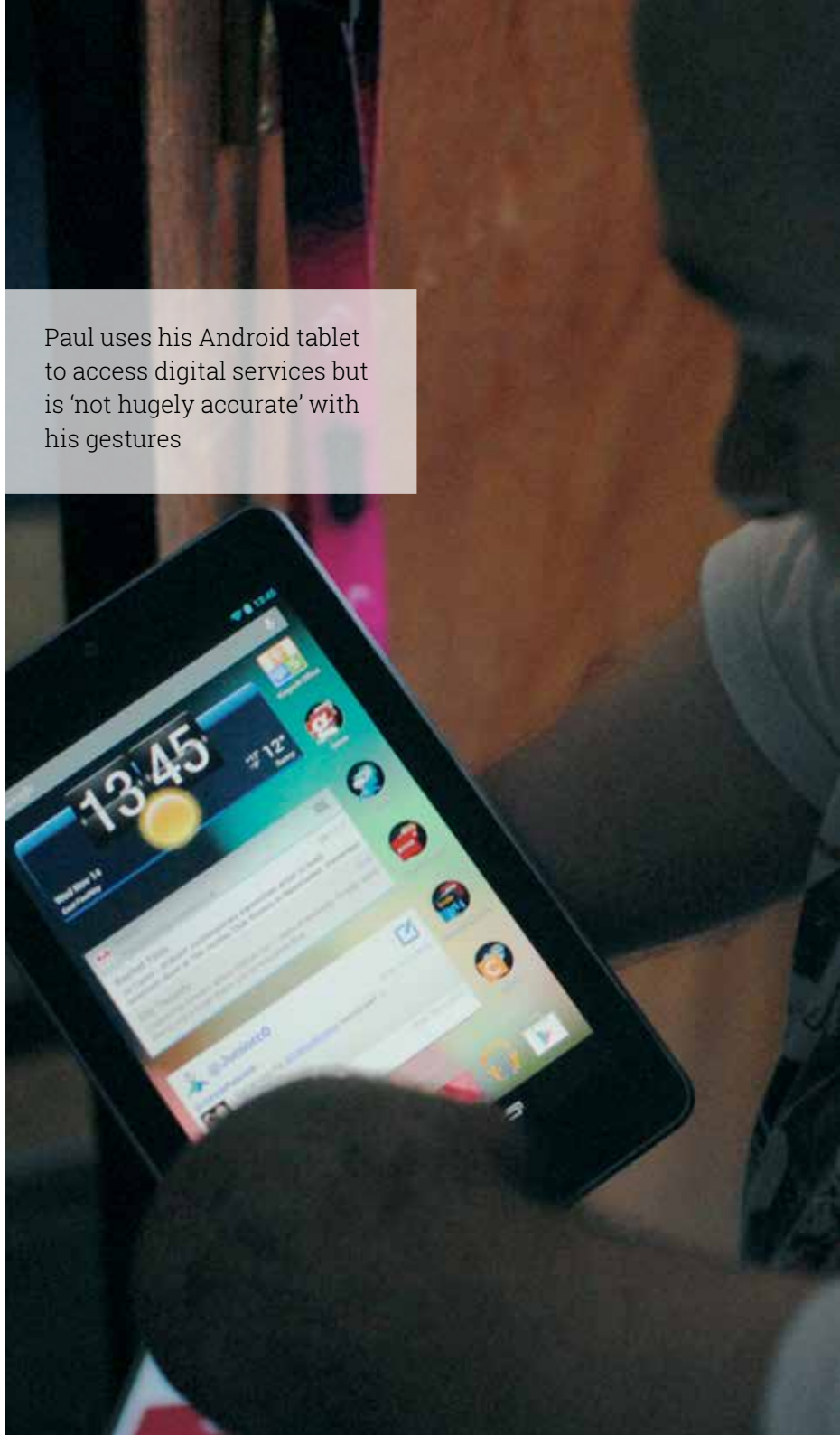
"The WCAG is all about technical conformance - 'you must do things this way'. Oh, but by the way, it's subjective, and not everyone is going to agree that you have ticked the accessibility box. That's not particularly useful for a software developer or engineer. They just want to know 'will this work or not'.

Apps have taught us that people want to do discrete tasks and complete them easily, such as watch a video, send a text, whatever. But WCAG has never been tested with users for task completion! It [WCAG] is a theory! At the end of the day, people need to complete tasks".

Reducing complexity, curating information, presenting the user with fewer, more relevant options and requiring fewer interactions to complete a task will all speed up interaction and make it easier. That in turn will help everybody, and in particular will help disabled people, as every interaction is more difficult and more likely to go wrong, as explained by Paul.

"Because I'm not hugely accurate, any extra swipe or press I've got to do is likely just to make it more convoluted to get to do what I want to do."





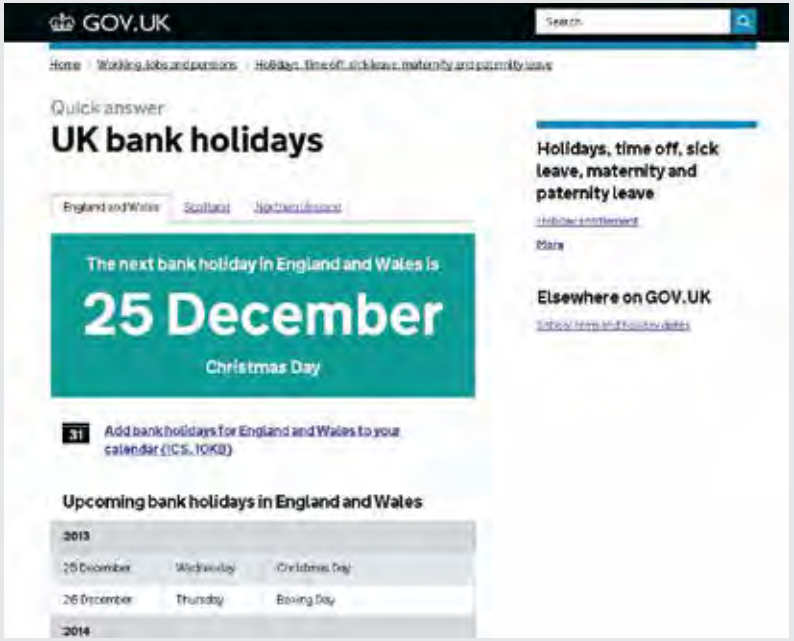
Paul uses his Android tablet to access digital services but is 'not hugely accurate' with his gestures

For example Shani no longer shops for groceries online, nor has she ever used national or local government websites to access the services she needs. This is because, despite all her patience, they are too difficult to use, too slow and too frustrating. Although theoretically she could complete them using a screenreader on her smartphone or desktop.

"Some of the difficulties are that I can hear what it is that I want to buy but it's tedious, long winded and I often need to have someone here to help me."

- As well as assessing a design for its accessibility with the WCAG or other accessibility guidelines, use the time people take to complete task as a measure of whether they are accessible. Set a target for the amount of time each transaction or 'task completion' must take, so that both developers and project managers know when they have reached their goal.
- Disabled people should be able to complete the same task in a similar period of time and with a similar amount frustration to other people in their peer group.

Case Study: GOV.UK Quick Answer



The new UK government website has been built with a 'Quick Answer' functionality which ensures the most common requests for particular kinds of information are served with the smallest number of steps for the user. This has been done by placing the piece of information people are most likely to be looking for near the top of the page and with prominent formatting. This ensures that both screen reader users and others are able to get to the key information quickly. When finding out when the next Bank Holiday is, this strategy has meant that the key piece of information (the date of the next one) is actually visible in the search result in Google, meaning that the user does not even need to visit the GOV.UK website.

B3 Consider the experience before and after the web

A system is only as strong as its weakest part. To be usable by disabled people a whole service must be considered in from end to end, with the accessibility of every step ensured.

Ivy, who is blind, used to order her shopping online and have a friend help her label all of the shopping as it arrived. Once labelled, either with braille or audio tags, she could then put it into the cupboards in the right order, and later on when she wanted to eat she could identify what she wanted, and also hear or read the cooking instructions if she had decided to record them.

She cannot do this by herself however, and as the friend is now not available she cannot shop online any more, and has to navigate to the shops and ask for help with the shopping.

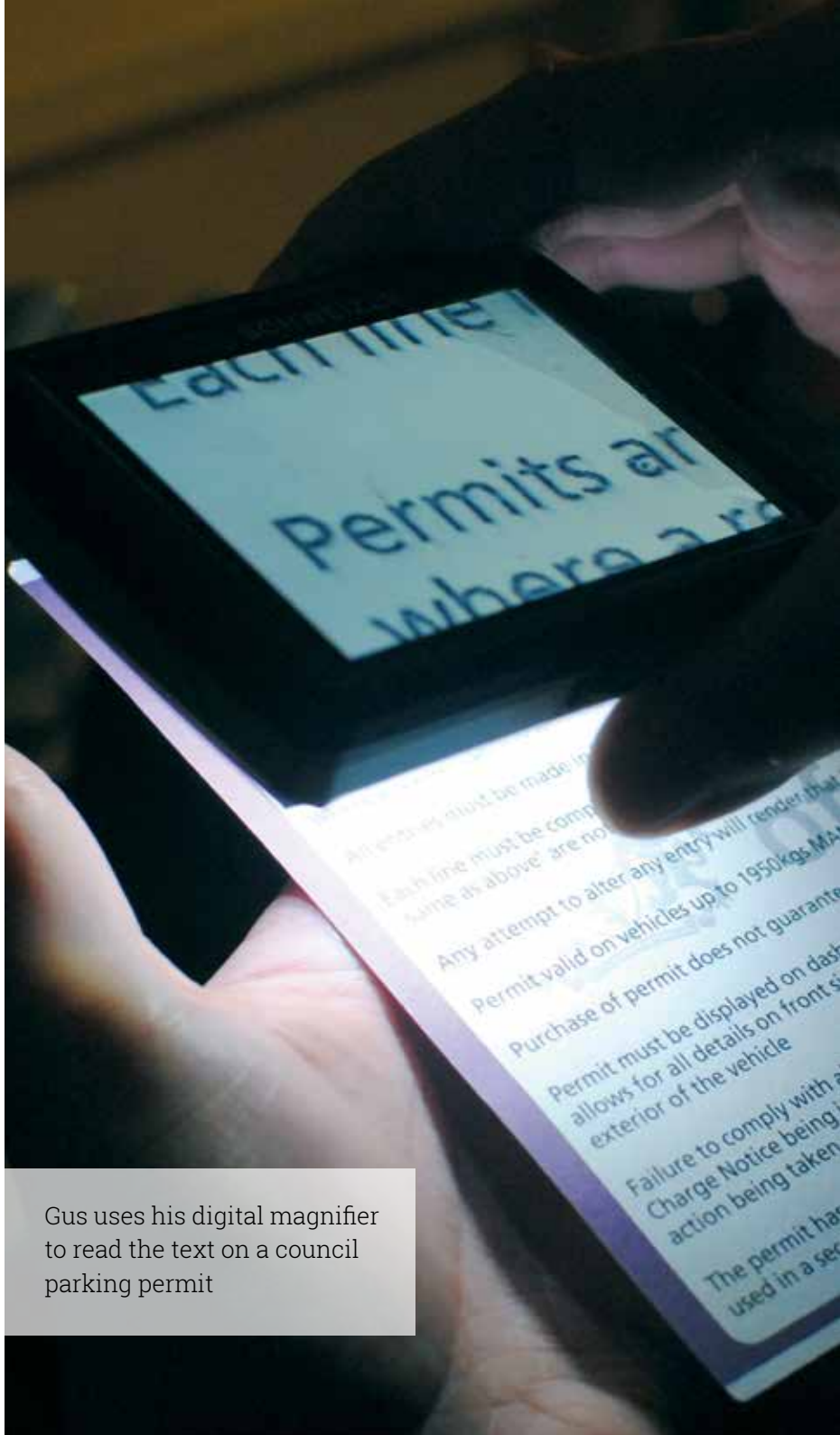
This is just one example, as there are plenty of services that have a paper component, which may be inaccessible to a blind person. Services with any physical components might exclude people with poor motor control or dexterity, or mobility.

Shani would like to make her benefits claim to the local council by herself, but it requires that she complete various paper forms and send it in, with accompanying ID. Each step of this transaction in isolation is incredibly difficult, and when combined together become totally impossible.

Lyn would also like to be able to deal with any benefits issues herself. Unfortunately, as she does not have sufficient control over her speech to phone the necessary people, she must wait until a particular support worker (who has good English skills) is available to help. If she could perform these transactions digitally she could do them herself.

Paul finds contactless payment a huge improvement over Chip and PIN.

"If you're not that dexterous is there an alternative option? One of the biggest things for me recently is contactless cards. I was always fine with pin numbers but when they started putting those guard things around the keypads, my arm is quite big so it meant I was having difficulty getting to the buttons in the corners or on the top row. Whereas now it takes no skill at all, you don't even have to get massively near it for it to work, so that is good for me."



Gus uses his digital magnifier to read the text on a council parking permit

As it will be an extension of the default digital channel the UK Government's 'Assisted Digital' scheme is likely to be more expensive to administer than the fully digital service (per transaction).

It may also be difficult for disabled people to use, whether they have to telephone during limited hours, or travel to an office in person.

Maximising access to the digital service, by filling in any technology gaps before and after the web service itself, as well as building in the best accessibility features, ought to both maximise the independence of the disabled people using them and save the service provider money.

Fixing a particular link in a chain for one transaction may also have positive wider consequences and knock on effects for others. The broken part of one chain may potentially be the same broken part of other chains. Fixing this may allow not just one, but many tasks to be completed independently.

- Consider the experience end-to-end, and make sure that the parts of the service which are not digital or online are just as accessible as those that are. The service is only as accessible as its weakest link.
- Allow the physical parts of a transaction to be also be performed with a digital device (such as near-field payment). This can often overcome an otherwise inaccessible step in the delivery of a service.

Case Study: British Gas MyHome app

MyHome is a native app for iOS and Android, which allows customers (who have the heating control unit installed) to control their heating from their smartphone. This is all made accessible through the native apps which support the accessibility features of iOS and Android, making it usable to people with impaired dexterity or motor control, or people who have visual impairments. It demonstrates how an already accessible interface (of the smartphone) can be leveraged to make other devices and services accessible.

Case Study: Voiceye

Voiceye is a proprietary system for making paper documents accessible to people with visual impairments by printing a high-density optical digital code on them. The codes are generated by a piece of software and can then be printed onto a document. A 25 mm square code can hold up to two pages of text. The codes can be read by iOS or Android devices with a dedicated app, which makes the text available to outputs such as speech, large print or braille. Voiceye represents an option for making printed documents more accessible to people with sight loss, one that could also be provided by using non-proprietary QR codes to link to text information served by a web service.

B4 Include switch users

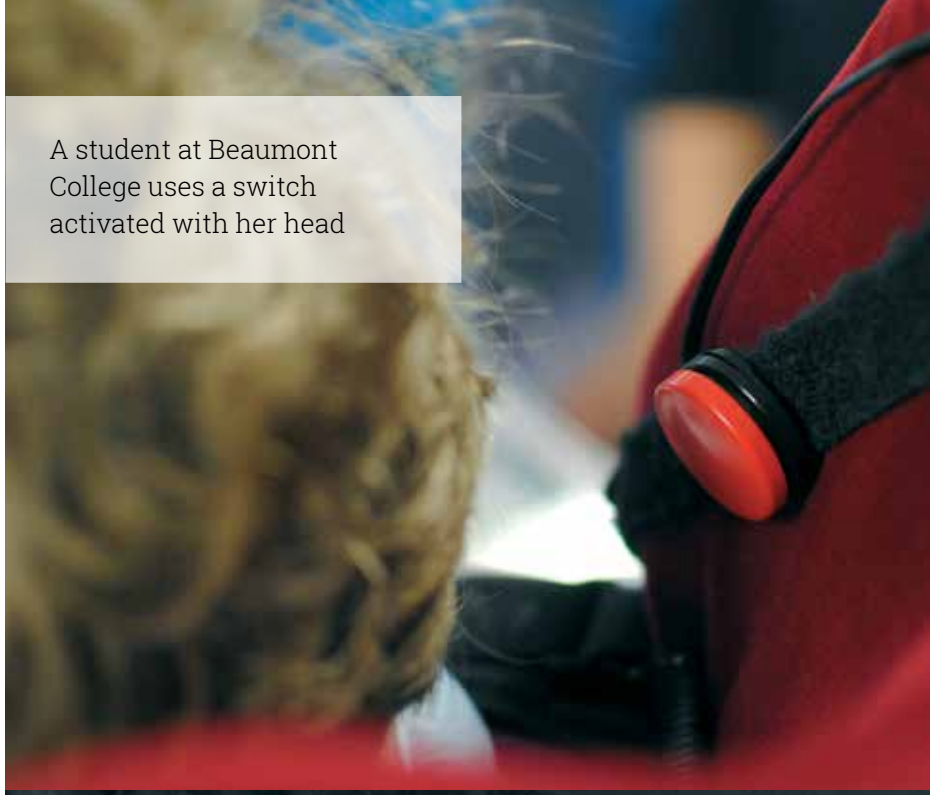
In comparison to other groups of disabled people, users of 'switch access' systems (people whose impairments prevent them accessing other digital interfaces but are able to activate one or more speciality access switches) have not received significant representation in either web standards or wider accessibility discussions. This section outlines a range of different ways digital services can be made more inclusive to them. For these reasons the recommendations presented are more detailed and technical than in previous sections.

There are many reasons why a person may be using a switch access solution, but most often it is due to diminished physical or cognitive capabilities, or a combination of those things. For example, people with severe spasticity caused by Cerebral Palsy may use one or more access switches carefully positioned to convert those movements which they can make repeatedly and voluntarily (with any part of their body) into computer commands.

Switches may also be used by people with cognitive impairments to teach 'cause and effect', and to provide simplified computer interfaces.

A typical switch access setup will involve one or more switches connected either directly to an assistive device such as a dedicated communication aid (communication aids help non-verbal disabled people to speak), or to a mainstream computer via a specialist connection device.

There are an enormous variety of switches available from circular plastic buttons of many different sizes to switches activated by breath or with one's tongue. Activating the switches typically executes a scanning command (move down, left, or select) on a specialist device, or emulates a keystroke such as 'enter' or 'space' on a computer. These commands are usually used to scan through a grid of options and select one of them. In this way speech can be generated, or other tasks can be accomplished digitally.



A student at Beaumont College uses a switch activated with her head

Access switches at an assistive technology centre in London

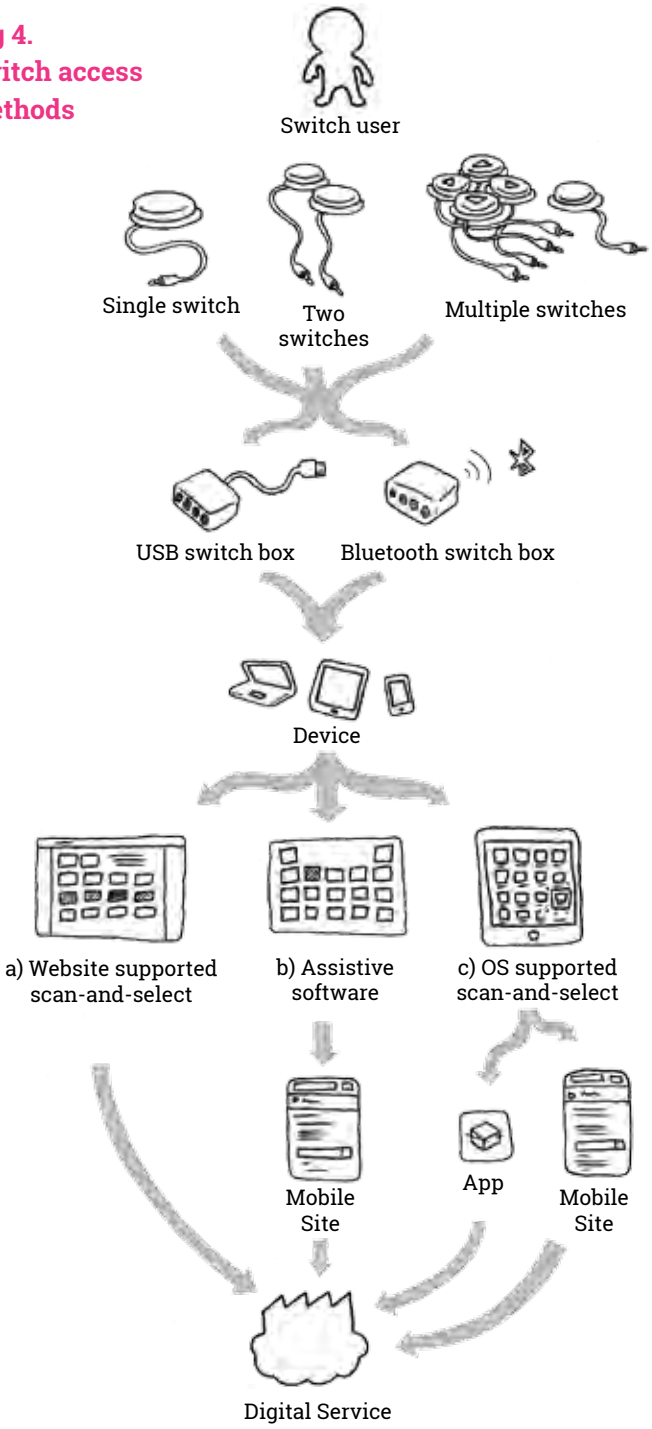
B4 Include switch users

Digital services can be accessed by switch access users in three ways (illustrated in Fig 4):
a) The interface for the service itself (website or app) can be built to support 'scan and select'. An example which provides this functionality is HelpKidzLearn [1] which hosts a number of switch-accessible games and activities.

b) An intermediary program could be installed on the disabled person's PC to make computer functions available as a scan and select interface. An example is The Grid 2, made by Sensory Software [2], which runs on Windows computers and tablets. The Grid 2 supports much core Windows and Office functionality, which it does by using the keyboard shortcuts provided by Microsoft across their products. It also supports popular digital services like Twitter and Facebook, by using mobile versions of the sites, which are cleaner and less busy, in conjunction with keyboard shortcuts. The Grid 2 allows the creation of custom grid-sets, which are often built bespoke by assistive technologists for individuals. Where keyboard shortcuts are available other digital services can be added to these grid sets with relative ease. The Grid 2 also includes a web browser which converts HTML sites into simplified grids navigable by switches, through scan-and-select.

c) On tablets and smartphones switches can be connected via cable or Bluetooth (until now via assistive technology) with scan-and-select provided by the operating system. With the release of iOS7 in autumn 2013 Apple introduced full support for switch access on all iOS devices. This will make the whole operating system, as well as third party apps (if written to best practice) support scan-and-select straight 'out of the box'. Tecla Access, a free App, already makes similar features available to Android devices. Both of these mean there are likely to be a large number of switch-access users soon using mobile devices with built in or free switch access software.

Fig 4.
Switch access methods



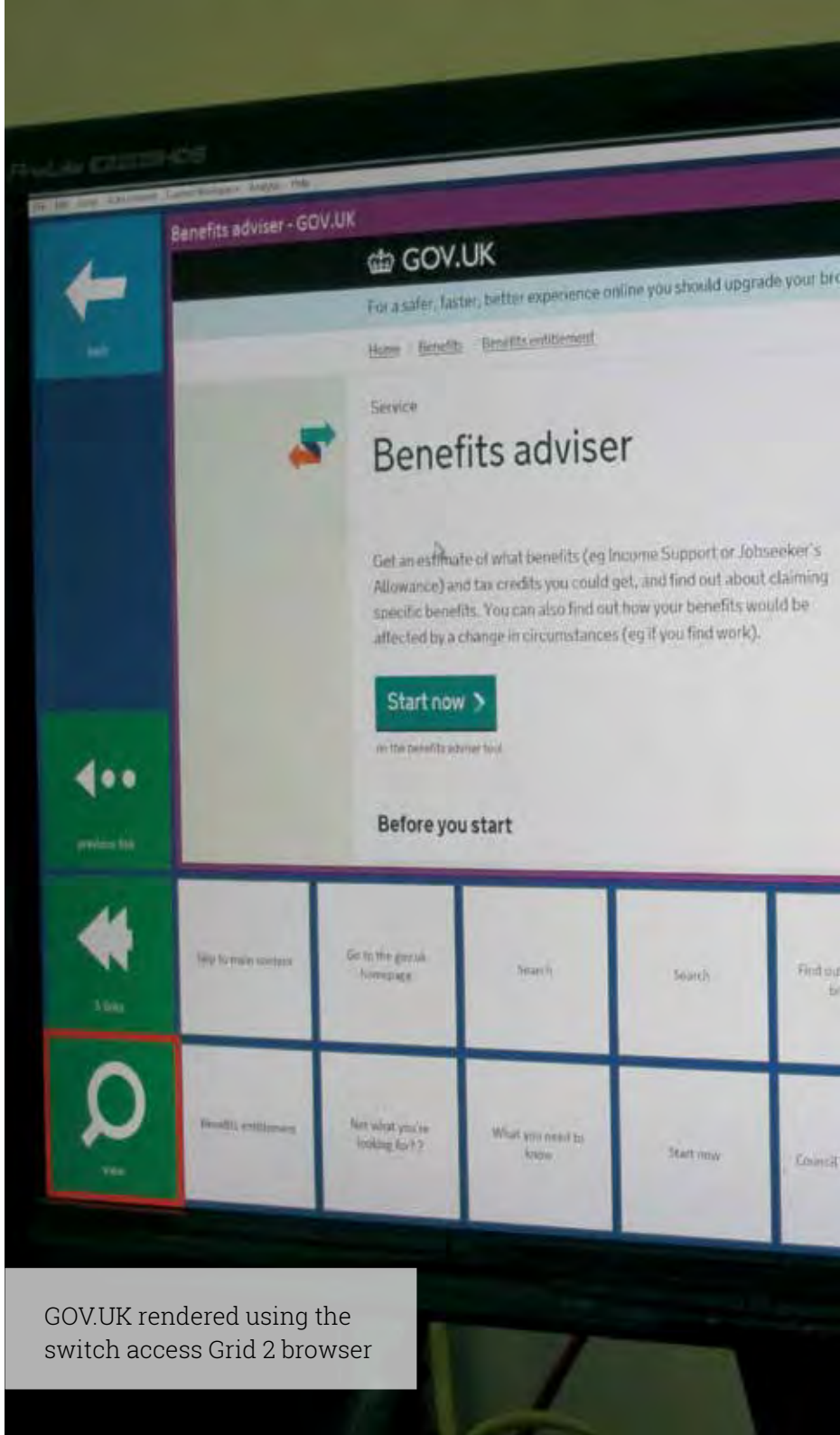
B4 Include switch users

- Go native. Writing good HTML and using standard interface elements should allow switch access users to use a website or web app. Likewise creating native iOS or Android apps to best practice, again using standard interface elements wherever possible, will make them available to scan-and-select. On iOS, build apps which are fully compatible with VoiceOver, as scanning on iOS is implemented through VoiceOver. On Android the same support for scanning (and bonus inclusion for people using keyboards or hands-free kits) can be implemented by following the KomodoLabs guide [3].

- Keep it simple. Like screen reader users, switch access users can take longer to navigate a website, web app or app. Because of this, reducing the steps required to achieve a given task is a great help. In addition, reducing (or consolidating) the number of elements between the top left corner of the screen and the elements of the task in hand will also speed things up significantly.

- Support keyboard shortcuts. The speed that switch-users can accomplish digital tasks can be dramatically increased by providing keyboard shortcuts. These make it much easier to hook up assistive technologies like The Grid 2. Maintain consistency with existing widely-used combinations such as those found in Windows or Google Docs.

- Build in scan-and-select. For digital services which are expected to be used heavily by disabled people it will be helpful to build in a dedicated scan-and-select version. This will enable switch users to use the service quickly and effectively without the need for specialist software. In this situation single switch (with automatic scanning and using 'enter' to select) or two switch (using 'space' to scan and 'enter' to select) should be supported.



GOV.UK rendered using the switch access Grid 2 browser

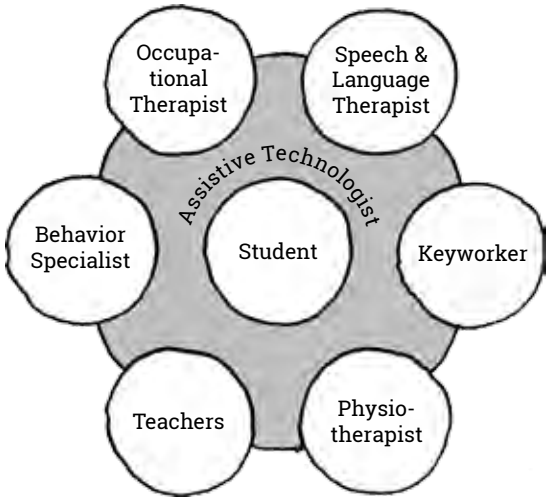
C
Future Options for Support

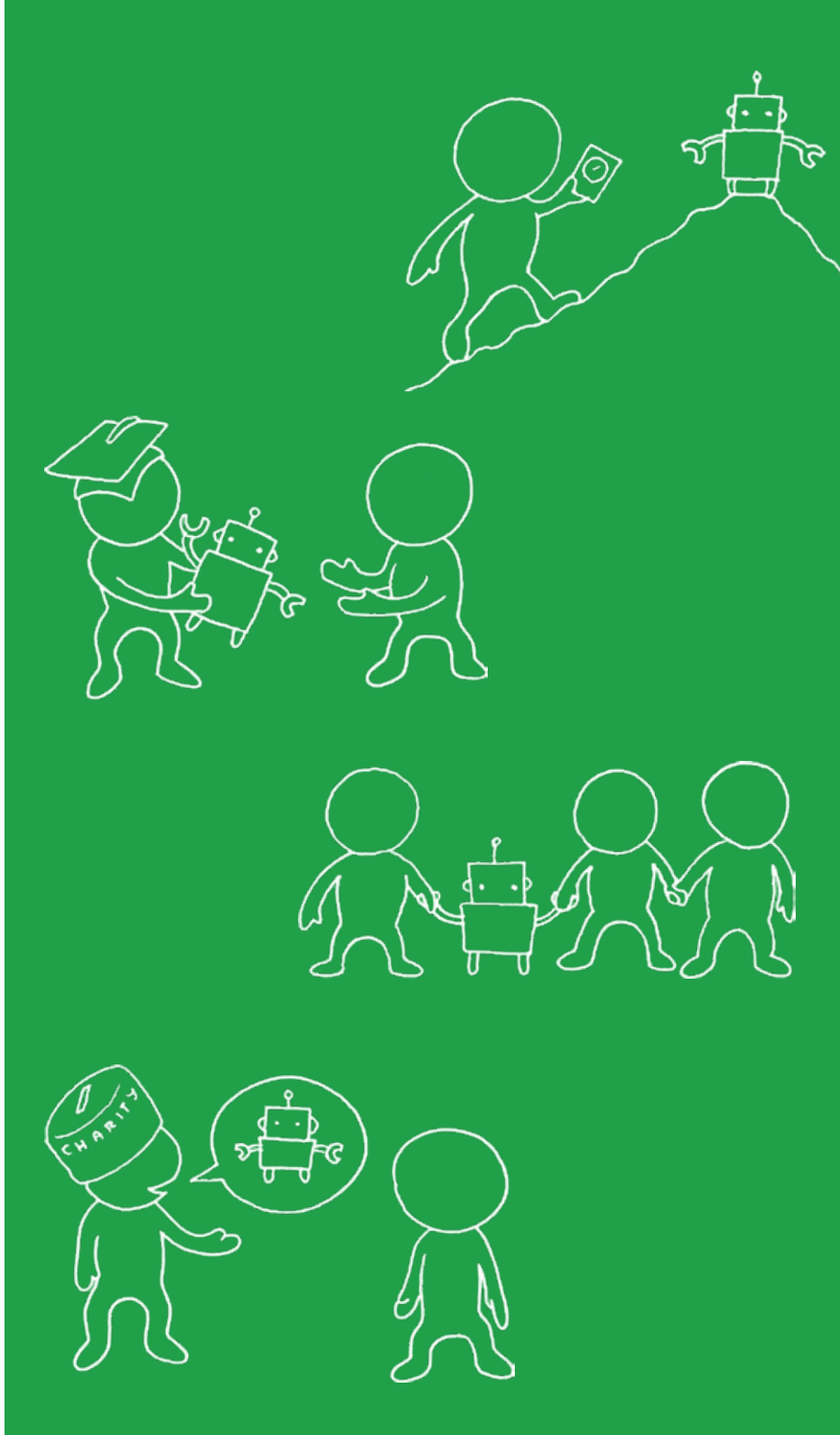
The enabling potential of both digital technology and digital services are contingent on the support that is offered to disabled people, in terms of advice on specifying and setting up devices and software, financial assistance to make purchases and support to use the technology to accomplish tasks. This section looks at opportunities where technology could be used to improve this support in the future.

The emergence of the Assistive Technologist as a profession at Beaumont College (along with similar roles at DART partner colleges) and its dissemination to other education institutions through the DART (Disseminating Assistive Roles and Technology) project points to a way technology is changing the way some of the people with the most complicated disabilities are supported. (Fig 5 illustrates how the Assistive Technologist sits between the other professionals responsible to supporting students at Beaumont College).

This section identifies two other areas where new kinds of support could be usefully be offered. It does not propose concrete recommendations for support providers but rather possible directions of travel.

Fig 5.
Diagram (after Rohan Slaughter) of the role of the Assistive Technologist in relation to the other professionals working at Beaumont College





C1 Enabling technology awareness

Disabled people who are not affiliated to any sort of institution often find it difficult to find out about potentially beneficial technologies and pieces of equipment. Indeed when analysing the balance of assistive, mainstream and bespoke technologies being used by project participants, the context in which they had been introduced to technology
was a much better predictor than their impairments or capabilities.

Gus described the importance of the services provided by the RNIB and Moorfields Eye hospital in identifying the technology he needed to overcome his sight loss:

"When I was diagnosed and my vision problems really kicked in there was a point at which I would describe myself as totally stranded in terms of vision access... And then through RNIB and the low vision clinic at Moorfields Eye Hospital I was at least able to get technology demonstrations and that introduced me to the concept of a handheld CCTV, a portable electronic magnifier, a desktop electronic magnifier, zoomtext. Otherwise how would I have heard of those things?"

Despite this help and support, when it came to identifying potentially helpful new mainstream technology - such as a smartphone that would work for his level of vision - he felt a total lack of support either in the mainstream...

"I go to mobile phone shops and they've got no idea about it at all."

...or from the accessibility specialists.

"There is no source to go to for advice because basically I've researched this as much as any of the people I could go to."

Gus still has yet to obtain a smartphone despite the enormous benefit having one would be to overcoming his limited mobility.

Shani was also unaware of inexpensive mainstream technology that could transform the ease with which she could access the digital world. After she explained how much easier she found navigating her iPhone with VoiceOver than her Windows desktop machine with a screen reader, the HHCD researchers introduced her to an iPhone compatible bluetooth keyboard. As well as improving the speed with which she could communicate, it turned out to have the added benefit of allowing her to use her iPhone in public without having to worry about displaying it to potential thieves.

Gus can not get advice on a smartphone with magnification to replace his ageing Nokia

All of the disabled people interviewed as part of the project were happy to spend their own money on increasingly helpful and affordable mainstream equipment, but often struggled identifying this equipment. Equally some, such as Paul and Lyn, keep abreast of many of the latest developments and experiment with apps and devices to work out set-ups that worked really well for them. For example, on the researchers' second visit, Lyn showed off her new Unity infra red remote, which allowed her to quickly and easily control her fan, TV and Hi Fi using her iPad, and meant she no longer had need of a more complicated assistive solution.

The Paraorchestra provides an amazingly fertile environment for its members and the people who support them to exchange information about enabling musical technology and even collaborate in the creation of new instruments.

An opportunity exists to extend this manner of, collaboration to allow disabled people to share information on which devices and software could be of use to them, how they can be best be configured and potentially how to make new open source technology.

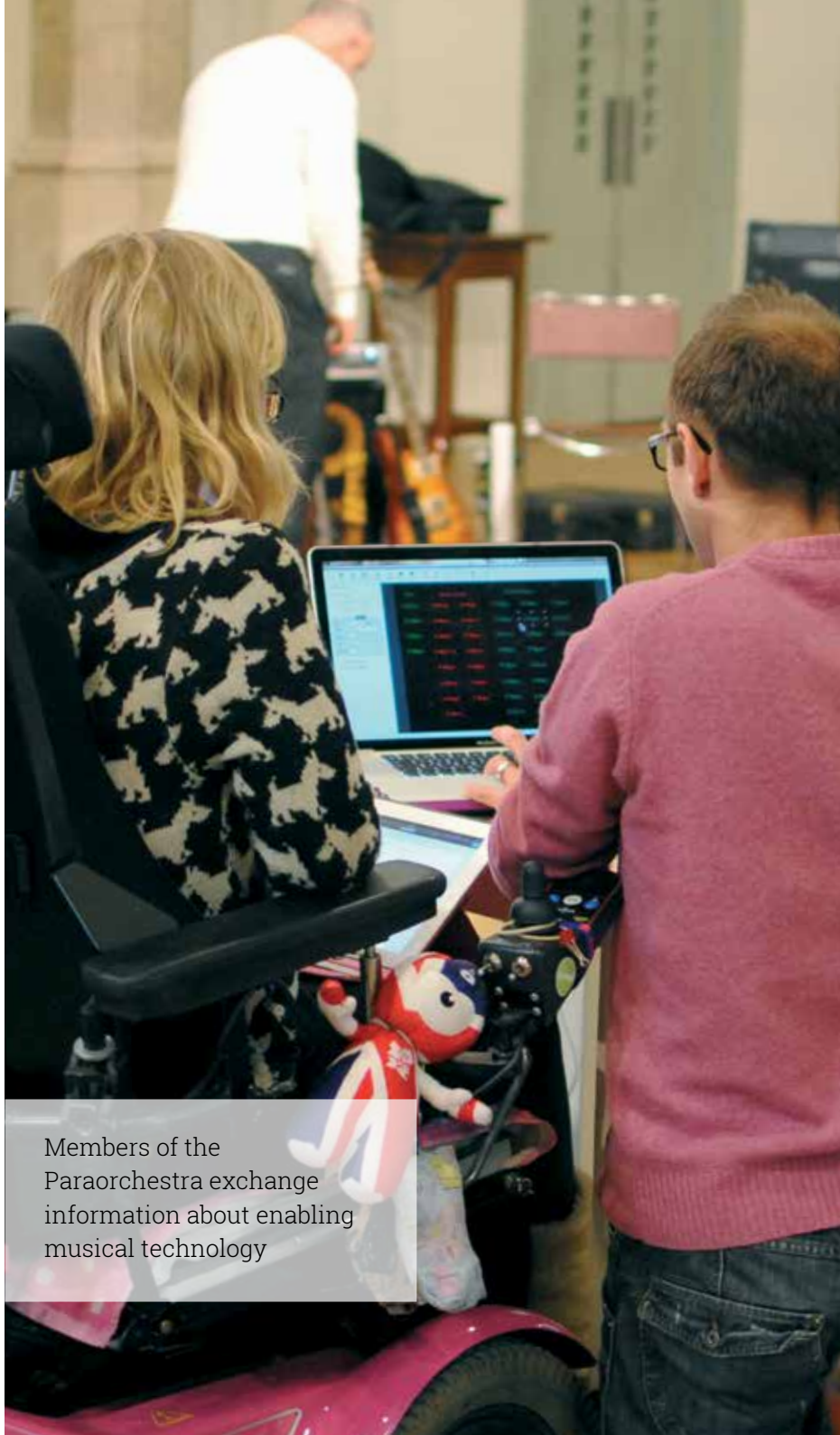
This could be achieved in two ways, but the success of either is contingent on significant promotion of the platform to disabled people and the people who support them in order to ensure a critical mass of content is established quickly.

Awareness using a new platform

The limitations in the usability of existing mainstream digital services outlined in section B point to an opportunity for a new dedicated platform, built specifically to be easy to use for disabled people to host this information. In addition education institutions and other professional support services may be more willing to share information on their practice on an 'official channel'. Moderation of the platform could be used to ensure quality, potentially increasing its standing as a trusted source of information.

Awareness using existing platforms

Despite the potential power and utility of a new platform, existing social platforms such as Instructables, Twitter and Tumblr could be used to host the information at a much lower expense. In order to create a usable database of content across disparate existing platforms, a comprehensive but simple system of tags would need to be established and publicised. Curation of a channel on an existing platform like YouTube could provide a way of ensuring quality and discoverability.



Members of the Paraorchestra exchange information about enabling musical technology

C2 Remote personal assistants

Considering transactions or services that must be designed and delivered successfully from start to finish, there will always be parts of the chain that are less inclusive than others, and are very difficult to make inclusive without the live support of a human helper.

At these points in the chain the experience for disabled people today is that they must get help from another person. This can be relatively straightforward, as they can wait for a carer to arrive and help out, or ask their family or friends for help when available, although this will always compromise their independence.

In addition, for many disabled people, just getting help from another person itself can be much more difficult than it is for non-disabled people. Dick, for example, is a retired police officer who is now living by himself and registered blind. He does not have a support worker, so for him and others like him, asking for help is both difficult and risky. He has to go and find help, and then is vulnerable to exploitation.
Meanwhile, non-disabled people in the general population, at work, college, or at home, are very used to having remote support. This can be anything from calling a telephone support helpline in a call centre, screensharing with the IT department to resolve issues, using an instant messenger (IM) program to get a quick answer from a colleague, or using LivePerson and LiveChat to "chat now" with salespeople on a website.

Society continues to accept and adopt these practices, as they lead to cheaper services and provide more flexibility to get help wherever we are, whenever we need it.

For some disabled people obtaining support on these terms may also provide increased flexibility, independence and control. Having access to a wider pool of skills than those held by a support worker who is present at a particular time, access to assistance when a support worker is not preset, and greater control over when a support worker appears and leaves, are all attractive attributes of remote support.

Opportunities also emerge for disabled people to support one another.

Obviously there are many support tasks and disabled people for whom remote support will be unsuitable. In addition for others where it may prove workable, the social contact provided by a support worker's physical presence is vital.

The protection of vulnerable people from abuse in many scenarios is also a huge challenge so robust safeguards such as procedures for vetting, alerting, reporting and checking of practice would be required.

Remote Personal Assistance should be viewed as a way to increase control and independence and not a way to provide support more economically. It could potentially dovetail as part of a wider package of support potentially delivering an overally higher quality relationship with the service user.

Lyn and her fiance Matthew, who both have Cerebral Palsy, articulated some scenarios where they felt having access to remote personal assistants would be useful.

"This would be great - we'd be able to call for help when the wheel fell off the wheelchair and stranded us in Charlton, and we'd be able to call Apple support helpline when our wifi goes down. Last time that happened we spent £80 on calling out an IT guy, who didn't even fix the problem!"

Rather than replacing the physical support workers that some disabled people have, Remote Personal Assistants could augment what currently exists to increase independence and participation.

The following scenarios illustrate some examples of how this could work.

- A person with a hearing impairment could have an important video they needed to watch for work quickly captioned or signed.
- An individual with a visual impairment could obtain help finding a mislaid object, such as a set of keys, or identifying and reading the instructions on a piece of packaging, such as a microwave meal.
- Someone with impaired speech could get assistance collecting quotations from local tradespeople over the telephone.
- A person with learning difficulties could be supported through performing a complex transaction on a website such as purchasing tickets for a concert.

Case Study: BabelVerse

BabelVerse provide remote language support over a webapp. They offer both free and paid language interpreting services by connecting interpreters with people who need them, when and where they need them. Professionals on the site must be paid for, while amateurs and beginners offer their time and help for free, to practice their language skills and help another person out.

The founders Josef Dunne and Mayel de Borniol explain:

"Interpreters are often in a position of power... So how do we ensure that people are never taken advantage of? We can't and we don't. Instead we advise people never to use BabelVerse for anything remotely 'mission critical', and tell people that they use BabelVerse entirely at their own risk. Failing this, they advise people to only use the professionals, who share their certificates online, and have passed the ethics as well as the language requirement. People still love using BabelVerse - they choose to use it and are empowered by it (using it at their own risk), and must judge the benefits to outweigh the risks for the things they use it for."

Both groups (interpreters and those that require translation) sign themselves up for the service, and create their own profiles, where they describe the days and times they are available, as well as the languages they speak, and the domain expertise they have.

In practice, Remote Personal Assistance could be offered in two basic forms.

Remote assistance on a per-user basis

Remote personal assistants could be assigned to individual disabled people, to help across different digital services and physical problems as needed for that client. In one scenario, individual disabled people would each choose their own remote assistants, with each worker having a caseload of a number of disabled people to support. Strong relationships and trust would be built up, with remote personal assistants being able to quickly and easily offer appropriate support, delivering a tailored service, as they would know and understand the needs of their clients.

Remote assistance on a per-product or per-service basis

In this model, remote personal assistants could be built into existing digital products and services, and be available for all consumers to use, as and when they need that extra level of support. This would be a more powerful version of LiveChat, screensharing or call-centre support, where many different channels of communication are visible to the digital support worker. These channels could include:

- Screensharing
- Webcam(s)
- Audio in
- Audio out
- Sharing of keyboard, mouse and other inputs (such as switch inputs) from the client
- Transmission of keyboard and mouse from the remote personal assistant. Sharing of keypresses would allow the support worker to correct for missed keys, and other small errors which build up to large frustrations

Conclusion

The Enabling Technology project has built on Scope and BT's pioneering partnerships in the field of technology. It has defined enabling technology as piece or combination of mainstream or assistive technology which can enable a disabled person to live more independently.

Underpinned by focussed qualitative research with people, this report has explored the causes, impact - and offered solutions – to the challenges disabled people experience when trying to utilise the full potential of new technologies.

Key insights have included: the importance of flexibility in all types of technology and digital services for disabled people, the cost and lack of flexibility inherent in much assistive technology, the limited availability of good quality information to help disabled people find enabling technology, and the huge potential for digital services to increase disabled people's independence, if they can be made accessible to them.

The solutions that were identified fall across the development of new technologies, and the delivery of digital services. Key recommendations include adapting mainstream hardware and using open, flexible technology to create products that can be tailored to individual users. Two technology exemplars, the Pop-up Reader and Tailored Touch, have been created to show these broad principles working in practice.

When addressing key digital services, the report emphasises the importance of customisation, using the time taken to completing tasks to assess accessibility and considering the service in its entirety. It also explains how switch users can be included. Taken together, the insights and recommendations set out a vision for the future of technology that spans business, utilities and government and has a relevance to all.

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www.sensorysoftware.com

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www.komodoopenlab.com/tecla/developers

Guidance

'Includification - a practical guide to game accessibility', AbleGamers
This guide shows how to make gaming as accessible as possible to people across all disability groups. Accessibility options are arranged by "Good/Better/Best" in an easy to understand way
www.includification.com

'Mobile Developer's Guide to the Galaxy', Enough Software
A guide to developing apps for all mobile platforms which has a whole section devoted to accessibility. It covers the basics and links to other sources for further detail.
www.enough.de/products/mobile-developers-guide

Data

WebAIM
A source of quantitative data on the browsing habits and the usage of various assistive and mainstream technologies amongst disabled people. Surveys now cover screenreader users, low vision users and people with impaired mobility.
www.webaim.org

Resources

Communication Matters
This is an umbrella organisation and annual conference concerned with providing a voice to those who need one, through the provision of AAC (Augmentative and Alternative Communication)
www.communicationmatters.org.uk

AppsForAAC
A comprehensive list of Apps (for mainstream devices) available for AAC, including reviews and details of pricing and operation.
www.appsforaac.net

Online Grids for The Grid 2
Contains over 300 grids available for switch users to download and use. It gives more flexibility and versatility to The Grid 2, making it more powerful for the people who use it.
www.sensorysoftware.com/onlinegrids

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Sam + Ross

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