Assistive and inclusive home technology for people with visual impairment

A review for Thomas Pocklington Trust by Jay Stow

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Introduction and summary

Introduction
Thomas Pocklington Trust plans to produce new guidance on assistive and inclusive home technology (AIT) for people with visual impairment and this report is intended to inform the organisation’s approach. The term ‘home technology’ refers to the types of technologies and devices that can be useful when carrying out daily tasks around the home and in home-based social, work and leisure activities.

The terms ‘sight loss’ ‘visual impairment’ and ‘sight impairment’ are used interchangeably throughout the report.

The aims of this report are:

- To collect and organise information on the range of technologies, products and systems currently available;
- To update Pocklington on recent advances and trends in assistive and inclusive home technology and on new and emerging systems and products;
- To present options on the scope, content and format of new information and guidance.

The report covers:

- Products, devices and systems designed primarily for people with visual impairment;
- More general assistive technology that is useful to people with visual impairment;
- Inclusive technology and accessible features that are integral to mainstream products, devices and systems designed for everyone.

Pocklington’s current Good Practice Guide (GPG6) on assistive technology in the home was published in 2011. It focuses on low-tech assistive technology and ‘how it can make a big difference at relatively low cost and effort’. The Guide gives examples of simple devices to help with daily living activities and includes individual case studies about the kinds of products that people use and like and what else they would find useful, if it were available or affordable.

Pocklington has also run an Assistive Technology (AT) Champions Project, which trained volunteers, including people with sight loss, to
enable them to help and support others to understand and make the most of technology.

Pocklington has recently commissioned the consumer research organisation Rica to carry out two separate research projects on the design and accessibility of central heating controls and cooking appliances. While the research found positive examples of accessible features and thoughtful design elements, the studies highlighted a number of issues and problems, some of them created or magnified by technological advances and trends in modern design (e.g. tiny digital displays, touch screen technology and smooth, shiny, streamlined surfaces).

Extensive desk-based and online research was undertaken in order to inform this report and fourteen expert informants were identified and consulted. The interviewees offered a diverse range of perspectives and included: academics, researchers, technology developers, frontline advisors, technology users and experts from non-profit organisations in the sight loss sector.

In order to develop a comprehensive overview of the technology landscape, this project has taken a broad definition of assistive technology, including any products, equipment, gadgets, systems, software or hardware that could be useful for visually impaired people within the home environment. The report discusses technologies that are both hi-tech and low-tech, considering the technically complex alongside the profoundly simple, with a central focus on how products can enable and empower people with sight loss in their everyday lives. The term ‘assistive technology’ here includes products that may be referred to elsewhere as ‘adaptive’, ‘accessible’ or ‘assisted living’ technology or as ‘accessible ICT’. ‘Inclusive technology’ refers to mainstream products that are accessible to visually impaired and other disabled people. The notion of inclusive technology is connected to concepts such as ‘inclusive design’, ‘universal design’ and ‘design for all’, although, as we shall see, some mainstream products are inclusive more by accident rather than deliberate design. The subject of home-based technology naturally overlaps with areas of AIT for education, employment, mobility and community access (for example, with online shopping and banking
becoming increasingly popular, it now seems correct to consider these as potentially home-based activities).

**Summary**
The report begins by exploring current and emerging assistive and inclusive technology. Taking a person-centred, task-oriented approach, the sub-sections move through a range of different home-based activities, integrating assistive and inclusive technologies and considering the super high-tech alongside the traditional low-tech. Low-tech products are found to be generally improving both aesthetically and ergonomically, while at the high-tech end of the spectrum a colourful explosion of radical new technological innovations are noted. A trend towards inclusive, mainstream technology replacing certain types of specialist technology is observed and the potential cost savings for AIT-users are highlighted. Mobile-based AIT apps and software are mentioned throughout the first section, but the accessibility of the interfacing device itself is not discussed until the end of the chapter.

The next section of the report discusses technology trends and their relevance to people with sight loss. Some general trends in assistive technology are observed and the emerging trend towards inclusivity is emphasized and explored in detail. Moving on to describe how wider technology trends are affecting visually impaired people, many exciting, new and emerging technologies are spotlighted. There is a glimpse of a possible future where ultra-easy-to-use, highly-versatile, inclusive, personal technology is used as standard within the mainstream, with visually impaired people customizing it to their personal needs just like everybody else.

The final section of the report considers the crucial question of how far AIT is actually used. The issue of technology utilization is discussed before focusing in on the question of how people get information about AIT. Currently available online information sources are described and several interesting opportunities for improvement are identified. The report concludes by considering where Pocklington can position itself within the flourishing area of AIT and what steps the organisation can take to maximize the potential benefits of technology for visually impaired people. The idea of producing an updated guidance publication is recommended, along with the suggestion that Pocklington explore the
possibility of developing an online resource, in the form of an interactive website devoted to home-based AIT for people with sight loss.

Current and emerging technologies

Home environmental control
There is a burgeoning range of AIT available for home environmental control. Inclusive technology such as counter lights can usefully illuminate work surfaces and dimmer switches enable a greater degree of brightness control. The new Philips Hue Personal Lighting System is a good example of mainstream technology that could be especially useful for people with sight loss. It offers the ability to vary the brightness, hue and tint of the lighting to enable a wide range of subtly diverse options. The system is remotely controlled via an integrated device such as a smartphone or tablet. The RNIB LED lamps offer visually impaired people hands-free lighting that is highly portable and slickly designed, enabling them to adapt the localized lighting as appropriate to the task.

In regard to home temperature and hot water control, concern has been voiced over the proliferation of inaccessible equipment, with streamlined designs and digital visual displays leaving less scope to get tactile information and feedback from machine interfaces. Centralizing control of all home heating and hot water through an accessible integrated device could form part of the solution to this problem. British Gas is attempting to do this through its ‘Hive’ smartphone and tablet application. The latest version of the app is still not fully accessible, although British Gas is working with visually impaired technology users to try and improve the system.

Recent technology trends also threaten to undermine home access and security for visually impaired people, with concerns that touchscreen-reliant security systems could make front doors inaccessible. However, there is potential for such technology actively to improve accessibility, with biometric security technology (similar to the iPhone’s Touch ID fingerprint identity sensor) possibly making it unnecessary for people to have to fiddle around finding the right key and guiding it into the keyhole. Lower-tech solutions such as keys with in-built torches and basic intercom systems can also assist with home access and security control.
The concept of high-tech automated homes has been around since the 1930s but it is only with recent advances related to integrated technology devices and the ‘internet of things’ that this sci-fi dream has started to become reality. The integration of lighting and heating control systems (such as the aforementioned Hue and Hive apps) with systems for controlling door access, window blinds, plant-watering mechanisms etc. could enable all home environmental control to be coordinated through a single device, such as a smartphone or tablet. The European ‘IStay@Home’ Project is researching the potential for smart home technology such as this and is developing a whole system demonstrator where older people test out multiple ATs within the home. They interface with the smart home technology through an easy-to-use tablet that also acts as a highly accessible communications device. Research is also being undertaken to try and by-pass the need for a hand-held interfacing device altogether, by building speech recognition technology into smart homes themselves (so that environmental control instructions could just be directed to the room in general); however, this technology is not yet mature. There is much interest in the potential of smart home AIT, with a number of entrants in the 2015 Nesta Inclusive Technology Prize developing innovations in this area.

**Household chores and tasks**

There is an extensive range of AIT that can assist visually impaired people with household tasks such as cooking, DIY and housework. However, many household appliances seem to be getting less accessible, as the modern streamlined design and the use of digital visual displays often hinder touch-based control of the machine. Modern appliances can be an accessibility rollercoaster, with many ovens, microwaves, dishwashers, washers and dryers being inoperable by people with sight loss. Sometimes accessible options are withdrawn from the market without being replaced and some manufacturers have highly inconsistent degrees of accessibility across their range of products.

On the positive side, Whirlpool has recently released the Whirlpool Duet, a washer-dryer combination that features auditory feedback to verify programme selection. Whirlpool also offers other accessible mainstream appliances, demonstrating that some manufacturers are improving the
consistency of accessibility across their range. Mainstream microwaves are often inaccessible but specialist talking microwaves are available. Sometimes simple options, such as labels and tactile markers, can improve an appliance’s accessibility and special discs to fix around cooker dials can be useful in this respect. There are mainstream products that offer smartphone control of various kitchen appliances (such as kettles) and one of the entrants in the Nesta Prize is developing accessible technology to integrate control of multiple kitchen appliances through a mobile device.

There is a wide range of equipment that is specially designed to enable people with sight loss to accomplish tasks in the kitchen and around the home. Special gloves, grips, silicon handles and oven shelf guards minimize the risk of burning or spilling. Kitchen utensils such as baby box graters, guides for bread cutters, one-touch tin openers, Dycem mats and liquid level indicators can be very useful, as can talking tins and talking utensils such as temperature probes, egg-timers and scales. Mainstream products such as sandwich makers can also make good, easy-to-use devices for vision-impaired people. Gadgets such as needle threaders and sock-locks can be used to assist with household chores and tools such as tactile measuring tapes and audible spirit levels can enable DIY. Some entrants in the Nesta Inclusive Technology Prize are developing interesting new technology in this area. ‘Leaven Mugs’ offer liquid-level information using an elegant, temperature-based feedback system designed into their cups. Another innovator is aiming to develop bio-reactive labels that can alert visually impaired people to the condition of their food.

**Timekeeping**
A variety of special clocks, watches and timers are available to assist visually impaired people with timekeeping. Talking clocks and watches verbally speak the time on request or give auditory updates at set intervals. Vibrating watches deliver the same information through a different medium and tactile watches allow users to feel the time. The Bradley Timepiece is an elegant tactile watch and this popular product is a good example of how AIT can be desirable to consumers when it is deliberately designed as an attractive and aesthetically pleasing product. One entrant in the Nesta Prize is working on technology to translate the
visual information delivered by mainstream watches into vibration-based information, through the attachment of a small device under the clock face.

**Recognizing, identifying and locating**

AIT to assist with recognizing, locating and identifying is important to visually impaired people and a variety of technologies approach this problem, offering a diversity of interesting solutions. Labelling systems can be very useful and products such as braille stickers, bump-ons, tactile markers and squeeze-on marking gel are available to facilitate this. Devices such as the Penfriend can be used to add personalized audio labels to items and objects and the latest version of the technology works with freezer food (previous audio-labels malfunctioned under frozen conditions).

There are simple gadgets to assist with finding commonly misplaced items, such as keys that can give off auditory alerts to signal their location. The Locator Lite device can connect with two items to enable ease of detection. Specialist identification equipment, such as money identifiers, can assist with cash management and the colour coordination of clothes can be enabled by colour detectors. There is now a variety of apps offering these capabilities, meaning that smartphone owners don’t need to carry around lots of different gadgets and can often get access to the technology free of charge. Barcode recognition apps (such as LookTel or Digit-Eyes) can read the barcodes of a huge range of products and then verbally relay salient information with a good degree of accuracy. Taking identification AIT one stage further, ‘TapTapSee’ is an exciting new app that combines money identification, colour detection and complex computer vision technology to recognize a huge variety of things and relay accurate information for people with sight loss. The app also uses crowdsourcing and remote working techniques so that more complex identification assignments can be referred to real humans for resolution. The ‘Be My Eyes’ app entirely relies on crowdsourcing for identification, drawing on a pool of 130,000 sighted volunteers to provide real-time information based on images transmitted from a visually impaired person’s smartphone camera.

The ongoing smart-glasses project at Oxford University provides an interesting example of emerging technology to assist with recognizing,
locating and identifying. The glasses take advantage of an individual’s remaining vision and use enhanced contrast and boundary definition to help visually impaired people recognize objects and faces. The project has won Google Impact Challenge funding to trial the technology with forty visually impaired people and aims eventually to develop an affordable and aesthetically pleasing product. There are many different research and development projects focusing on variations of smart-glass technology and some of these are discussed later.

**Reading and writing**

There is a wide range of AIT to assist with reading and writing. Simple products such as extra-large stationery and easy-to-see calendars and diaries can be useful, as can basic tools such as signature guides, envelope guides and writing frames. ‘Swell Paper’ can enable someone to write text that rises and becomes readable through the medium of touch and scented pens enable writers to smell what colour pen they are using. One of the entrants in the Nesta prize is developing pens that can read graphical and visual information and translate it for visually impaired people using auditory and tactile feedback.

Magnifying glasses (sometimes with in-built torches) can help some partially-sighted individuals to read and recent versions of this traditional tool have steadily become more streamlined and ergonomic. Specialist electronic magnification devices (such as the Optelec Compact Magnifier) magnify images through a hand-held screen, enabling digital highlighting and contrasting to enhance visual clarity even further. Large CCTV machines do the same thing but display images on a big monitor. There is now a wide range of mobile apps (many of them free) that can replicate the magnification functions of specialist devices and such software can also be used on large-monitor computers as a cheaper alternative to traditional CCTV machines.

Reading machines combine optical character recognition (OCR) technology with scanning hardware and text-to-speech software to read out printed documents verbally when they are placed under the camera. These machines are traditionally large and expensive but once again modern mobile apps offer a cheaper alternative to smartphone and tablet users. The KNFB Reader iPhone app can read documents with a high degree of accuracy, provided the camera is pointed correctly. The
innovative Giraffe-Reader is a portable stand that is designed to hold the iPhone in place whilst reading, enabling the device to replicate all the advantages of a traditional reading machine at a significantly lower cost. Current OCR technology is very reliable under simple conditions but struggles in complex real-world environments (e.g. when text overlays images). A lot of research is being undertaken in this area and the Humanware Zoom-Twix technology is a good example of advanced OCR, as it is able to scan a whole book very quickly and can read text accurately at a long distance.

As well as the low-tech, non-electronic writing equipment mentioned at the beginning of the section, there are various technologies that enable accessible electronic writing. Text-to-speech software (such as Aesop) verbally announces letters when typed. Speech-to-text technology facilitates writing by dictation and speech and voice recognition systems have taken massive leaps forward in reliability in recent years.

A range of braille equipment is available to people with sight loss. Braille note-takers are specialist braille-centric computers, while another option is to connect braille keyboards to mainstream computing devices. Refreshable Braille Displays connect to computing devices to translate information into braille, using mechanical pins to present the text. Braille writing machines (Braillers) and braille label-printing devices (Embossers) are also available. The specialist nature of braille equipment tends to make it expensive and attempts to significantly lower the costs have yet to bear fruit. The Transforming Braille Group is one of several organisations hoping to help with this, stating that they aim to make a low cost Braille Display (£200 rather than £1000) available by 2016.

**Accessing computers and online resources**
Using computers and the internet is increasingly important in the modern world, but there is much concern that visually impaired people may be left behind if they are not able to access this technology in an effective way. Fortunately, there is a lot of AIT available to assist people with sight loss and make computers easier to use for the wider population in general. Mainstream computers have various accessible features built-in as standard, for example: embossed dots on the f, j and 5 keys, scroll wheels and easy-to-use keyboard shortcuts. Physical adaptations such
as extra-large monitors, screen-attached magnifiers, special keyboards, keyboard skins and stickers can be used to improve accessibility.

Screen magnification tools (such as ZoomText) can zoom in to enlarge text or images and software can also improve contrast and definition in a variety of useful ways. Screen readers speak out the contents of the computer screen. The JAWS screen reader is the most popular, although the NVDA Reader offers an effective (and free) alternative. The VoiceOver screen reader comes built into Mac computers as standard. Screen readers generally work well but also have many problems, a key issue being how to accurately and comprehensively translate a complex field of visual imagery into the intrinsically linear format of speech. Innovators are approaching this problem from many angles, one interesting example being ‘Matopy’, a winner in the TSB Digital Inclusion Contest (2013). Matopy attempts to translate the screen using different voices and tones to differentiate between different sections of the display and bringing in auditory signals and sound-effects to try and convey the feel behind visual imagery. The task of accurately conveying visual information through alternative modes is very important to accessibility and the problem is some way from being solved. Other approaches, such as tactile screens, are discussed later.

It is becoming increasingly common to do shopping and banking online and effectively accessing these resources could be especially useful for people with sight loss. Unfortunately, many of these sites are not fully accessible and screen readers often interact badly with the information displayed on the web-page. Bank card-readers (required for security verification during many online transactions) are often a problem for visually impaired people, as the devices tend to be small, fiddly and difficult to use eyes-free. However, some banks offer speaking card-readers or enable eyes-free phone transactions.

Apple’s Mac computers come with multiple accessibility features installed as standard, with software for screen-reading, magnification, contrasting, text-to-speech, speech-to-text, etc. Bundles of AIT software are available to be installed on other computers. UK public organisation Jisc TechDis worked on a project (Access Apps) to package 50 pieces of open source AT software together on a single USB stick that can be plugged into any computer to make it immediately accessible.
AbilityNet’s ‘My Computer My Way’ offers advice to disabled people on how to use AIT to adapt their computer to be as accessible as possible.

Entertainment and leisure
There are a large number of AIT products that can assist visually impaired people in accessing books, radio, music, TV and games. DAISY Talking Books have been around for many years and they can be accessed using specialist Victor Reader Stream Players. E-books have been great news for people with sight loss because once text is in electronic form, there opens up a huge range of options for making it accessible. The mainstream drive to translate all books into electronic form has thus had a very positive impact for people with sight loss, especially when combined with the great strides forward in inclusive tablet technology. The newest kindle e-readers have accessibility features built in as standard and are designed to be accessible right out of the box. A vastly expanded range of books can now be read in braille, thanks to new software such as the recent Kindle iPhone app. Listening to audio-books is becoming an increasingly mainstream activity and Amazon Audible is designed to cater for this mass market, with the disproportionate benefits for people with sight loss a happy bonus. National Talking Newspapers and Magazines (part of the RNIB Group) offers auditory versions of all major UK papers and magazines for a very reasonable price.

Despite the intrinsically sight-loss accessible nature of the medium, radio devices have often been quite inaccessible. The ‘Pure Radio’ provided a rare, easy-to-use option but the product was decommissioned and withdrawn from the market without adequate replacement. However, as radio and TV steadily merge into the digital amalgam of the internet, improvements in internet accessibility may be coming to the rescue. The ‘Sonata’ device is a new product developed by the British Wireless Association for the Blind: it can access internet radio, podcasts, etc. and its six easy-use buttons make it highly accessible.

The mainstream trend of dematerialisation holds many potential advantages for visually impaired people and radical changes in methods for accessing music are a great example of this. Provided the device itself is adequately accessible, storing and accessing music using a computer is much easier than finding and playing a CD (or a video or
DVD for that matter). Mainstream music cloud services like Spotify can give access to a huge amount of audio content through a computer or mobile device, although the websites themselves are not always very accessible.

Specialised TV-watching glasses and big button or easy-use TV remotes can be used to improve TV accessibility. Mainstream voice-controlled TVs, such as those recently developed by Panasonic, promise to be especially useful for people with sight loss. Audio Description (AD) enables visually impaired people to understand TV programmes better, as it provides a narrator to verbalize salient visual information. More and more content is provided with AD, as regulators have steadily introduced more stringent requirements on TV channels. The BBC improved the accessibility of its online iPlayer after sight loss organisations exerted pressure on the organisation. The BBC and Channel 4 both give information about the AD content on their websites and people with sight loss can also get information from sites such as ‘TV Help’ (which lists recent audio-described TV programme and DVD options). TalkingFlix is attempting to develop a service providing AD films and TV on demand, where people would have the option to use earphones and watch the programme alongside someone who doesn’t want to listen to AD, thanks to a synchronised audio-feed.

There is a range of specially designed board games, packs of cards, family games and toys available for people with sight loss. There is currently a big movement in computer games accessibility, with the ‘Blind Legend’ audio game one example of many new eyes-free games. The RS Games Client site enables screen-reader users to play games against each other online.

**Health, fitness and wellbeing**

AIT available to assist with fitness includes gadgets such as talking pedometers and talking timers. Smartphone apps can also provide these functions. Talking blood sugar level monitors and audio-thermometers can help with maintaining health and accessible pill-organisers and ergonomic eye-drop dispensers can assist with medication management. Personal care equipment with in-built lights (such as tweezers and mini-torch combinations) can also come in handy. Telecare and TeleHealth systems can be useful for visually impaired
people with other disabilities or health issues. They enable remote monitoring of individuals within their home and provide emergency contact and rescue services for individuals who fall or get into difficulty.

**Communication and interfacing with technology**

There are several accessible landline phones available for people with sight loss, Doro easy-see phones and BT Big Button phones being popular examples. The Alto2 talking phone is an accessible mobile device with tactile controls that is specially designed for use by people with sight impairment.

Modern smartphones offer much more than just a phone-line. As already noted in the course of this report, mobile devices can be used to interface with a wide range of AITs. These integrated technology devices are so useful that they have been unavoidably mentioned in every section of this chapter. For many people, mobiles are moving towards becoming the single gateways to facilitate interfacing with a huge range of different technologies, enabling lighting control, household appliance operation, object-identification, reading, writing, web-searching, shopping, banking, etc. to be coordinated using just one device. These tools are versatile and multi-functional thanks to the model of building a basic hardware foundation (mini-computer, touchscreen, camera, microphone, speaker, communications equipment) upon which a vast range of different software can run. The potential of these integrated technology devices to revolutionize AIT for people with sight loss is already being realized for early adopters of the technology and, as we have seen, there are many exciting new possibilities on the horizon. Making sure these integrated technology devices are as accessible as possible is therefore highly significant.

There has been a lot of concern that streamlined designs and touchscreens make modern mobiles less accessible for people with sight loss. However, adaptations such as screen-readers can mitigate these issues and can actually make touchscreen devices more accessible than their mechanized counterparts. Touchscreen readers speak what is on the screen as the finger explores, allowing visually impaired people to get information regarding the layout of the screen that would not otherwise be available. Once a user gets the hang of it,
touchscreen reader navigation in many ways represents an advance for people with sight loss, in terms of effectiveness and ease-of-use.

Apple should be credited with leading the way in being the first major mobile developer to include basic accessibility technology as standard on its devices. The iPhone and iPad come with effective screen-readers, screen-magnifiers with zoom functions, colour contrast controls, speech-to-text and text-to-speech software pre-installed and ready to go straight out of the box. The Siri voice recognition app (which comes as standard) is impressively accurate and represents a radical leap forward in speech recognition technology. The iPhone’s Touch ID system (using fingerprint recognition rather than passcodes to access the device) can also make things easier for individuals with sight impairment.

Other major mobile manufacturers have followed Apple’s lead and started producing highly inclusive smartphones and tablets. According to the Global Accessibility Reporting Initiative (GARI), several Samsung mobiles are currently even better than Apple products in overall accessibility terms. Bundles of accessibility apps can be downloaded all at once to transform inaccessible phones into accessible ones. Examples of such packages include: Equal Eyes Accessibility, IDEAL Accessibility Installer and CapturaTalk. One Nesta prize entrant is developing the Georgie Phone, a package of 20 apps for android phones all drawn from freely available open source software. The fact that mobile manufacturers are currently leading the way in assistive and inclusive technology development is very good news for people with sight loss, given the increasingly central role that these devices play in enabling access to technology in general.

Technology trends

Trends in assistive technology
From a technical perspective, the field of assistive technology has changed dramatically over the past few years, with combinations of radical new technologies proving to be game-changing in multiple areas. Traditional low-tech specialist equipment still remains very important and this will surely always remain the case. When it comes to keeping one’s pairs of socks together in the wash, for example, it seems inconceivable to think of a high-tech substitute for the simple but effective sock-lock.
Traditional specialist equipment has been steadily improving over the years, generally becoming more ergonomic, better-designed and less aesthetically offensive.

Assistive technology is increasingly being recognized as an important subject area, especially as the UK struggles with the problem of caring for and enabling an ageing population in an environment of financial austerity. Disability-focused organisations are increasingly turning their attention towards assistive technology, often beginning to develop new specialist AT teams. There are also a growing number of non-medical AT courses being offered at UK universities. However, public spending cuts have fallen quite hard on several organisations related to assistive technology, the decommissioning of the FAST database of AT-related research projects being a prime example.

The field of assistive technology is increasingly blurring into other areas as the world becomes more techno-centric. As AT develops, it naturally blends into subjects such as architecture, design, lighting and technologies for assisted living, health and rehabilitation. Advances in technology can cross over from other sectors such as sports, health, education, geo-data and computer games design. For example, headsets originally designed to improve the immersive atmosphere of computer games have provided foundational technology that is being adapted to develop specialist eyes-free navigation AT. Crucially, it seems that AT could be blurring into the technological mainstream, with inclusivity becoming increasingly prevalent in certain key technology areas.

**Trends in inclusive technology**

Mainstream technology can be considered inclusive when it is accessible to a wide range of users with a variety of different disabilities or specialist needs. Inclusive technology will be as intuitive and easy-to-use as possible (with reasonable tolerance of human error) and will be flexible and customizable to an individual’s personal preferences. A fully inclusive product should ideally be accessible right out of the box (enabling eyes-free and low dexterity set up). However, mainstream technology that can be made accessible relatively easily, such as a smartphone that becomes accessible after downloading one bundle of apps, can also be considered inclusive technology (although many of the
individual apps within the package may on their own be most accurately defined as specialist assistive technology). Versatility and scope for adaptation and add-ons are thus key elements of inclusivity. How far the accessibility is built into the foundation of the technology is a good indicator of its overall inclusiveness; a mobile with an in-built high resolution zoom function could be considered more inclusive than a device which only acquires the extra resolution after downloading a specialist magnifier app.

Although many low-tech specialist AT products seem unlikely to need radical improvement, at the higher-tech end of the spectrum this report has highlighted numerous cases of specialist AT equipment being effectively made obsolete by inclusive mainstream technology (and often by smartphone apps). Highly effective OCR or electronic magnification apps can now be obtained for free (after the initial outlay for the mobile device) and can replace specialist equipment that costs hundreds or thousands of pounds. Inclusivity can result in substantially lower costs for consumers of AIT, because mass producers recoup their costs by selling a large number of competitively priced products.

But why would mainstream, profit-making companies suddenly start caring about making their products inclusive? Several decades ago, Microsoft executives explicitly declared that accessibility was not a core consideration for them, saying that they wanted to enable a specialist digital AT marketplace to develop around their mainstream products. Unfortunately it is generally much harder to work backwards and make something accessible as an afterthought and so people with sight loss were often excluded or had to endure frustrating time-lags as complicated accessibility workarounds were devised.

In contrast, companies like Apple, Panasonic and Whirlpool now say they consider accessibility to be a core element in the technical design of their products and all these organisations can point to some good evidence to support this claim. The disability rights movement has certainly helped to make this a reality, improving disability awareness and encouraging the principles of Universal Design to become more embedded within mainstream culture. Accessibility regulations have also generally been moving in the right direction. But it is not merely that corporations are deciding to be nicer or being forced to be nicer; they
are opting for inclusivity because the practice closely aligns with key business and technology trends. Notable among these are the trends towards improved user-friendliness and personalization, which are driven by mainstream consumers wanting products that are easy to use and highly customizable. Because of this, many improvements in inclusivity occur largely by accident. The surging use of the FaceTime app (mobile video-conferencing) by deaf people communicating via sign language was a happy accident for all concerned and perhaps Amazon Audio could be an equivalent example within the sight loss sector.

The ‘happy accidents’ are happening alongside increasingly deliberate moves by companies towards accessibility and inclusivity. Product developers are realizing that they can work with disabled people to test out whether their technology is fundamentally user friendly. If they can make their products accessible to a range of ‘specialist’ users, this is likely to be advantageous for all users. Therefore, in progressive organisations, accessibility is moving from the fringe of the company (Corporate Social Responsibility) to the core of the business (Product Development). Microsoft has now changed its tune, with one of its chief technology officers enthusing about the company’s desire to ‘design for the 1% and create a novel innovation for the 99%’. Entrepreneurs are beginning to see the potential of this strategy. The start-up company Fleksy deliberately engaged with visually impaired users in order to develop its ultimately mainstream predictive text software. By starting at the ‘specialist’ end of the user spectrum, companies can benefit from an enhanced public image and improved access to grant or crowd funding, as well as actually improving their chances of developing a flexible, user-friendly product that is attractive to the mass market.

Of course, being accessible to visually impaired people doesn’t necessarily make a product properly inclusive. By definition, truly inclusive technology must enable accessibility across a broad spectrum of specialist needs, including people with other sensory impairments and people with physical, communication or learning disabilities. Accessibility for those with age-related conditions, such as dementia, also needs to be considered. Making technology accessible for individuals with multiple disabilities or health conditions can be especially complicated. For example, individuals who are vision and hearing impaired may find
audio-based screen-readers inaccessible and would generally require better tactile feedback to enable device access. The ViBe mobile app, that enables information about caller identity to be transmitted through the medium of vibration, is an example of useful AIT for this group. Enabling individuals with sight loss and learning disabilities to access technology generally demands considerable advances in user-friendliness. From another perspective, it also represents a great opportunity for innovators to learn to develop ultra-user-friendly products by actively engaging with these more ‘specialist’ technology users. Considering inclusivity for people with multiple and complex disabilities further underlines the importance of flexible technology with multi-modal, multi-sensory options.

But perhaps this report has been overly positive about inclusivity so far – highlighting success stories while perhaps not properly acknowledging how much mainstream technology remains inaccessible. The advance of accessibility regulations has been slow and the code in place is often not enforced. Accessibility rules for app developers on the Apple and Android platforms are routinely ignored. The significant issue of previously accessible apps suddenly becoming inaccessible after updating can be infuriating for visually impaired users and suggests that many companies are not quite as concerned about inclusivity as they may claim. The trends towards visualized information, miniaturization and touchscreens are in many ways making household appliances less inclusive. For the majority of manufacturers, it appears that accessibility remains far from a core consideration in the product design process.

These issues highlight the current position that mainstream technology and business trends are pointing in opposite directions when it comes to inclusive technology. Information visualization and miniaturisation trends point towards a decline in accessibility, but this may be countered by inclusivity-positive trends towards user-friendliness and personalization. The debate about how the touchscreen trend impacts upon inclusivity is complex and this is related to the trend towards integrated technology devices, which hold so much revolutionary promise for AIT.
Wider technology trends

Information visualization
The introduction of the Graphical User Interface (GUI) in the late 20th Century was generally bad news for people with sight loss. The linear DOS system was replaced with Windows and suddenly the screen was a chaotic jumble of images inaccessible to visually impaired people. The use of imagery brought advantages for most sighted people and so the trend towards greater visualization of information has continued, with quantitative data representation being a particularly current topic of interest. But there are also efforts to translate visual information into the auditory medium, with Microsoft’s Soundscape Headband being a good example. The headset uses auditory signals to show where things are (the ‘sound’ of the object appears to come from its actual location) and thus enables the development of a soundscape-based understanding of the spatial environment. Nesta Prize entrant THEIA is developing a ‘new language for motion’ to try to make sports spectating more accessible for people with sight loss. Haptic technology is trying to translate visual into tactile information and this is discussed later. NASA has developed a multi-sensory map of the stars, where sound and temperature indicate the brightness of stars. So perhaps the visualization trend could be just one aspect of a multi-sensory ‘realization’ trend, leading us towards an immersive and sense-rich virtual environment that is potentially more accessible to visually impaired people.

Miniaturisation and streamlining
The trend towards miniaturization means that products are getting smaller and more awkward to use, with fewer moving parts and less scope for tactile feedback. This is, in many ways, not good for people with sight loss, although the problem may be mitigated through utilizing accessible gateway devices or using voice control. There are some advantages of this trend for visually impaired people however, as it enables technology to become small enough to wear and can help make AT more aesthetically pleasing and thus more likely to be used.

Touchscreens
As already discussed, touchscreen mobiles can be made accessible by combining them with a basic screen reader. But if touchscreens become the standard interface for things such as kitchen appliances and door-
security systems it could be a big problem for visually impaired people unless all touchscreens are to be fitted with screen-readers as standard. This wouldn’t be particularly difficult or expensive for manufacturers to do, but that doesn’t mean they would do it. Easy-to-use gateway interfacing devices could help mitigate this problem. There are many possibilities for making touchscreens more accessible, including efforts towards translating visual information into auditory and tactile information, as discussed elsewhere in the report. There are also interesting efforts to change how touchscreens work in ways that enable eyes-free access. For example, a touchscreen dialling system (developed for drivers) where the numbers are positioned systematically (in traditional layout) relative to where the finger first touches the screen.

**Integrated technology devices**

Integrated technology devices (mobile interfacing devices) have been discussed throughout this report but it is worth emphasizing here that the trend is towards ever deeper and broader integration of technologies. It is plausible that mobile devices could become door keys, bank-cards, ID cards, etc., as well as gateways to many of the other functions already described.

**User friendliness**

User-friendly products are naturally more popular with consumers and there has been a concerted drive by producers and developers to make their technologies easier to use. The user-centred design approach engages with users throughout the product development process, using iterative feedback to refine technologies. The general principles of user-friendly design are very similar to the principles of accessible or inclusive design and some developers have realized that designing for a variety of ‘specialist’ users is likely to be the best way to make reliable, easy-to-use products for the mass market. Mainstream user-friendly technologies aimed at people who are temporarily disabled, such as the driver’s touchscreen dialling technology (mentioned above) can often have spill-over benefits for visually impaired people.

**Personalization**

Consumers are demanding that products become more flexible and customizable so that they can personalize them according to their own individual needs and preferences. Amazon Audio provides a good
example of why this is generally good news, as the mainstream demand for multi-sensory reading options has improved text-accessibility for visually impaired people. Personalization could dramatically change the fundamental concept of ‘specialist’ technology. After all, what is ‘specialist’ if everyone carries personal technology that is specialized to their needs? A visually impaired person may have a non-glare, defined-colour-contrast appliance, not because it was especially designed to be accessible but because everyone expects detailed choices regarding the colour of their products… not just because of need, primarily because of preference.

3D Printing
3D printing enables greater personalization of products and could change the economics of production in a way that is highly significant for visually impaired technology users. If 3D printing removes the economies of scale usually enjoyed by mass production and encourages decentralized production closer to the point-of-need, then specially-adapted assistive equipment could be ‘printed’ at a low cost. The BBC recently reported the case of a wheelchair user developing his own personalized ramp and posting the resulting design file on the mainstream innovation forge Thingiverse, along with an open request for assistance in improving his equipment.

Open innovation and crowdsourcing
The open innovation trend impacts on the development of AIT for visually impaired people in a variety of ways. Open source products (software or datasets describing physical hardware) are developed through an online cooperation of volunteer workers. OATS is an open source ‘forge’ specifically developing AIT and Vinux is an open source project developing pre-configured, eyes-free adaptations of Linux software. Open sourcing software development enables the core code to be modified and adapted by others, potentially making it much easier to build in accessibility features at a later date. Crowdsourced innovation can facilitate user-centred design and enable co-creation between producers and consumers and such mechanisms can be used to help AIT manufacturers engage with visually impaired people. RNIB’s ‘Read Wonderland at Waterloo’ event in 2013 showed how crowdsourcing can help produce lively audio books and the previously mentioned
BeMyEyes app (crowdsourced image recognition) is another example of how this trend can be imaginatively utilized to assist people with sight impairment.

**Voice recognition and the conversational internet**
Voice recognition has the potential to be a very significant enabler for visually impaired people. Since Siri first really cracked the problem for iPhone users, Apple’s rivals have developed competitive alternatives, with Android’s Voice Assistant often doing even better than Siri when tested head-to-head. As this technology advances there is scope for a huge range of AIT to be voice controlled and there is the tantalizing prospect of the conversational internet, where you can ask questions and give instructions and let the artificial intelligence decide how it is going to accomplish the task (without necessarily bothering to tell you what apps or sites it is using, for example). The technology needs considerable improvement in real-world environments.

**Internet of things**
A proliferation of computer chips inside a wide variety of machines and objects has given rise to talk of the internet of things. This is already being used to facilitate beacon technology for outside navigation and could also be used within the home as appliances become increasingly smart (fridges that can assess food safety, for example).

**Computer vision**
Computers are getting dramatically better at recognising writing, objects, faces and expressions. In simple conditions most of these problems are effectively solved but in the real world the technology falters in complex, chaotic environments. The previously-mentioned Oxford smart-glasses project was partly inspired by the insight that the task that the computer finds difficult (the final recognition) is the task that the human often finds easy. Therefore in the Oxford smart-glasses, the computer focuses on enhancing the image in order to maximise the person’s ability to accomplish the recognition task using their remaining biological vision.

**Wearable technology**
Advancing computer vision technology is enabling wearable Glass technology to move forward on a variety of fronts. Google’s 2014 ‘Give Vision’ project aims to combine text, object, face, expression and
environment recognition technology in an ambitious piece of Glass AIT which could narrate the visual world to a visually impaired user. Smart watches could be advantageous for people who may benefit from hands-free interfacing with technology. The joint MIT and Singapore university project to develop a finger-worn OCR reader provides another example of how wearable AIT could be useful to people with sight loss.

**Haptics**
Haptics is an exciting area of emerging technology very much in its infancy. A Disney-backed project has developed prototype technology that enables images on a touchscreen to be felt, by creating an ingenious tactile illusion for the exploring finger. There are also attempts to develop effective artificial skins that could sheath touchscreens to enable greater tactility. Bristol-based company Ultra-haptics has developed technology that can create tactile illusions above the surface of its special device. The technology can make users feel bubbles popping under their hands and can even enable them to turn an invisible dial in mid-air using their fingers. Haptics provides a new medium to deliver information feedback that is intrinsically accessible to people with sight loss.

**Aesthetics and design**
One significant trend is that personal technology is becoming increasingly cool in the mainstream. Slick, aesthetically pleasing devices such as the iPhone and iPad are highly desirable status symbols and it is now normal for people to walk around with multiple gadgets on their person. AIT needs to be designed to be as appealing as possible in order to reduce stigma and encourage its use. The previously mentioned Bradley Timepiece is an example of designers responding to this demand.

**Technology of the future**
Despite several areas of concern, there is a good prospect for mainstream technology trends to enable an exciting future for assistive and inclusive technology. Government regulations and pressure from special interest groups can provide a stick to encourage private companies towards greater inclusivity but the carrot of profitable business opportunities is probably more important. The ageing population is increasing the market size for AIT and encouraging profit-
motivated investors to target the sector in search of financial returns. Although most organisations have not yet adopted inclusivity as a core concern, the companies that are taking it seriously include the most profitable companies, the market leaders and the biggest brands in the technology sector.

In a future where everyone uses personal and home technology specialised to their individual needs and preferences, perhaps inclusivity will be expected as standard. Visually impaired people would have less specialist equipment and would increasingly rely on inclusive mainstream technology. Often these mainstream products will need to be adapted with specialist add-ons or modifications but many of these specialist elements are likely to be discreet.

**Applying technology in practice**

**Using technology**

There is an extensive range of AIT available that could be useful for visually impaired people, with many radically new products released in just the last five years. However, the potential benefits of the already-available technology are far from being realized. Reasons for this include: people with sight loss may not know what products exist; they may have difficulties acquiring or learning to use AIT; or they may be sceptical about technology in general. People decide what technology to use based on what works for them in their specific context, and whether they believe that the technology is reliable. Cost is, of course, a significant issue, especially given that visually impaired people tend to have lower than average incomes. The stigma that is attached to AT is a big factor inhibiting its use, with traditional equipment often looking medical or child-like and with bulky, awkward designs drawing attention to someone’s disability in an unwelcome way.

Certain groups tend to be in greater danger of getting left behind when it comes to accessing technology that could help them in their everyday lives. Disabled people are statistically less likely to use the internet or mobile technology, compared to the non-disabled population. Older disabled people are even more likely to get left behind, as are people with complex disabilities.
Deciding whether to use AIT (or what AIT to use) is very much a matter of personal preference and some people are less technology-inclined than others. Some people will take a minimalist approach to technology. Why use complex, smart-glass, object recognition technology to distinguish between your tea, coffee and sugar jars, when a low-tech solution like tactile markers will suffice? Why even use the tactile markers, when buying three differently shaped jars offers a subtler and perhaps more aesthetic solution? Why even bother doing that if your hearing enables you to identify the contents with one quick shake of the jar? But then some people would prefer the high-tech solution anyway, perhaps because they are a technophile at heart or because think that smart-glasses look cool.

There are technophiles of all ages and disabilities and such individuals often find it hard to understand that most people are instinctively quite technophobic. People may recognize the potential value of AIT but don’t use it because they think it would be too difficult or because they simply never get round to learning how. There is often a ‘hump’ when it comes to learning to use a particular piece of technology. For example, it takes time to get used to using a smartphone and some people may not have the patience to train themselves. Therefore technology training and education (both formal and informal) can play a significant role in encouraging utilization of AIT. People need to habituate their use of AIT in order to maximize its benefits, so it is important to think about how technologies can fit into people’s lifestyles, routines and habits.

Using technology can encourage the human urge towards ingenuity. Many people with sight loss enjoy using their own resourcefulness and creativity to help them find solutions to everyday problems. For example, individuals might enjoy using a ping pong ball as a pleasingly eccentric liquid level indicator, while using the actual liquid level indicator as a handy device to test their fuse box. Or they might tie a red ribbon to the handle of their teacup, as an elegant and aesthetic solution to help them locate and drink their tea. Once they have adequately resolved a problem, many people like to stick with what they know, even if they acknowledge that a more efficient alternative is newly available.
Whatever they ultimately choose to do, people need to have good access to information about AIT in order to inform their decisions in this area.

**Getting information about technology**

People with sight loss can get information about AIT from a variety of sources. Word-of-mouth is important, with many people hearing about technology from friends and family. If a visually impaired person knows someone who actually uses a particular piece of AIT, this can make them more likely to imagine themselves using it. People also get information from professionals such as occupational therapists, support workers, GPs and vision specialists, although many of these frontline workers do not themselves have detailed knowledge about available AIT. Individuals may receive limited technology-related information when they are first registered as sight impaired (although they often don’t feel like concentrating on getting AIT at that moment in their lives). Local authorities can provide AIT information, although the service varies dramatically between different localities. Low Vision Clinics or Local Disability Resource Centres can also be useful information sources, with resource centres enabling people to try out the technology for themselves. People with sight loss often engage with charities (both at local and national level) to get information about AIT, for example through Macular Society magazines, RNIB’s ‘Switched On’ newsletter or from various assistive technology roadshows. Because of their extensive reach, mainstream media sources can be especially effective in communicating information about AIT, when they choose to cover the subject.

A variety of AIT information is available online to people with sight loss and to family members, friends or support staff who might search on their behalf. Websites with useful AIT information include:

Sight loss sector (UK):

- Royal National Institute of Blind People
- Action for Blind People
- Royal London Society for Blind People
- Guide Dogs
- British Computing Association of the Blind
• Sense
• Seeability

Wider disabilities and AT sector (UK):

• Disabled Living Foundation
• Rica
• Age UK

International:

• American Foundation for the Blind
• European Assistive Technology Information Network (EASTIN)
• Global Accessibility Reporting Initiative (GARI)
• Cool Blind Tech
• Open Source Assistive Technology Software (OATS)
• AppleVis

AIT developers and professionals can also get information from the above sources, as well as:

• NHS Online Catalogue
• British Assistive Technology Association
• DLF Data
• Ability Net

These websites provide a range of AIT information in different formats, including: information and advice webpages, downloadable factsheets and documents, product lists and databases, online shops and loan services, question and answer-based recommendation systems, product reviews and tech blogs. The general trend in the sight loss sector is that organisations are increasing the amount of AIT information they provide online and are focusing their efforts on technology that is especially relevant to their particular area of specialization. For example, the organisation Guide Dogs concentrates on AIT that assists mobility, transport and navigation, whilst the Royal London Society for Blind People tends to focus on high-tech AIT and technology likely to be especially popular with young people. The value of a sight loss organisation’s disability-specific, special-focus information resources becomes clear when they are compared to large databases (such as the
European portal), which are generally not user-friendly and are unlikely to be used by many visually impaired people directly.

There is quite a bit of AIT information available online, but there is much progress to be made in this key area if the potential benefits of assistive and inclusive technology are to be fully realized. There is a need to improve opportunities for people to search from a task-oriented, rather than technology-specific, focus, enabling people to ask ‘what AIT options are available to help me with reading?’ rather than ‘what magnifiers are available?’ This would allow people to start with the real-life problem they need assistance with, rather than jumping straight into selecting a technological solution. Bringing together information and guidance on mainstream, inclusive technology and specialist AT represents a considerable opportunity to improve the system, as does integrating information from areas such as lighting and housing design, where technology is playing an increasing visible and frontline role.

There is also much scope to provide improved guidance alongside product information, for example product accessibility rating systems that take account of different types of visual impairment. People generally want personalized technology recommendations rather than long lists of difficult-to-compare alternatives and new systems could be developed to offer these facilities online. There is good potential for improving user-review systems as well as developing online communities where visually impaired technology users can discuss AIT peer-to-peer. Such communities could also connect visually impaired technology users with AIT developers, enabling designers and manufacturers to learn from those with first hand experience.

There is a general recognition across the sight loss sector that AIT information provision needs to be improved considerably in order for the benefits of technology to be maximized. Suggested strategies for progress put forward by experts in the field include measures such as better integration of AIT needs assessment within Government support or benefits assessments and improved opportunities for face-to-face AIT advice and training. There are also many calls to improve and expand web-based AIT information resources. The UK ‘Assistive Technology Alliance’ has produced a report entitled ‘Anarchy or Opportunity: The Future for Assistive Technology Information Services’, calling for
improved online AIT information provision. The International Assistive Technology Alliance also emphasizes the importance of this endeavour, with further support coming from documents such as the Helen Hamlyn Centre for Design’s ‘Enabling Technology Report’.

**Opportunities for Pocklington**

This review highlights the importance of producing guidance that assimilates low-tech and high-tech solutions and includes both assistive and inclusive technology. The guidance should also link across to lighting and architectural design, as AIT is an increasingly important driver for change in these areas. It is recommended that the new guidance publication builds on this report by taking a person-centred and task-focused approach to organizing the presentation of the information (household chores and tasks, reading and writing, etc.) The primary audience for the new guide should be people with sight impairment and their families and advisors, but it should also aim to be a useful resource for technology developers and professionals working in relevant industry sectors.

One of the unavoidable limitations of the new guidance publication would be the problem of it quickly becoming outdated. This is always true where cutting edge technology is concerned but the issue is especially significant because the field of AIT is currently undergoing a paradigm-shifting technological revolution. Many of the example products mentioned in this report were not available a couple of years ago and the trend of exponential advance is likely to continue. This report has detailed numerous ways that digital technology can improve access to information for visually impaired people, so it seems natural to consider a virtual solution to the problem of keeping guidance up-to-date. Pocklington could build on the published guide by developing an online information resource, in the form of a dedicated website connected to the main Pocklington site and carrying links to other sources of information, advice and support both within and beyond the sight loss sector.

An online resource would give Pocklington the ability to present and readily update information on specific products, systems and devices, including what they cost and where to find them. It could provide advice and guidance on types of products, how they are evolving and what new devices and systems are becoming available. The site could also look to develop an online community focused around AIT, facilitating discussion, peer advice, exchange of ideas and the crowdsourcing of innovative solutions and ‘workarounds’. It could become a platform for comment
blogs, a regular news slot and features such as ‘product of the month’ or a design competition.

The site would provide the opportunity to communicate the findings of Pocklington’s research and development work around AIT to a wider audience. It could also become an integrated platform to publicise new research (by Pocklington and others) and promote research-led initiatives in related fields, such as lighting and architectural design. The versatility of the online medium would allow Pocklington to design particular areas of the website for specific target audiences (e.g. frontline professional advisors, product designers and technologists, manufacturers and retailers etc.) In this way, designers and producers could be encouraged and supported to develop well-designed assistive and inclusive technology.

The online guidance could take advantage of some of the technologies and systems discussed in this report to present the information in a highly accessible, multi-sensory manner. Useful visual information such as screen layout could be conveyed elegantly using audio cues and voice variations and features such as a virtual ‘walk-through’ home with an audio guide could be included. The online community element has a lot of potential, given the importance of peer advice in the adoption and utilization of AIT. There is the possibility of creating an expert panel of volunteers willing to test and advise on products and the potential to use social networking to raise awareness of available and emerging AIT. Such a resource could also be useful to AIT producers and could lead to development of a commercial consultancy service or facilitate direct engagement (and possible co-creation or user-led design) between companies and visually impaired technology users. The project would bring opportunities for partnership with university-based research centres, design companies, consumer research groups and other interested organisations. It could also attract sponsorship from major manufacturers, retailers etc. across a range of industry sectors.

The online resource would build on some of Pocklington’s core areas of specialist expertise by focusing on home-based technology and integrating information on lighting and architectural design. As well as building on the AT and proposed AIT guidance publications, it would draw on knowledge and insights developed during the recent Rica research projects focusing on heating controls and household appliances. Expert volunteers, reviewing technology on the site, could
be regarded as ‘Virtual AIT Champions’, extending Pocklington’s AT Champions project online.

It is recommended that Pocklington explore the idea of developing an online resource as outlined here. This would involve consideration of the aims and scope of the proposed website, its position in relation to other available online resources and the site content, structure, design and key features. The initial feasibility stage should include investigation of project costs and skills required for setting up and managing the resource as an interactive website. It would also involve exploration of possible partnerships and models to sustain the resource over time.

In conclusion to this review, Pocklington is very well-placed to make a highly distinctive, original and timely contribution that will complement the work of other organisations in the field of AIT and will, most importantly, assist people with sight impairment to maintain, regain or increase their independence in and around their homes.

A summary of this report has been produced as Research Findings 50 and is available on the Thomas Pocklington Trust website. Please contact research@pocklington-trust.org.uk to obtain a copy of the full report or the summary research findings in an accessible format.