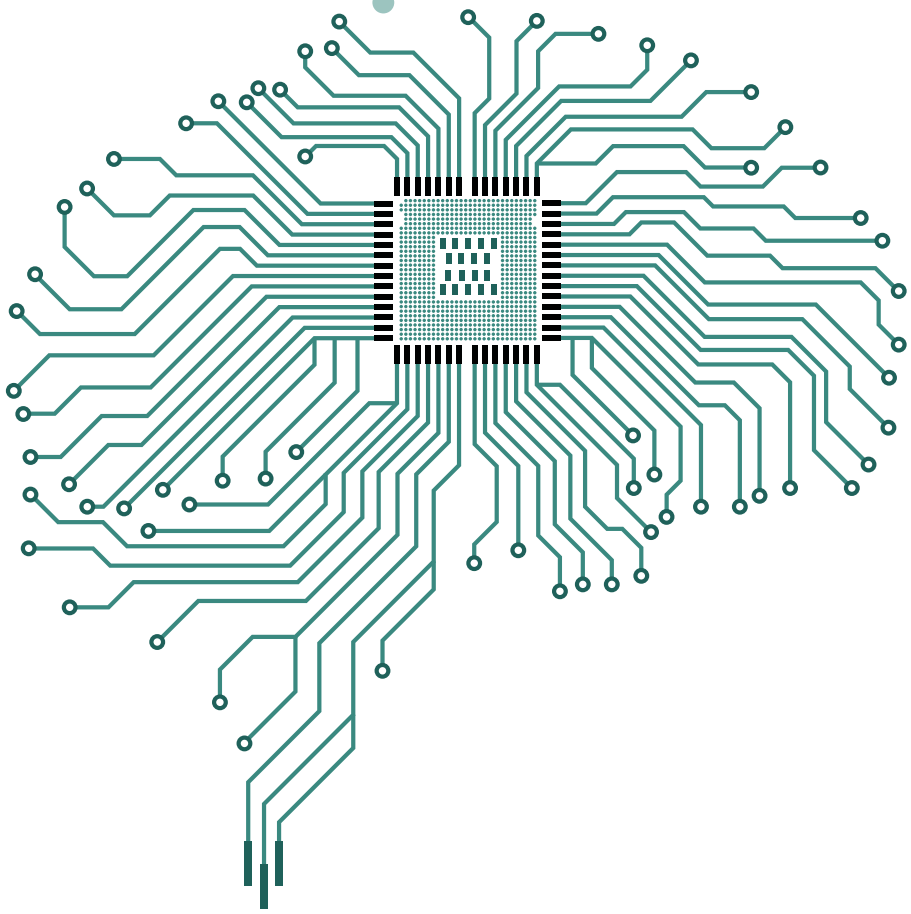
EUROPEAN DISABILITY FORUM



PLUG AND PRAY?

A disability perspective on artificial intelligence, automated decision-making and emerging technologies

An accessible PDF and Easy to Read version of this report is available on the website of EDF: **www.edf-feph.org**

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Contents

Foreword

Emerging technologies are changing the way people work, travel, communicate and interact, both at home and in their communities. For persons with disabilities, emerging technologies have the potential to increase inclusion, participation and independence and in some instances, are already doing so. However, there are very legitimate concerns and challenges about emerging technologies that all citizens, including citizens with disabilities, want to see addressed.

Development and use of emerging technologies should be critically assessed for their effects on our rights and freedoms, and regulated accordingly. Citizens are becoming aware of the potential of artificial intelligence but also of the potential misuse of their data. So, it is essential to widen the debate about these technologies beyond the technology community. Persons with disabilities should take part in this debate so they can reap the benefits of technology like everyone else. We want this report to provide an opportunity to start meaningful conversations between stakeholders, including persons with disabilities, the technology industry, policy makers and academia.

Together, we must ensure that emerging technologies deliver more independence and inclusion for 80 million European citizens with disabilities. The United Nations Convention on the Rights of Persons with Disabilities (UNCRPD) gives us the right to be involved – time to engage!

Yannis Vardakastanis
EDF President

About EDF

The European Disability Forum (EDF) is an independent non-governmental organisation (NGO) that defends the interests of 80 million Europeans with disabilities. EDF is a unique platform which brings together representative organisation of persons with disabilities from across Europe. EDF is run by persons with disabilities and their families. Our mission is to promote equal opportunities for, and human rights of, persons with disabilities in Europe.

Introduction

Emerging technologies have gradually permeated our lives. Relationships between people and organisations can now take place online and most of us are able to connect to networks and opportunities more easily. With new technology we can, for example, use voice commands to turn on a light or call a friend, remotely take part in a meeting or stay in contact with other people on social media. We have entered a new age where computers have the capability to learn and artificial intelligence is present in products we use on a daily basis. Emerging technologies are affecting our businesses, our homes and how we access public services. This presents opportunities for increased convenience, greater choice and increased independence for persons with disabilities.

Over the last 10 years, technology has enabled people with disabilities to overcome a range of barriers in access to health, transport, work, education, leisure and culture, participation and many other areas of life, creating new prospects. For many, it has increased independence in ways we could not have imagined just a decade ago.

Persons with disabilities are often prevented from fully taking part in society because of environmental and attitudinal barriers. One in six people in the European Union (EU) has a disability[1]; that's an estimated 80 million persons with disabilities in Europe and 1 billion[2] worldwide. Over a third of people aged over 75 have disabilities that restrict them to some extent, and over 20% are considerably restricted[3]. Taking into account demographic ageing, it is expected that there will be approximately 120 million persons with disabilities in the European Union by 2020[4]. Persons with disabilities are more excluded from work and education, and are at higher risks of experiencing poverty[5]. So, do emerging technologies provide an opportunity to remove some of the barriers that affect them?

Persons with disabilities are often early adopters of technology. As the technological pace of change continues to increase, it is crucial that barriers to independent living, success and equal participation and opportunities are not recreated in this new age. It is imperative that rights set out in the UNCRPD are fully realised. We believe that people and organisations, large and small, can play their part in driving innovation in technology that works for everybody.

The objectives of this report are as follows:

- to briefly outline the opportunities of emerging technologies for persons with disabilities (part 1);
- to highlight the concerns and risks that need to be addressed in order to ensure that emerging technologies are inclusive (part 2);
- to provide practical recommendations to the disability movement, industry, policy makers and academics so that they can better engage with each other in a meaningful and productive dialogue about emerging technologies (part 3).

In order to prepare this report EDF worked in consultation with its members and expert groups. We conducted a series of interviews with representatives of technology companies as well as NGOs and other experts in the field. In addition, we carried out a small online survey of persons with disabilities between 6 and 13 November 2018; this survey highlighted issues that are incorporated in part 2 of this report.[6]

Glossary

Some of the vocabulary in this report may not be familiar to readers so we recommend that you read this glossary first, or refer to it as necessary. Please note that definitions below are only included as a guide[7].

Emerging technologies

There is no commonly agreed definition of emerging technologies but what this term potentially covers is vast[8 9] and of course will change over time. For the purpose of this report, 'emerging technologies' are technologies that are relatively new, fast developing, with the potential to deliver a considerable impact on individuals and society in the next 5 to 10 years. We focused on emerging technologies that are readily available to consumers. Many emerging technologies highlighted in this report rely on artificial intelligence.

Please note that there are many other emerging technologies which could have a significant impact on individuals and society, for example in the medical or other fields (e.g. gene therapy, nanotechnologies, etc.). These are out of scope as not 'readily' available to consumers. This does not mean that we do not have an interest in those technologies.

Artificial intelligence

Artificial intelligence is a field of computer science[10]. Artificial intelligence is the ability for a digital computer or computer-controlled robot to perform tasks commonly associated with intelligent beings.[11] These tasks may include visual perception, speech recognition, decision-making, and translation between languages.[12 13]

Algorithm

A process or set of rules to be followed in calculations or other problem-solving operations, especially by a computer.[14]

Big data

Extremely large data sets that may be analysed computationally to reveal patterns, trends, and associations, especially relating to human behaviour and interactions.[15]

Machine learning

Machine learning is a subset of artificial intelligence. Machine learning is about teaching computers to learn by interpreting data from the world around us, classifying it and learning from its successes and failures[16]. Machine learning can also be described as the capacity of a computer to learn from experience, i.e. to modify its processing on the basis of newly acquired information.[17 18]

Deep learning

A type of artificial intelligence that uses algorithms (set of mathematical instructions or rules) based on the way the human brain operates.[19]

Universal design

Universal design means that the design of products, environments, programmes and services has to be usable by all people, to the greatest extent possible, without the need for adaptation or specialised design. Universal design shall not exclude assistive devices for particular groups of persons with disabilities where this is needed.[20] [21]

Reality Technologies

An umbrella term that refers to all technology that may alter the human experience of the real world through adapting, altering, complementing a variety of sensory experiences. Examples of reality technologies include 360 video, virtual reality, augmented reality, holograms, avatars, and so on. See definitions of these terms below.

360 Video

This is also known as immersive or spherical video. 360 video enables the user to control which part of the video or image they are seeing. These videos are usually created using a special camera with several lenses. Once all images have been collected, they are merged to create a seamless film. In most cases, 360 videos are viewed on a screen, through a tablet, a computer or phone and users can navigate the video through a 'click and drag' technique using a cursor. It is also possible to use headsets, goggles or a cardboard viewer, where user movements are used to scan the image instead.

Virtual Reality

Virtual Reality (VR) is the most immersive type of reality technology. It convinces the brain that an artificial experience is real and then allows the user to explore or interact with the virtual environment. VR is usually experienced with goggles, but other equipment such as reactive seating and hand controllers can be used to provide a fully immersive experience.

Augmented Reality

Augmented Reality (AR) merges our reality with the digital world. It does this by adding digital images onto a real-life object, situation or person. AR uses your existing natural environment and simply overlays information on top of it[22]. AR can be used with goggles or a screen, or without a screen, for example when holograms or projections are used instead.

Robotics

The branch of technology that deals with the design, construction, operation, and application of robots.[23] There are many different types of robots, which look different, are made from varied materials and their tasks range in size and complexity. A robot can be remotely controlled by a human operator, sometimes from a great distance.[24]

Holograms

A three-dimensional image formed by the interference of light beams from a laser or other coherent light source.[25]

Avatar

A digital image or figure representing a particular person (for example in a video game or on an Internet forum). Avatars also exist in 3D and are created and accessed with a computer, tablet or smart phone.

Gesture Recognition

The mathematical interpretation of a human motion by a computer. Gesture recognition is part of a family of recognition components called Perceptual User Interface (PUI). PUI includes alongside gesture recognition, facial recognition, voice recognition, eye tracking and lip movement recognition. PUI helps computers to understand body language.[26]

Haptics

Haptics is a technology that provides a user interface based on the stimulation of the senses of touch and movement. This words also describes the branch of science or engineering concerned with such technology.[27] This technology utilises touch to control and interact with computers[28]. Haptic technology may provide vibrations or other sensations to the user.[29]

Exoskeleton

Exoskeletons are wearable devices that work in tandem with the user. They are placed on the user's body and act as amplifiers that augment, reinforce or restore human performance. Exoskeletons can be made out of rigid materials such as metal or carbon fibre, or they can be made entirely out of soft and elastic parts.[30]

Internet of Things (IoT)

The interconnection via the Internet of computing devices embedded in everyday objects, enabling them to send and receive data.[31]

Smart City

A city that incorporates information and communication technologies (ICT) to enhance the quality and performance of urban services such as energy, transportation and utilities in order to reduce resource consumption, wastage and overall costs.[32]

Smart Home

A home equipped with lighting, heating, and electronic devices that can be controlled remotely by phone or computer[33]. Also known as an 'Automated Home'.

Smart speaker

A type of wireless and often voice-activated devices with an integrated 'virtual assistant' that offers interactive actions with the help of a trigger word. Examples include Google Home and Amazon Echo. Some smart speakers can also act as a smart device that uses WIFI or Bluetooth to control home automation devices.[34]

Virtual assistants

A virtual assistant - also called an intelligent personal assistant - is software that can perform tasks or services for an individual. Examples include Apple's Siri, Google Assistant, Amazon's Alexa and Microsoft's Cortana. Virtual assistants are installed on smartphones, smart speakers and personal computers.[35]

Wearable Technology

Also known as 'wearables' or 'wearable devices', these are smart electronic devices that can be incorporated into clothing or worn on the body as implants or accessories. Wearable devices such as activity trackers or smartwatches are examples of how the 'Internet of Things' work: they exchange data through the internet with a manufacturer, operator, and/or other connected devices, without the need for human intervention. Wearable technology is being incorporated into a range of products, such as textiles and services, such as healthcare.[36]

Autonomous Vehicle

Also called 'driverless vehicle' or 'self-driving car', an autonomous vehicle is a vehicle that can guide itself without human conduction. This technology involves use of artificial intelligence and a range of other technologies. Autonomous cars are being tested in a number of countries and may provide opportunities for greater independence for persons with disabilities who are currently unable to drive conventional vehicles.[37]

5G connectivity

5G or fifth-generation mobile internet connectivity is promising much faster data download and upload speeds, wider coverage and more stable connections by making better use of the radio spectrum and enabling far more devices to access the mobile internet at the same time[38].

Assistive technology

Hardware or software added to or connected to a system that increases accessibility for an individual. Examples include Braille displays, screen readers, screen magnification software and eye tracking devices.[39]

Legal and policy framework

The EU and governments will need to decide whether existing laws and enforcement bodies are equipped to protect citizens' rights when using emerging technologies, or whether there is a need for new regulations to be put in place. Below is an outline of the existing legal and policy framework.

International legal and policy framework

The UN Convention on the Rights of Persons with Disabilities

The UNCRPD is an international binding human rights treaty stating the rights of all persons with disabilities. The European Union was the first regional integration organisation to ratify the UNCRPD and all its member states have also ratified the Convention. As a result, the EU and its member states have to take action to ensure they uphold the rights of persons with disabilities.

The Convention is the first human rights treaty that recognises the right of persons with disabilities to access information and communication technology. Article 3 of the Convention sets out a number of **general principles**, including full and effective participation and inclusion in society and accessibility. These, and other general principles are all pre-conditions to enjoy the other rights enshrined in the Convention.

Article 4 of the Convention sets out a number of **general obligations**, including an obligation to undertake or promote research and development of universally designed goods, services, equipment and facilities and to promote **universal design** in the development of standards and guidelines. There is also an obligation to undertake or promote research and development, availability and use of new technologies, including information and communications technologies, mobility aids, devices and assistive technologies, suitable for persons with disabilities, giving priority to technologies at an affordable cost, as well as to provide accessible information to persons with disabilities about these products and services.

Article 9 of the Convention gives persons with disabilities the right to access, on an equal basis with others, the physical environment, transportation, information and communication, including information and communication technologies and systems and to other facilities and services open or provided to the public, both in urban and rural areas.

Article 21 of the Convention further states that all measures should be taken to ensure that persons with disabilities can exercise their right to freedom of expression and opinion, including the freedom to seek, receive and impart information and ideas on an equal basis with others and through all forms of communication of their choice.

The Convention also includes obligations for states parties to ensure that the private sector, professionals working with persons with disabilities and the general public uphold the rights of persons with disabilities.

Last, but not least, the Convention states that persons with disabilities and their representative organisations should be actively involved and consulted in the development of legislation and policies to implement the Convention. The development of emerging technologies must be seen in this context and take on board the fact that persons with disabilities represent a significant number of the population.

The 2030 Agenda for Sustainable Development and the Sustainable Development Goals

The 2030 Agenda for Sustainable Development[40] was adopted in September 2015 at the United Nations in New York, where 193 countries committed to this plan of action to end poverty, protect the planet and ensure global prosperity. The 2030 Agenda promotes universal respect of human rights, human dignity, the rule of law, justice, equality and non-discrimination. Its motto is to "leave no one behind", with the pledge to recognise the dignity in every person and to reach the "furthest behind first". There are 17 Sustainable Development Goals (SDGs) which are meant to be guiding national and international development agendas.

While non-binding, SDGs represent a unique political commitment. They are universal and provide a clear policy framework for regulatory actions. In relation to ICT, it is worth noting that in 2017 the Stakeholder Group of Persons with Disabilities presented a paper[41] with a clear set of recommendations in relation to emerging technology.

Emerging technologies can support the achievement of SDGs. UN Deputy Secretary-General Amina Mohammed stated: *"See Goal 9, where you see the word "innovation" as a docking station for all other 16 goals. Do not silo this, you will leave so many people behind.*[42]*"*

For more information about SDGs, please refer to our 2018 report[43] "The 2030 Agenda and the Sustainable Development Goals: A European perspective to respect, protect and fulfil the United Convention on the Rights of Persons with Disabilities."

European policy and regulatory framework

The EU Charter of Fundamental Rights[44] brings together all the personal, civic, political, economic and social rights enjoyed by people within the EU in a single text.

As technologies are converging to the web, existing EU directives are directly relevant in the context of emerging technologies. These are the **EU directive on accessibility of public sector bodies websites and applications**[45] and the upcoming so-called **European Accessibility Act**[46]. The latter is a directive covering a broad range of ICT products and services and lays down a set of accessibility requirements, including a list of functional performance criteria, which will be useful for future technological developments. Both directives will make use of the first European standard on accessibility requirement for ICT products and services EN 301 549[47]. Technical accessibility requirements in this standard are very much aligned with other national and international accessibility standards.

The EU General Data Protection Regulation[48] is also relevant; it came into force in May 2018 and provides a high standard of personal data protection, including the principles of data protection 'by design and by default'.

The EU has high standards in terms of safety and product liability but it is not yet clear whether these are sufficiently robust for emerging technologies. It is essential for citizens and businesses alike to be able to trust the technology they interact with, to have a predictable legal environment and rely on effective safeguards protecting their fundamental rights and freedoms.

There is currently no dedicated EU legislative instrument comprehensively regulating emerging technologies or related fields such as artificial intelligence. However, both the European Commission and the European Parliament are developing their policy positions on these issues. The European Commission published a ***Communication on Artificial Intelligence***[49] in

April 2018, stating that "Growth in computing power, availability of data and progress in algorithms have turned AI into one of the most strategic technologies of the 21st century. The stakes could not be higher. The way we approach AI will define the world we live in. Amid fierce global competition, a solid European framework is needed." The European Commission wants the EU to "be the champion of an approach to AI that benefits people and society as a whole." The Communication states that ***"Europe should strive to increase the number of people trained in AI and encourage diversity. More women and people of diverse backgrounds, including people with disabilities, need to be involved in the development of AI, starting from inclusive AI education and training, in order to ensure that AI is non-discriminatory and inclusive."***

It is important to note that consumer organisations have raised concerns about the fact that the European Commission's Communication does not include a clear commitment to update relevant consumer rights laws to ensure these are fit for the AI era.[50]

The European Commission wants to promote a "human-centric" approach to AI and "ethics-by-design principles" and appointed an independent AI high-level expert group to draft AI ethics guidelines. A first version of these guidelines[51] was published the end of 2018 and a final version of the guidelines is expected in March 2019 after a public consultation involving the European AI Alliance[52].

In November 2018 the European Parliament published a draft report on a **Comprehensive European Industrial Policy on Artificial Intelligence and Robotics**[53] (available in all EU languages[54]). Work on this report is expected to complete in 2019, before the end of the current legislature.

On 7 December 2018 the European Commission published a **Coordinated Plan on Artificial Intelligence**[55], calling on Member States to develop national AI strategies by mid-2019.

Part 1. Emerging technologies: opportunities for persons with disabilities

Emerging technologies have the potential to increase inclusion, participation and independence and in some instances, are already doing so. In this section we will outline some common examples.

1. Artificial Intelligence

Artificial Intelligence (AI) is often used to create attention grabbing headlines, but it is also used for more routine decision-making or tasks such as deciding eligibility for a credit card, or helping companies recruit by deciding which applicant should get the job. AI systems are already part of our life: they can drive cars, decide on loan applications, translate texts, recognise faces on social networks and so on.

AI began developing in the 1960s but the so-called 'AI revolution' took off in the 2000s with the combination of increased computing capability, a faster Internet and access to larger data sets. AI is now seen as a major part of our future economies, therefore governments, as well as technology companies, are investing in this area of computer science. AI is present in many of the products and services we already use (e.g. predictive text on our smartphones; digital assistants such as Amazon's Alexa); it is also helping scientists analyse vast quantities of data (e.g. brain scans) improving speed and accuracy of diagnosis. There is evidence that AI could help improve health, better manage traffic or save us time or, for persons with disabilities, increase independence and accessibility. Axel Leblois, President and Executive Director of G3ICT[56] believes that we will see more and more AI embedded in user interfaces, so that the devices and operating systems can automatically adjust to the behaviour or particular requirements of the user: *"Incorporating AI in user interfaces and user interaction will be very, very powerful"*. Leblois emphasised that this will be particularly useful for older people who are experiencing physical and sensory disabilities, as well as cognitive issues. Right now, these people are excluded when it comes to emerging technologies, because they don't want or can't learn about user interfaces.

Below are more examples of how AI can help persons with disabilities.

Providing descriptions of online content

Social media platforms are used by millions of people to stay in touch with friends and family. For someone who is blind, deafblind or partially sighted, it is difficult to access the images that are shared online. Screen readers are capable of reading aloud accessible text, but images are not 'readable' so if there is no alternative text provided to describe the image by those who upload it, this makes a large portion of social media content inaccessible to blind people.

Facebook has tried to use AI to improve accessibility of images.[57] In April 2016, a new tool called "Automatic Alternative Text"[58] was released; it uses AI to recognise objects or scenes in an image and reads a description aloud.[59] The system can also determine human

Facebook is using AI to improve the experience of blind and partially sighted users.
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characteristics, including expressions such as smiles as well as features such as beards and the presence of glasses. It can also describe weather or landscapes, e.g. the presence of sun, snow or sea. In 2017 facial recognition technology also enabled users to find out which individuals were in the picture they were trying to view, even if they were not tagged in that picture by the uploader[60].

Similarly, Microsoft delivered the 'Seeing AI' app, which provides image description to those who are blind or partially sighted[61]. Microsoft is also working on a 'Hearing AI' app, aimed at people who are hard of hearing; this app would translate sound into visual representations. More applications that do not require the user to be connected to the internet would be helpful, such as the AIPOLY app which gets around the Internet connectivity issue by storing any 'lessons learnt' about the identification of objects until it is once again connected to the internet[62].

Translation

Translation tools are being applied in a multitude of ways to increase inclusion for people with disabilities. Examples are outlined below.

Subtitling and Captions

Captioning and Sign Language make TV, video, and events accessible to people who are hard of hearing, deaf or deafblind. AI can enable automatic captioning; for example, YouTube provides this feature, however the current accuracy level is not high and the uploader needs to edit this captioning in order to ensure 100% accuracy. Microsoft's Presentation Translator can automatically provide real-time subtitles for PowerPoint presentations whilst keeping the presentation's formatting[63]. This enables people to follow the presentation in a different language and it also enables better inclusion for those who cannot hear the presentation, although their accuracy levels do not currently enable full participation[64 65].

Sign Language

People whose primary communication method is sign language often remain isolated from conversation and information. Developers are trying to create technological solutions that would help close this communication gap. Advances in AI have enabled the use of computer vision in combination with machine learning to transform Sign Language into written language that can be read on a device[66] and several apps now provide this, although there are also concerns about these applications, for example in relation to the use of avatars, as outlined in the section below on reality technologies.

Clarity of complex information

Some documents may be hard to understand for some readers, in particular, for persons with intellectual disabilities. And for many of us, understanding densely written text that uses complicated language can be difficult. New applications use AI to automatically configure information in a way that helps the user understand it[67]. For example, Polisis developed a way of creating visualisations of the content of privacy policies[68]. The website uses a process of deep learning, which helps the user understand what data the company in question is collecting and what it is going to do with it.[69] This use of AI could apply to many areas where information is difficult to understand. For persons with disabilities and for everyone, this could mean greater autonomy and choice.

2. Reality Technologies

2.1 Virtual reality and augmented reality

We experience the world through a combination of sensory information. Put together, this enables us to understand and interact with the world around us. Reality technologies recreate sensory information in a virtual world, tricking the brain to believe that the experience is actually taking place. The most popular use of reality technologies is currently in the gaming sector but there is great potential for this technology to create new methods of exploration, learning or socialising.

If these reality technologies were accessible and inclusive of persons with disabilities, they could be applied in a variety of ways to increase independence, inclusion and equal participation in society.

Exploration of Environments

For people who are unable to move autonomously, virtual reality (VR) could provide the opportunity to experience currently 'out of reach' experiences, such as skateboarding or climbing a mountain.

Environmental inaccessibility is a significant barrier for persons with disabilities, and consequently navigating unfamiliar environments can be extremely frustrating, stressful, time consuming and dangerous. VR could enable people who use a wheelchair, people with autism or people

Virtual reality can provide out of reach experiences to persons unable to move. ©iStock/LightFieldStudios

who are partially sighted to plan a route or gain knowledge of an environment ahead of a trip, meeting or appointment.

VR is already used to give people an idea of what a person with autism, epilepsy or Alzheimer[70] may be experiencing, thus could be used to train people who are keen to better understand these disabilities and conditions, for example carers or medical students.[71]

All reality technologies, including Augmented Reality (AR) and 360 Degree video, can be useful in the exploration of new environments. 360 Degree video has proved useful, for example, in mapping services where the user can zoom and then navigate using a mouse to drag the image in all directions. Partially sighted people can also use AR to see on a screen (e.g. smartphone or tablet) detailed features that they are not able to see in their environment.[72]

Learning

Some people learn more effectively when engaging with images or experience rather than text, and for them, reality technologies offer new ways to acquire knowledge. Digital learning environments are not new, but their use to support learning for persons with disabilities has been somewhat limited until fairly recently[73].

People with dyslexia for example, often struggle with reading, spelling and memory, therefore traditional forms of education are less accessible to them and result in barriers to achievement[74]. Many children with dyslexia find education stressful and research shows that virtual environments can help them focus and enjoy learning.[75]

Students with disabilities could benefit from virtual learning environments.
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Rehabilitation

In neuro-rehabilitation settings, reality technologies can be of benefit to persons with disabilities. Dr Jane Marshall of City University London has been conducting trials using VR and avatar technology in aphasia therapy. Aphasia is a disability that often results from stroke, affecting the part of the brain that controls communication and language[76]. As a consequence, people with aphasia often have issues with speech, language, vocabulary and comprehension. City University built a virtual environment named EVA Park, with input from people with aphasia, speech and language therapists, computer scientists and human-computer interaction experts. EVA Park enables people with aphasia to interact with a variety of support professionals, therapists and each other. The study found that the participants' comprehension skills improved, as well as their happiness and confidence level, while feelings of isolation were reduced. Participants enjoyed socialising, being able to 'play' and successfully complete real-world tasks in the virtual world.[77]

2.2 Avatars

Traditionally, avatars were used in gaming settings, but recent developments have seen an expansion of avatars into the automated assistant space and sign language translation, for example. Avatar technology is combined with artificial intelligence to provide guidance and information in a variety of settings. We have also seen the appearance of signing avatars where vocabulary is limited, for example in hotels or train stations, where instructions might be given about where to check in or queue up.[78]

While the technology has progressed and offers potential for wider use, deaf advocates are keen to emphasise that these do not currently match the quality and skill provided by qualified interpreters and translators. They also state that signing avatars should not be used where 'live' signing is required, for example when the information is of significant importance to the lives of deaf citizens such as news broadcasts or public emergency announcements.[79] [80]

With the increasing use of avatars in various contexts greater consideration is necessary to ensure adequate representation of disabilities in avatar design. Unfortunately, when

Examples of Microsoft's Xbox Live Characters with a disability[83]

users can create an avatar, it is not always possible for them to create an avatar with disabilities. Avatars could represent an opportunity to increase the visibility of persons with disabilities and help dispel many of the stereotypes about disability, challenging inaccurate assumptions about what they can or can't achieve. Equally, it is important to ensure that avatars with disabilities do not reinforces the widely held belief that a disability is always visible[81]. People should be able to design characters that look like them, if they so wish. In this context, it is encouraging to see companies like Microsoft introduce Xbox Live avatars[82], providing options to include various disabilities in avatar designs, such as bionic arms or given a wheelchair.

3. Robotics and smart environments

3.1 Robotics

Combining many traditional robot devices with artificial intelligence and other emerging technologies has expanded robots' capabilities and applications. This may provide greater opportunity for persons with disabilities to enjoy independent living, as many robots move towards mass market and are applied in more domestic settings. There are areas of interest for persons with disabilities, for example the production of exoskeletons, but also the use of robotics in health and social care.

Robots could support independent living.
©European Union

Demand for business and consumer robotics is expected to grow seven times faster than in manufacturing[84]. The global exoskeleton market size was valued at USD 25.4 million in 2015. Over the past decade, exoskeleton devices have made an appearance in rehabilitation settings where they are used by people with spinal cord injuries or other trauma affecting the nervous system[85]. Experiments show that exoskeletons could also prevent falls in older people, using an algorithm to detect when falls are likely to happen and to apply movement to the body to prevent that fall.[86]

3.2 Smart environments and the Internet of Things

The integration and interaction of various technologies in our environment, combined with greater computing capability and greater reliability of internet connections and WIFI enabled the development of so-called 'smart environments', which connect people to devices and devices to devices.

We have seen new ways of interacting with our environment emerge, where devices are able to anticipate behaviour and, as a result, our needs. As this technology increases in scale and impact, a phenomenal amount of data is collected that can be used to make systems smarter, more reliable and useful. These smart technologies could be very helpful for people with disabilities, on condition that their needs are included from the outset and the various user interfaces to interact with devices are designed in an accessible manner.

Amsterdam is one of Europe's smartest cities. Photo by Azhrjl on Unsplash

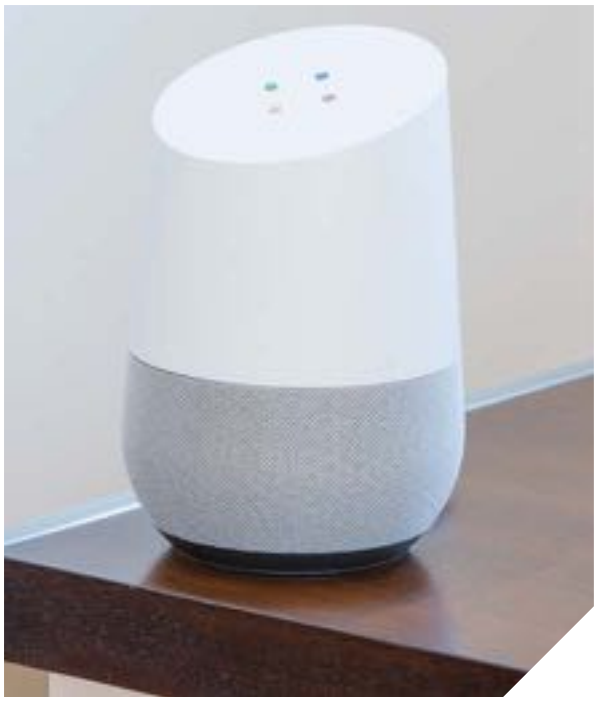
Smart Cities

Large and medium size cities are increasingly adopting 'smart' cities features, using digital technologies to make traditional networks and services more efficient for the benefit of inhabitants and businesses. According to European Parliament research, there are 240 European cities with populations over 100,000 that have some 'smart city' features. Amsterdam, Barcelona, Copenhagen, Dublin, Helsinki and Manchester ranked highest in the list of Europe's "smartest" cities.[87]

This offers opportunities for 'smarter' urban transport networks, as well as water supply or environment services, or more efficient ways to light and heat buildings. Smart cities can also mean a more interactive and responsive public services, safer public spaces and provides a unique opportunity to meet the accessibility needs of citizens with disabilities or older citizens. Smart systems on a variety of public transport, such as buses and trains, can use technology to provide real time updates.

Navigation of external environments is one of the most challenging parts of daily life for many persons with disabilities. Smart environments can connect people and their environments more closely, enabling greater independence through timely information. Examples of beacon systems designed to enable safer and more accurate navigation of space can be of particular use for persons with disabilities, and were set up to help blind and partially sighted people navigate their way around Euston Tube station in London[88].

Over time, the opportunity to use or drive an autonomous – or driverless – vehicle could also provide greater independence, reducing reliance on others and difficult journeys navigating inaccessible transport systems[89]. Google tested its self-driving car technology with Steve Mahan, a blind user.[90]



Google Home. Photo by Thomas Kolnowski on Unsplash

Apple Watch. Photo by Mateo Abrahan on Unsplash

Smart Home and connected devices

The Internet of Things (IoT) has enabled smart homes and other automated environments, a development that could enable greater independence for persons with disabilities. *"Of all the Internet of Things applications that have the potential to improve life for persons with disabilities, home automation or 'smart home' – technologies are among the most promising"*[91]. Smart environments rely on 'smart' technology within objects or devices. Today, smart devices are everything from thermostats to coffeemakers, televisions or toothbrushes. Working together, connected devices can bring more access and more autonomy, including products such as self-driving wheelchairs, smart canes or wayfinding systems. With future 5G connectivity, it is expected that these emerging technologies will be able to deliver many more services faster, with more reliability.

This evolution in smart devices is slowly bringing down their cost and expanding the number possible uses. The mainstreaming of smart devices means that there is a means of gaining access to lower cost solutions for many persons with disabilities.[92]

The combination of these devices with artificial intelligence has delivered home assistants such as Amazon's Alexa, Microsoft's Cortana, Apple's Siri and Google Assistant. A majority of these use a voice activated system, which has great benefits for people with a variety of disabilities, enabling them to control devices through speech rather than through a screen interface or touch.

Wearables such as smartwatches can also significantly increase independence for persons with disabilities. Phones or smartwatches can work with other connected products, bringing even more benefits. Deafblind blogger Molly Watt explained how she is now able to answer phone calls or join conference calls using her smartwatch with sound streamed to her smart hearing aids.[93]

Part 2. Challenges and risks of emerging technologies

Result of EDF survey

When preparing this report, we carried out a small online survey[94] in order to gather views of persons with disabilities on Emerging Technologies. We collected a total of 50 responses with valuable insights from people with a wide range of disabilities[95], covering all adult age groups[96 97]. The survey was carried out online so it does not take on board the views of persons with disabilities who do not use the Internet. Further research about this group is needed, as well as research on how children with disabilities interact with emerging technologies.

Twelve percent of respondents believed emerging technologies would have 'a positive impact' on their life over the next 5 to 10 years, while 88% said emerging technologies would have 'a positive impact on their lives, but only if the views of persons with disabilities were taken into account'. None of the respondents thought that emerging technologies would have a negative impact on their lives.

Respondents were also asked about their concerns in relation to emerging technologies. Results were as follows:[98]

- 88% were concerned about lack of accessibility
- 60% were concerned about lack of standardisation
- 56% were concerned about interoperability with the assistive technology they already use
- 50% were concerned about emerging technologies leading to discrimination
- 40% were concerned about emerging technologies affecting their privacy
- 42% were concerned about ET affecting their security
- 20% had other concerns, including concerns about usability, affordability and lack of digital skills

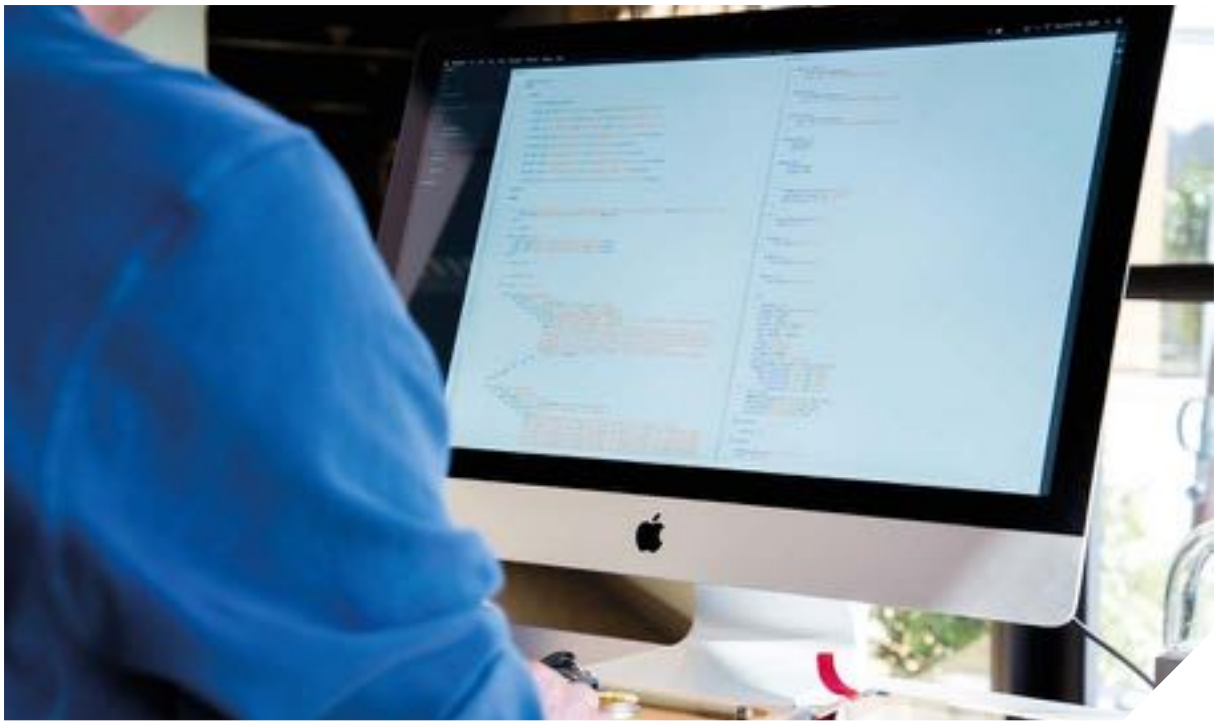
We outline some of these risks and concerns below, with insights from the experts we interviewed and the persons with disabilities who responded to our survey.[99]

Accessibility and usability

Understandably, accessibility of technology is a major concern for persons with disabilities. While there are technical challenges to overcome to ensure better accessibility of goods and services, having a design process that prioritises universal design is a major driver of accessibility and inclusion.

"We don't need specially built solutions. We need solutions, which are accessible to everybody." *(Jakob Rosin)*[100]

Many reality technologies require the use of equipment, which can be inaccessible for some persons with disabilities. For instance, virtual reality technology often requires the use of a headset and handsets or controllers. Handsets often have small buttons and require a particular grip. If gesture recognition is being used, users may need to move their body



Peter Korn from Amazon: "It's too easy in any industry to think that your customers look like you. (...) We will make better products when the staff reflect the customer."
Photo by Lee Campbell on Unsplash

and/or their head, unless eye tracking technology provides an alternative.[101] [102] For many persons with disabilities, actions such as holding, lifting or clicking on small buttons can be a problem; so too is the movement of their body or head. Consequently, this can make experiences in reality technology inaccessible.[103] It is important for accessibility features to adapt to these technologies. For example, how will subtitles or audio description be incorporated in a 360-degree video? User testing with persons with disabilities is absolutely essential to find out about accessibility requirements for these emerging technologies.

Smart environments are not immune to accessibility issues. For example, research found that most of today's smart cities are not fully accessible, resulting in a growing digital divide for persons with disabilities and older persons[104] [105]. Both the tech industry and the urban planning field are male-dominated fields, so lack of diversity could mean that public spaces end up being designed primarily for people that look like them[106] [107].

In addition, Jutta Treviranus, Director of the Inclusive Design Research Centre at the Ontario College of Art and Design University raised concerns about the risk of data-driven design in smart cities, because these techniques focus on averages and perceived 'norms': *"How do we plan a better city? I would say it is by addressing the needs of people that have difficulty with or are excluded by our current urban design, so we create an urban plan that is more welcoming and humane."*[108] [109]

The lack of diversity and negative impact of young white male dominance in the tech industry is recognised by accessibility experts; Peter Korn from Amazon[110] said *"It's too easy in any industry to think that your customers look like you. (...) We will make better products when the staff reflect the customer."*

And what about IoT services, such as smart heating controls, rendered inaccessible simply because the app that controls the heating is itself inaccessible? Concerns have also been raised in relation to interference IoT may cause for hearing aids and cochlear implants as

the spectrum they all share is becoming very congested, so functioning of these hearing devices could be disrupted.[111]

Adopting a universal design approach from the outset would enable developers to build goods and services that can be used by more people. Compliance with existing digital accessibility standards and guidelines[112] would also help. Having tools and guidance available for developers is also important. For example, Google provides free, open-source Web and Android accessibility testing tools to developers[113].

Shadi Abou Zahra, Accessibility Strategy and Technology Specialist at the World Wide Web Consortium[114] explained that focus on accessibility will continue to be necessary long term, though one of his concerns is that some developers believe that AI or other solutions will take care of accessibility.

All the experts and industry leaders we interviewed pointed to one of the root causes of poor accessibility in ICT product and services: accessibility is rarely taught on computer science, design or user experience courses. Axel Leblois of G3ICT stated *"the biggest gap is not in technology but in awareness and training"*. Ania Helseth, Policy Manager at Facebook[115] stated *"To help address this gap, Teach Access[116] launched an online tutorial covering best practices for accessible software design in order to advance accessibility training in higher education"*. This is a welcome initiative, but it would make sense for academia to address the accessibility knowledge gap to ensure that young graduates in computer science, design or user experience courses are taught about accessibility and universal design, so that they are equipped with the skills they need to build more inclusive products and services. Axel Leblois believes that change will happen because industry players are confronted with the fact that they are not able to serve the older population well enough, giving the example of Japanese mobile company Docomo, one of the first to very successfully implement a corporate strategy with universal design[117] at its core, from design to point of sale and customer support.

Poor usability[118] is also a common issue in ICT products and services. Products may be

Poor usability and interface design leave users confused and frustrated.
©iStock/ AntonioGuillem

accessible, but very difficult to use. The onus is then on the user to find his or her way through poorly designed interfaces.

"We are expected to know how to operate new technologies but many of us don't know how to do this. There is no training. I find it extremely difficult." *(Lisa Jones)*[119]

"Usability is often overlooked and some tech breakthroughs "expect" users to have the necessary digital skills, and then the burden is put on that person. If these technologies are to succeed, they need to suit the user and not the other way. Personalisation and ease of use must play a crucial role." *(Alejandro Moledo, EDF Policy Coordinator)*

Emerging technology products and services should be user-friendly. There should also be adequate support from manufacturers and operators for consumers purchasing emerging technologies. Many consumers, including those with disabilities, need help to set up and learn how to use products and services, but this is lacking. It should also be easy to contact technical support services and get advice where needed. Google has an accessibility support team[120] that can be contacted by email or chat, but few are aware of its existence. Likewise, Apple provides phone and online accessibility support[121]. However, some technical teams can only be contacted by phone and this is a barrier for deaf, deafblind or hard or hearing people who cannot physically go in a store because there is none close to where they live. In all industries, there is scope to significantly develop and improve customer support so that all consumers, including those with disabilities, can find answers to their accessibility or usability questions. Providing different ways to access support is very important. Training of front-line staff, ensuring they have good knowledge about accessibility features is also paramount.

"Make it a requirement to ensure that customers are shown how to use products and that they can go back to shops and ask for advice and support. This should be part of their rights as customers." *(EDF survey respondent)*

Poor accessibility, poor usability and lack of digital skills lead to understandable frustration and people either give up on technology or use it improperly. The promise on many products is that all we need to do is to 'Plug and play', however, as Barcelona Autònoma University Professor Pilar Orero puts it, more often than not the reality is *"Plug and... pray that it works"*.

In addition, people want to personalise their devices but find limitations in the way they can do this, or they cannot opt out of unwanted settings:

"It seems that AI in hearing aids may take over what I can still manage myself... Directional hearing and other features. I do not need that in my hearing aids, but it cannot be switched off" *(EDF survey respondent).*

"Enable hyper-personalisation/customisation, so tech adapts to human diversity, including on complexity/digital skills required". *(Alejandro Moledo, EDF Policy Coordinator)*

It is very important to give users the ability to personalise their experience and customise

settings on their devices. This is not always an easy task though and it can be particularly frustrating if accessibility or customisation tools are hidden in settings sub-menus. These features are rarely publicised by manufacturers and, with notable exceptions[122], sales staff are often unaware of them. It is as if accessibility features were a 'best kept secret' despite the fact that, for many consumers, the ability to customise a product is an advantage. For users with disabilities, having these settings available in mainstream products and services also reduces the feeling of difference and exclusion.

In responses to our survey, there was strong demand for better communication, better information and better customer service from manufacturers and service providers:

"Explain to clients all the accessibility features in your products"
(EDF survey respondent)

"All people like to customise their products, not just disabled people"
(EDF survey respondent)

Interoperability and standardisation

Concerns over lack of standardisation and interoperability with assistive technologies were raised by a majority of respondents to our survey. This is not a surprise as people with disabilities frequently experience such problems with ICT, including when navigating websites and apps. Interoperability is extremely important to people with disabilities, who use a wide range of assistive technologies and bespoke solutions for many of their accessibility needs.

This concern is also raised by experts from the World Wide Web Consortium (W3C), who are arguing for web standards to enable an accessible and inclusive Internet of Things: *"There are still many challenges to address, without which the Internet of Things (IoT) threatens to be more of a disabler than an enabler. In particular, the current lack of interoperability makes it hard for assistive technologies to easily tap into IoT systems. Web standards could extend the open web platform to resolve many of these issues, much as it did on the traditional internet."*[123]

In this context, it is welcome news that a European standard on 'Accessibility following a Design for All approach in products, goods and services' has recently been approved[124]. This standard was developed in response to a European Commission request[125] to include 'Design for All' in relevant standardisation initiatives and in training material on accessibility standardisation.

Meanwhile, international standardisation work on AI has already started[126] and European standardisation bodies are also planning to publish a roadmap for AI standardisation[127]. We hope that this will provide an opportunity for industry and members of civil society to work together on inclusive AI standards that all consumers can trust.

Discrimination

It is a fact that automated decision-making based on AI could discriminate against some categories of the population. If an algorithm making a decision on the price of insurance policy discriminates against persons with disabilities, they may end up paying more for insurance or be denied cover. There are similar potential risks of discrimination in a wide range of areas: automated screening for recruitment, financial services and so on.

"Not all emerging technologies are as promising as they seem to be". (Lidia Best)[128]

Persons with disabilities come across bias and discrimination in their daily life. If you carry out an image search using an online search engine and search for words relating to disability for example, results will bring up a set of images that are not representative of their disability. Conversely, persons with disabilities (or indeed other groups) may not be represented accurately within other searches, such as a search for a profession – search for the word 'doctor' and search engines are likely to show you images of a white male in a white coat; search for the word 'athlete' and you are unlikely to see any representations of an athlete with a disability.[129] [130]

While this may be unintentional, AI and other emerging technologies systems are likely to reinforce already pervasive exclusion of persons with disabilities, encouraging misrepresentation of persons with disabilities or other characteristics such as race, age, gender, sexual orientation, religion and so on.

There is plenty of evidence that algorithms are biased and the technology industry[131] as well as academics are aware of the fact that bias is an issue to be addressed. Algorithms are biased because they learn from biased data[132]. Amazon, for example, had to abandon an automated recruitment tool as it found it was biased against women[133]. This happened because the algorithm was trained to select applicants based on information found in CVs sent to the company over a 10-year period and most of these came from men. With this in mind, it is easy to understand why other groups experiencing discrimination in the workplace, or other contexts, such as persons with disabilities, may have reasons to be concerned about the trend towards more AI-based automated decision-making in society.[134]

If much of the data we provide to AI systems is flawed due to pre-existing human bias or if data sets are incomplete, how do we address bias in these systems? This is a concern that academic Cathy O'Neill[135] sums up: *"When we blithely train algorithms on historical data, to a large extent we are setting ourselves up to merely repeat the past... We'll need to do more, which means examining the bias embedded in the data."*[136]

Human bias leads to bias in algorithms. Photo by Markus Spiske on Unsplash

As AI becomes more prevalent in goods and services, it is therefore particularly important to ensure that the existence and needs of persons with disabilities are reflected in the data AI is learning from and that persons with disabilities are involved when the ethical and legal frameworks for AI systems are developed.

Another question is whether AI should represent the world as it is or as it should be. AI should be fair, but who should define the concept of fairness and how? Should fairness be defined on the basis of need, deservedness or any other criteria? There are no easy or simple answers to these questions and they continue to generate debates and analysis from experts in computer science and academia.[137]

Privacy and security

As most emerging technologies will require access to personal information, including sensitive information, ensuring user privacy and security are key priorities. For Axel Leblois of G3ICT, the digital environment is *"super risky for persons with disabilities"* and he warned that they may end up being 'easy targets' for fraud. Progress in authentication methods, such as better use of biometrics[138], could help mitigate those risks and would also help other groups.

Shadi Abou Zahra, Accessibility Strategy and Technology Specialist at the World Wide Web Consortium[139] warned that people's use of technologies can disclose their condition and that their digital footprint could therefore lead to exclusion. Emerging technologies and systems work with a lot of data, including very sensitive personal data; this is something that persons with disabilities should be particularly concerned about. Abou Zahra stressed *"privacy needs much more attention and persons with disabilities need to be part of the conversation."*

These concerns were also reported by some respondents in our survey.

"I am worried about doing something wrong and putting my security and privacy at risk" *(Lisa Jones)*[140]

"Voice interfaces are great but I don't feel safe using them"
(EDF survey respondent)

A key recommendation of the International Disability Alliance Stakeholder Group of Persons with Disabilities[141] was to *"protect the data of all citizens, in particular those of persons with disabilities, including those deprived of their legal capacity."*

What information will be collected by emerging technologies and to whom will it be disclosed? Are users with disabilities adequately informed about the private, sensitive data that they are sharing when using emerging technologies? If AI is used to infer personal details that were not intentionally shared by a user, what are the implications? Similar questions have been raised about detection of assistive technologies. For example, some accessibility experts have raised concerns about screen reader or browser detection.[142] Lack of understanding about the implications of processing and sharing data, including highly sensitive personal data (e.g. health, disability, biometrics) is common. In a data driven economy, there is a risk that some could be using this to their advantage. It is therefore important for persons with disabilities to be aware of the risks and to know how to protect themselves.[143]

Emerging technology could endanger privacy and security of personal data.
©iStock/Chainarong Prasertthai

Many people are not well informed about how using online services or connected devices is affecting their privacy. In the European Union, citizens now have greater rights in relation to the protection of their personal data, thanks to the implementation of the General Data Protection Regulation (GDPR) but few people have practical knowledge of these rights, let alone how to exercise them. And it is not yet clear how emerging technologies will be covered by this legislation. With GDPR, the requirement to obtain consent to collect data on user behaviour should be upheld. This is particularly important, for example, for hearing aids and cochlear implants users, but in practice it does not always happen[144] and in addition there is a worrying trend where service providers restrict the use of hearing aids or cochlear implants apps if a user doesn't grant permission for data collection; in effect, people are asked to choose between convenience and privacy.

In this context, it is worth noting the European Consumer Consultative Group 's policy recommendations for a 'safe and secure use of artificial intelligence, automated decision-making, robotics and connected devices in a modern consumer world'.[145] BEUC, the European consumer organisation is also asking[146] policy makers to make sure that products are safe and law-compliant by default and that risks including discrimination, loss of privacy and autonomy and lack of transparency are avoided - they are also calling for robust enforcement.

Consumers with disabilities need to get involved in debates so that they are sufficiently aware of what happens to their data and what steps they need to take to protect their privacy online, or when using emerging technologies. Some are concerned about how this is affecting their security and asking for support in this area.

"Be very careful regarding security and privacy issues, bear in mind that disabled people can be more vulnerable. Use of these tools has to be guided." *(EDF survey respondent)*

"Make sure there is simple information about how to stay safe online and also when using other technologies, for example smart home devices." *(EDF survey respondent)*

We can all be exposed to cybercrime or abuse when going online, and similar risks will be associated with emerging technologies. Europe has seen a rise in violence against women[147],

including online, and this is also affecting women and girls with disabilities. This can have a severe impact on their mental health, but also affect their participation in online activities and engagement with emerging technologies. It is therefore important that all people with disabilities are equipped with the skills to protect themselves when using technology.

Affordability

Much of the emerging technology discussed in this report will be used to assist persons with disabilities or long-term conditions overcome barriers in society. But what use is a piece of revolutionary technology if it is too expensive for those who need it?

"I am concerned that emerging technologies will be so expensive that only a small portion of disabled people will be able to use them."
(EDF survey respondent)

Cost can be a major barrier to access technology and several of the people who responded to our survey raised this concern in relation to emerging technologies. How will those costs be covered? Will governments consider covering the cost of expensive emerging technologies that facilitate inclusion of persons with disabilities?

It is of course also important to note that access to the Internet is a prerequisite for most emerging technologies so if access to an internet connection is limited or if people cannot afford a connection, there is a risk of further exclusion.

Lack of digital skills

What use is revolutionary technology if the person who could benefit from it cannot use it? Whose responsibility is it to deliver support and training?

"I was given a smartwatch and I have not used it at all. I don't know where to start, how to set it up (...) I am visually impaired so I know I could benefit from using a smartwatch but I find it frustrating that the companies who sell them don't offer training and support using language I can relate to. Why are we expected to know how to set up these devices? It really feels like tech companies are targeting young people and leaving others behind."
(Lisa Jones)[148]

"Some people can do a lot by themselves, others will need help and should be supported to use devices confidently. Otherwise people will miss out."
(EDF survey respondent)

Many persons with disabilities are early adopters of technology. But others are less able to benefit from new technology because they do not have the skills to use them. How do we ensure that all persons with disabilities can keep up with technological change? Strategies need to be in place to ensure that users have lifelong access to learning.

Part 3. Recommendations

This report has highlighted how emerging technologies could provide unique opportunities to increase independence, participation and inclusion for persons with disabilities. However, this positive role is not guaranteed. Persons with disabilities often encounter societal barriers after significant technological change, when opportunity for inclusion can be missed, resulting in further marginalisation and exclusion. It is critical that this does not happen again and imperative, therefore, that persons with disabilities are consulted and actively involved in the debate about emerging technologies and at all stages of the development process. This will ensure that barriers and challenges can be foreseen and addressed in a timely manner.

We want this report to be a starting point for progressive and productive discussions about a future that we believe should be accessible and inclusive.

"We have to broaden our minds, think about how we are going to use change, how we're going to use innovation, how we're going to use technological and connectivity advances to the benefit of mankind, not to its detriment."[149]

General recommendations

- Industry, policy makers, DPOs (Disabled People's Organisations) and academics should follow the human-rights approach set out in the UNCRPD and UN Agenda 2030 and its Sustainable Development Goals; they should work together to ensure they understand what those rights mean in practice and promote the full inclusion and participation of persons with disabilities in society;
- Accessibility and the principles of Universal Design should be part of curricula is design, computer science, design, user experience and other relevant subjects, as well as mainstreamed in industry settings; this will create environments where the goods and services developed are usable and accessible to the greatest number of people possible. As stated in general comment 2 on UNCRPD article 9 on accessibility:[150] *"all new objects, infrastructure, facilities, goods, products and services have to be designed in a way that makes them fully accessible for persons with disabilities, in accordance with the principles of universal design."* All stakeholders need to have a good understanding of universal design principles and what their role is in implementing such principles;[151]
- European and international standards need to consistently include accessibility and adequate resources should be allocated to ensure participation of persons with disabilities in these standardisation activities. Accessibility standards should include minimum key performance indicators to ensure persons with disabilities are provided with functional equivalency;
- Emerging technologies offer many opportunities for persons with disabilities. Some technologies can also help provide services at a reduced cost. Technology should not be primarily seen as an opportunity to cut costs and as a convenient

excuse to close other routes to access services because some persons with disabilities will find it easier to engage with service providers face-to-face. There is also a need to find balance between the need for person-to-person interaction and the risk of reliance on the emerging technology, as the latter can lead to further exclusion.

Recommendations for industry

Diverse teams make better decisions. ©iStock/industryview

- Consult directly and closely involve persons with disabilities and their representative organisations when developing, testing and producing technology. Don't wait until the end of the development process to do this;
- Diverse teams make better decision. Make sure you have recruitment and training policies that do not exclude. Teams should reflect diversity in the general population, including persons with disabilities;
- Use universal design, or 'Design for all' principles and relevant standards[152] [153] to ensure your research and development teams build emerging technology products and services that are accessible to more consumers. This would also gradually remove the need to create expensive add-ons and upgrades;
- Test your product in a range of scenarios including challenging cases to ensure your product meets functional equivalence;
- Don't forget accessibility when you upgrade your products and services;
- Set up free and accessible customer support services so that all your customers, including those with disabilities, can access the advice they need when they need it;
- Be more proactive about promoting best practise on accessibility in your organisation and beyond;

- Customers should not struggle to set up, configurate, use or update the products and services they buy. Provide user-friendly guidance on how to set up and use your products and services, avoiding jargon;
- Include full and jargon-free information about accessibility features in product description. Make sure this information is available in accessible formats, such as large print or braille, but also on accessible websites and on products themselves;
- Create and promote open source accessibility tools for developers;
- Ensure that the authoring tools you develop are accessible;
- Ensure your staff receive disability-awareness training; this should apply to everyone: developers, engineers, but also management, marketing, sales and customer support staff. Work with organisations of persons with disabilities to design such training;
- If you want people with disabilities to trust your brand, be consistent in the way you address their accessibility needs across your range of products and services;
- Consider providing free digital skills training to all customers who request it.

Recommendations for policy makers

- Promote and support digital skills training for persons with disabilities of all ages. Make sure all citizens can develop or update their skills so that they can safely use emerging technology products and services. This requires inclusion of digital skills training in all curricula, from kindergarten to universities, and as part of life-long learning programmes. Targeted efforts should be made and funding allocated to train groups who experience greater digital exclusion, including persons with disabilities, so that these groups are not further excluded;
- Put UNCRPD obligations in relation to implementing and promoting universal design in research and development at the forefront of policy making;
- Make compliance with UNCRPD obligations on accessibility and universal design a pre-requisite when public funds are used to develop technology, so that resulting technology solutions are accessible for persons with disabilities;
- Ensure all emerging technologies used in e-government services are built with a requirement to apply universal design from the outset;
- Ensure all emerging technologies used in public services are able to provide functional equivalency;
- See emerging technologies as one of the ways to access services and give persons with disabilities the right to decide whether to use such technology or to access human support;
- Train public procurement staff to ensure they are fully aware of ICT and other accessibility legal framework and relevant standards;
- Include mandatory requirements for accessibility in all public procurement tenders; ensure relevant standards for universal design and accessibility are referenced in such tenders;

- Develop a legal framework that delivers a good level of accessibility for emerging technologies, but also supports the human rights of persons with disabilities using them and addresses the concerns outlined in this report; this framework should include a right to redress and a robust enforcement mechanism;
- Diverse teams make better decision. Make sure you have recruitment and training policies that do not exclude. Teams should reflect diversity in the general population, including persons with disabilities;
- Consult with and involve persons with disabilities when working on policies that directly affect them. When using digital platform to consult people, make sure those are fully accessible to persons with disabilities;
- Mainstream universal design approaches and accessibility in curricula for professionals, research and innovation programmes.

Recommendations for DPOs

- Understand how concerns about emerging technologies may affect the people you are representing, taking on board characteristics such as age, gender, level of digital literacy, and so on. Involve your members in order to find out what they think about such technologies, their concerns and priorities;
- Discuss the issues raised in this report in your organisation and work out how you can involve your members in current debates about emerging technologies with other stakeholders;
- Increase your organisational capacity to get involved in policy debates about emerging technologies;
- Identify what you may need to do, as an organisation, to ensure that the voices of people you represent are heard in those debates. What could you do to increase participation?
- Provide support to your members so that they can raise their concerns and advocate for their needs in different fora, including those not aware of accessibility matters;
- Ask questions to industry representatives and policy makers about the issues raised in this report; understand the active role you need play in a fast-moving environment. Don't assume that other stakeholders will know about your needs or concerns;
- Build strategic partnerships and join relevant networks to ensure you have greater influence on the debate about emerging technologies;
- Find out whether consumer organisations[154] in your country are working on emerging technologies – most do– and seek to build working relationships with them. This will enable you to ensure they know more about consumers with disabilities and therefore be in a better position to represent the needs of all consumers in their own advocacy;
- Find out about organisations working on digital rights[155] in your country and their work on emerging technologies; seek to build a working relationship with them;

- Work with organisations representing older people so you can join forces in addressing digital skills gap for groups that are not currently able to access emerging technologies;
- Find out which universities and academics are working on emerging technologies and how you can interact with them to ask any questions or raise concerns;
- There are numerous conferences and public meetings, many of them free, where emerging technologies and AI in particular are being discussed. Seek to attend those events, as a participant or as a speaker, to voice any concerns that you may have.

Recommendations for academia

- Promote and communicate your research on emerging technologies to people with disabilities and other stakeholders. Use easy to understand language and highlight practical examples of the benefits of your research;
- Work with organisations of persons with disabilities and research how emerging technologies are impacting on various groups, including those that are at risk of digital exclusion;
- Build multidisciplinary networks including computer science, social science and law academics to understand how your research impact on other research areas;
- Carry out research on how emerging technologies are impacting disability rights;
- Include accessibility and the principles of Universal Design in curricula for design, computer science, design, user experience and other relevant courses.

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Endnotes

[1] European Commission Disability Strategy 2010 2020 https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2010:0636:FIN:en:PDF

[2] WHO World Report on Disability 2015 http://apps.who.int/iris/bitstream/10665/70670/1/WHO_NMH_VIP_11.01_eng.pdf

[3] European Commission Disability Strategy 2010 2020 https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2010:0636:FIN:en:PDF

[4] As stated in the European Commission proposal for a European Accessibiity Act http://ec.europa.eu/social/BlobServlet?docId=14813&langId=en

[5] More information about statistics on persons with disabilities https://ec.europa.eu/eurostat/statistics-explained/index.php/Disability_statistics

[6] See part 2 of this report for more information about this survey. Please note that we did not survey people who do not use ICT; this survey does not claim to be representative of the views of the disability community.

[7] Definitions and references in this glossary should not be interpreted as an endorsement by EDF.

[8] https://en.wikipedia.org/wiki/Emerging_technologies

[9] https://www.sussex.ac.uk/webteam/gateway/file.php?name=2015-06-swps-rotolohicksmartin.pdf&site=25
https://www.stevenshenager.edu/blog/what-is-emerging-technology

[10] For more on the definition of artificial intelligence see https://www.forbes.com/sites/bernardmarr/2018/02/14/the-key-definitions-of-artificial-intelligence-ai-that-explain-its-importance/#36f3c66d4f5d

[11] https://www.britannica.com/technology/artificial-intelligence

[12] https://en.oxforddictionaries.com/definition/artificial_intelligence

[13] Another way to think of artificial intelligence is in how it is leveraged to 'augment' human intelligence https://www.artificialintelligence-news.com/2018/05/24/why-augmented-intelligence-is-a-better-way-to-describe-ai/

[14] https://en.oxforddictionaries.com/definition/algorithm

[15] https://en.oxforddictionaries.com/definition/big_data

[16] https://www.bernardmarr.com/default.asp?contentID=1140

[17] https://en.oxforddictionaries.com/definition/machine_learning

[18] The terms "machine learning" and "artificial intelligence" are sometimes used interchangeably, which can lead to confusion – see https://www.forbes.com/sites/bernardmarr/2016/12/06/what-is-the-difference-between-artificial-intelligence-and-machine-learning/#21d1db842742

[19] https://dictionary.cambridge.org/dictionary/english/deep-learning

[20] This is the UNCRPD definition

[21] [Universal Design] is not a special requirement, for the benefit of only a minority of the population. It is a fundamental condition of good design....By considering the diverse needs and abilities of all throughout the design process, universal design creates products, services and environments that meet peoples' needs" http://universaldesign.ie/What-is-Universal-Design/

[22] http://www.realitytechnologies.com/augmented-reality

[23] https://en.oxforddictionaries.com/definition/robotics

[24] http://whatis.techtarget.com/definition/robotics

[25] https://en.oxforddictionaries.com/definition/hologram

[26] https://www.techopedia.com/definition/618/gesture-recognition

[27] https://en.oxforddictionaries.com/definition/haptics

[28] https://www.techopedia.com/definition/3637/haptic

[29] https://www.techopedia.com/definition/3637/haptic

[30] https://exoskeletonreport.com/what-is-an-exoskeleton/

[31] https://en.oxforddictionaries.com/definition/us/internet_of_things

[32] https://www.techopedia.com/definition/31494/smart-city

[33] https://en.oxforddictionaries.com/definition/us/smart_home

[34] https://en.wikipedia.org/wiki/Smart_speaker

[35] https://en.wikipedia.org/wiki/Virtual_assistant

[36] https://en.wikipedia.org/wiki/Wearable_technology

[37] https://www.techopedia.com/definition/30056/autonomous-car

[38] https://www.bbc.co.uk/news/business-44871448

[39] See definition in standard EN 301 549 https://www.etsi.org/deliver/etsi_en/301500_301599/301549/01.00.02_30/en_301549v010002v.pdf

NB: Where ICT does not support directly connected assistive technology, but can be operated by a system connected over a network or other remote connection, such a separate system (with any included assistive technology) can also be considered assistive technology

[40] https://sustainabledevelopment.un.org/post2015/transformingourworld

[41] http://www.internationaldisabilityalliance.org/resources/accessible_icts_paper

[42] http://www.un.org/sustainabledevelopment/blog/2017/05/innovators-un-discuss-using-tech-to-tackle-worlds-development-challenges/

[43] http://edf-feph.org/sites/default/files/edf_-_sdgs_human_rights_report_final_accessible_0.pdf

[44] https://ec.europa.eu/info/aid-development-cooperation-fundamental-rights/your-rights-eu/eu-charter-fundamental-rights_en

[45] https://eur-lex.europa.eu/legal-content/en/TXT/?uri=CELEX%3A32016L2102

[46] https://ec.europa.eu/social/main.jsp?catId=1202

[47] EN 301 549 https://www.etsi.org/deliver/etsi_en/301500_301599/301549/02.01.02_60/en_301549v020102p.pdf

[48] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32016R0679

[49] https://ec.europa.eu/digital-single-market/en/news/communication-artificial-intelligence-europe

[50] See BEUC position paper 'Automated decision making and artificial intelligence – A consumer perspective' https://www.beuc.eu/publications/beuc-x-2018-058_automated_decision_making_and_artificial_intelligence.pdf

[51] https://ec.europa.eu/digital-single-market/en/news/draft-ethics-guidelines-trustworthy-ai

[52] The European AI alliance is an online platform hosted by the European Commission https://ec.europa.eu/futurium/en/eu-ai-alliance

[53] http://www.europarl.europa.eu/sides/getDoc.do?pubRef=-//EP//NONSGML+COMPARL+PE-630.525+01+DOC+PDF+V0//EN&language=EN

[54] http://www.europarl.europa.eu/sides/getDoc.do?type=COMPARL&mode=XML&language=EN&reference=PE630.525

[55] https://ec.europa.eu/digital-single-market/en/news/coordinated-plan-artificial-intelligence

[56] Interviewed as part of research for this report http://g3ict.org/about-us/governance

[57] https://www.usatoday.com/story/tech/news/2016/03/23/facebook-accessibility-people-with-disabilities/82026554/

[58] https://www.wired.com/2016/04/facebook-using-ai-write-photo-captions-blind-users/

[59] https://www.usatoday.com/story/tech/news/2016/03/23/facebook-accessibility-people-with-disabilities/82026554/

[60] https://www.facebook.com/accessibility/videos/1628143837229335/

[61] https://www.microsoft.com/en-us/seeing-ai/

[62] https://techcrunch.com/2015/08/17/aipoly-puts-machine-vision-in-the-hands-of-the-visually-impaired/

[63] https://www.microsoft.com/en-us/garage/profiles/presentation-translator/

[64] See G3ict article http://g3ict.org/blogs/efhoh-and-itu-joint-effort-in-improving-hard-of-hearing-people-accessibility-at-meetings

[65] Recent ITU standard of remote captioning provides for understanding requirements and user expectations https://www.itu.int/pub/T-TUT-FSTP-2018-ACC.RCS

[66] https://blogs.nvidia.com/blog/2017/05/11/ai-translates-sign-language/

[67] https://nakedsecurity.sophos.com/2018/02/21/artificial-intelligence-reads-privacy-policies-so-you-dont-have-to/

[68] https://pribot.org/

[69] https://www.wired.com/story/polisis-ai-reads-privacy-policies-so-you-dont-have-to/

[70] https://www.bbc.com/news/av/technology-36433868/alzheimer-s-virtual-reality-app-simulates-dementia

[71] See more examples in this article https://www.abilitynet.org.uk/news-blogs/8-ways-virtual-reality-could-transform-lives-disabled-people

[72] In museum settings, AR could also give better access to artwork that cannot be seen physically up close for securing reasons.

[73] https://ac.els-cdn.com/S1877050914000192/1-s2.0-S1877050914000192-main.pdf?_tid=104116e4-0ce5-11e8-86bc-00000aab0f26&acdnat=1518104039_cce43a4ecec9467a651c8e099c556664

[74] https://dyslexiaida.org/definition-of-dyslexia/

[75] ibid

[76] https://www.asha.org/public/speech/disorders/aphasia.htm

[77] Dr Jane Marshall said of EVA Park "It's a place where people can feel more relaxed thereby reducing emotional stress associated with stroke.... It's a great use for people who may not be able to travel or those that cannot, for whatever reason, make use of community services."

[78] Such avatars are also used for weather forecasts

[79] See World Federation of the Deaf and World Association of Sign Language Interpreters joint statement on signing avatars https://wfdeaf.org/news/resources/wfd-wasli-statement-use-signing-avatars/

[80] Live signing is also required for last minute gate changes at airports or platform changes at train stations

[81] It is also crucial to represent women and girls with disabilities as avatars as attitudes and prejudices have stereotyped them negatively, contributing to their social isolation and exclusion

[82] https://www.theverge.com/2017/6/14/15799064/new-microsoft-xbox-live-avatars-diversity-customization-features

[83] https://cdn.vox-cdn.com/thumbor/Pwgh3ROi33yApM_OLQcDZMwcjNc=/0x0:1594x893/1400x1400/filters:focal(670x320:924x574):format(png)/cdn.vox-cdn.com/uploads/chorus_image/image/55248791/xboxliveavatarsnew.0.png

[84] https://www.theguardian.com/media-network/2016/may/09/robots-social-health-care-elderly-children

[85] https://www.grandviewresearch.com/industry-analysis/exoskeleton-market

[86] https://www.wired.co.uk/article/exoskeleton-stop-falls-elderly

[87] http://www.europarl.europa.eu/RegData/etudes/etudes/join/2014/507480/IPOL-ITRE_ET(2014)507480_EN.pdf

[88] https://www.wired.co.uk/article/wayfindr-navigation-visually-impaired-euston

[89] Google asked a blind man to test its self-driving vehicle https://www.telegraph.co.uk/technology/google/9175494/Look-no-hands-Blind-man-is-first-user-of-Google-self-driving-car.html

[90] https://www.youtube.com/watch?v=cdgQpa1pUUE

[91] Forget-Leblois, C (ed) 2015. Internet of Things: New Promises for Persons with Disabilities" http://www.g3ict.org/

[92] https://dspace.mit.edu/handle/1721.1/107831#files-area

[93] http://www.mollywatt.com/blog/entry/my-applewatch-after-365-days

[94] This survey was carried out between 6 and 13 November 2018 and publicised by EDF on social media.

[95] Respondents included, inter alia, people who are blind, deafblind, partially sighted, hard of hearing, deaf, people who use a wheelchair, people with dwarfism, people with autism, people with intellectual disabilities, people with mental health issues and people with chronic conditions such as multiple sclerosis.

[96] From 18 years old to 61 and over. There was a slight over-representation of people aged 31 to 40 in the survey.

[97] Thirty eight percent of respondents were men, 60% women and 2% transgender. Just over half of respondents (51%) said they were already involved in policy or technical debates about emerging technologies in their own country, while 49% were not involved in such debates.

[98] Respondents could highlight as many concerns as they wanted

[99] Where people gave us authorisation to mention their name, we did. Many respondents chose to contribute anonymously but allowed us to quote them in the report, without mentioning their names.

[100] EDF survey respondent

[101] Eye tracking is already widely in use in a variety of Assistive Technologies (AT) and has been revolutionary for people who are unable to touch a screen, move their head, hands or other parts of their bodies

[102] Tobii who produce both assistive technology and VR with eye tracking capability told us that this was not a priority for many VR developers, but they emphasised that this would probably change over time. https://www.tobii.com/group/about/

[103] Eye tracking technology creates wider opportunities for independence by making it possible for an individual to control their environment through a device, such as opening or closing curtains or turning on and off a light.

[104] http://www.g3ict.org/resource_center/g3ict_smart_cities_initiative

[105] Smart Cities for All recently published a toolkit to help urban planners make smart cities more inclusive http://smartcities4all.org/#about-us

[106] See Samantha Fothergill blogpost https://www.fawcettsociety.org.uk/blog/danger-designing-public-spaces-favour-non-disabled-men

[107] See also ANEC factsheet on citizens requirements smart cities https://www.anec.eu/images/Publications/anec-leaflets/ANEC-Leaflet---Citizens-requirements-for-smart-cities---what-standards-can-do.pdf

[108] https://medium.com/datadriveninvestor/sidewalk-toronto-and-why-smarter-is-not-better-b233058d01c8

[109] See also Jutta Treviranus presentation 'Towards Digital Equity in Canada' at International Telecommunication Union (ITU) on 12 December 2018 https://www.itu.int/en/ITU-D/Regional-Presence/Europe/Pages/Events/2018/AE/WebcastArchive.aspx

[110] Interviewed as part of research for this report

[111] https://efhoh.org/wp-content/uploads/2017/04/EFHOH-Feedback-on-the-European-Commissions-Smart-Wearables.pdf

[112] EN 301 549 https://www.etsi.org/deliver/etsi_en/301500_301599/301549/02.01.02_60/en_301549v020102p.pdf or https://www.w3.org/WAI/standards-guidelines/#wcag

[113] Jack Chen and Chiara Tomasi, interviewed as part of research for this report, highlighted Chrome Accessibility Developer Tools, Android Accessibility Testing Framework https://developer.android.com/training/accessibility/testing and GTXiLib for iOS testing https://www.google.com/accessibility/blog/post/GTXiLib-announce.html

[114] Interviewed as part of research for this report https://www.w3.org/People/shadi/

[115] Interviewed as part of research for this report

[116] http://teachaccess.org/

[117] https://www.nttdocomo.co.jp/english/corporate/csr/hearty/

[118] https://www.w3.org/WAI/intro/usable

[119] EDF survey respondent

[120] https://support.google.com/accessibility/answer/7641084?hl=en

[121] https://support.apple.com/en-gb/contact

[122] Apple is often mentioned as an example, providing accessibility information on their website and in their stores; devices also have easy to access accessibility menus.

[123] https://dspace.mit.edu/handle/1721.1/107831#files-area

[124] Reference is EN 17161

[125] See European Commission mandate M/473 https://ec.europa.eu/eip/ageing/standards/home/accessibility-and-design-all/m473_en

[126] https://www.iso.org/committee/6794475.html

[127] https://www.cencenelec.eu/News/Events/Pages/EV-2018-016.aspx

[128] EDF survey respondent

[129] There are some search engine organisations, such as Google Search, that provide direct access to reporting of this kind of bias. In these instances, the user can directly feedback into the programme and can help to reduce or correct it.

[130] This kind of bias also exist in the field of machine vision, for example, where the technology cannot easily distinguish between genders and ethnicities. This is also true in some facial recognition software, where lighter pigments are more accurately labelled and darker tones less so.

[131] https://www.technologyreview.com/s/601812/microsofts-ceo-calls-for-accountable-ai-ignores-the-algorithms-that-already-rule-our-lives/

[132] More information: see Oxford University podcast series https://podcasts.ox.ac.uk/are-all-algorithms-biased

[133] https://www.reuters.com/article/us-amazon-com-jobs-automation-insight/amazon-scraps-secret-ai-recruiting-tool-that-showed-bias-against-women-idUSKCN1MK08G

[134] See also http://www.bbc.com/future/story/20161110-the-real-risks-of-artificial-intelligence

[135] Author of 'Weapons of Math Destruction' https://www.theguardian.com/books/2016/oct/27/cathy-oneil-weapons-of-math-destruction-algorithms-big-data

[136] https://www.cnbc.com/2018/05/30/silicon-valley-is-stumped-even-a-i-cannot-remove-bias-from-hiring.html

[137] https://research.google.com/bigpicture/attacking-discrimination-in-ml/

[138] For example, using 2 sets of biometric data (e.g. fingerprint, face, voice print) to authenticate the user.

[139] Interviewed as part of research for this report https://www.w3.org/People/shadi/

[140] EDF survey respondent

[141] 2017 Multi-stakeholder Forum on Science, Technology and Innovation for SDGs http://www.internationaldisabilityalliance.org/resources/accessible_icts_paper
http://www.internationaldisabilityalliance.org/sites/default/files/sti_sgpwd_advocacy_paper_final.pdf

[142] https://www.joedolson.com/2014/03/detecting-assistive-technology/

[143] This is particularly important for persons with intellectual disabilities or psycho-social disabilities.

[144] The European Federation of Hard of Hearing People told EDF that hearing care professionals often activate data login in hearing aids and cochlear implants without specific consent from their patients. This is a real concern.

[145] https://ec.europa.eu/info/sites/info/files/eccg-recommendation-on-ai_may2018_en.pdf

[146] See BEUC position paper 'Automated decision making and artificial intelligence – A consumer perspective' https://www.beuc.eu/publications/beuc-x-2018-058_automated_decision_making_and_artificial_intelligence.pdf

[147] http://fra.europa.eu/en/publication/2014/violence-against-women-eu-wide-survey-main-results-report

[148] EDF survey respondent

[149] Peter Thompson, President of the 71st UN General Assembly http://www.un.org/sustainabledevelopment/blog/2017/05/innovators-un-discuss-using-tech-to-tackle-worlds-development-challenges/

[150] https://tbinternet.ohchr.org/_layouts/treatybodyexternal/Download.aspx?symbolno=CRPD/C/GC/2&Lang=en

[151] Also see general comment No. 7 (2018) on the participation of persons with disabilities, including children with disabilities, through their representative organizations, in the implementation and monitoring of the Convention https://tbinternet.ohchr.org/_layouts/treatybodyexternal/Download.aspx?symbolno=CRPD/C/GC/7&Lang=en

[152] EN 17161 on Design for All (this standard will be published in 2019)

[153] EN 301 549 http://mandate376.standards.eu/standard

[154] BEUC, the European Consumer Organisation has a list of national members https://www.beuc.eu/beuc-network/our-members

[155] European Digital Rights (EDRI) has members in Europe and beyond https://edri.org/members/

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