

Nafath

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Enabling and Accessible Digital Resolution

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mada
digital access for all

About Mada

digital access for all نفاذ رقمي للجميع



Mada Center is a private institution for public benefit, which was founded in 2010 as an initiative that aims at promoting digital inclusion and building a technology-based community that meets the needs of persons with functional limitations (PFLs) – persons with disabilities (PWDs) and the elderly in Qatar. Mada today is the world's Center of Excellence in digital access in Arabic.

Through strategic partnerships, the center works to enable the education, culture and community sectors through ICT to achieve an inclusive community and educational system. The Center achieves its goals by building partners' capabilities and supporting the development and accreditation of digital platforms in accordance with international standards of digital access. Mada raises awareness, provides consulting services and increases the number of assistive technology solutions in Arabic through the Mada Innovation Program to enable equal opportunities for PWDs and the elderly in the digital community.

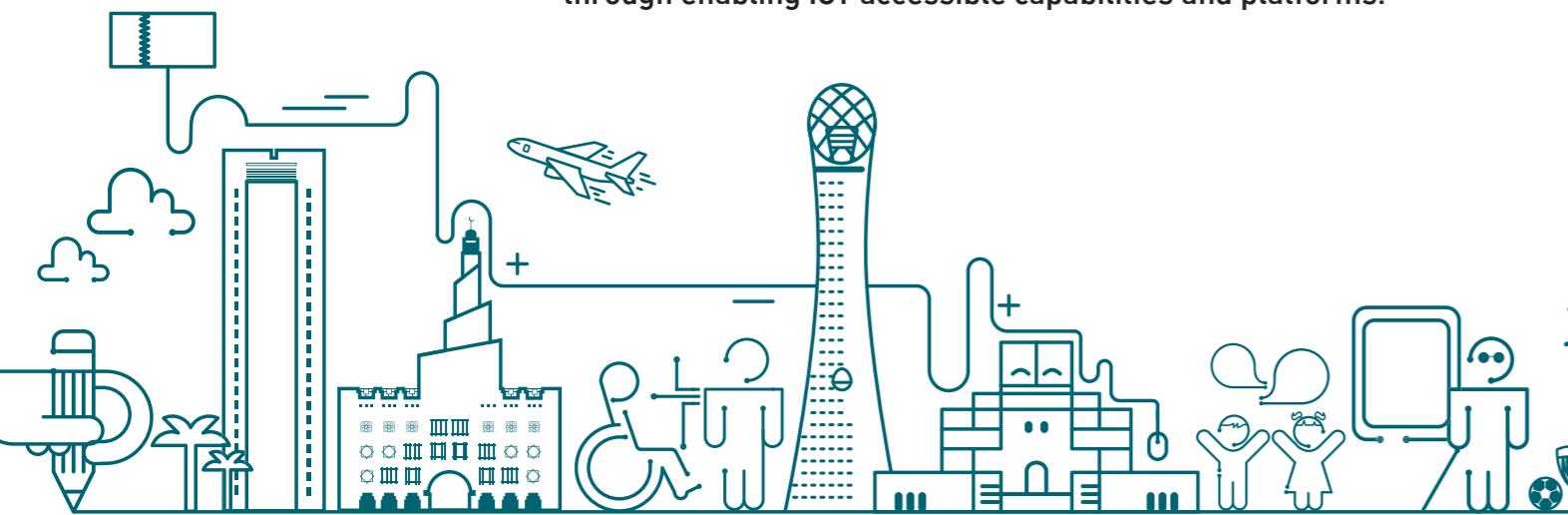
At the national level, Mada Center has achieved a digital accessibility rate of 94% amongst government websites, while Qatar ranks fifth globally on the Digital Accessibility Rights Evaluation Index (DARE).

Our Vision

Enhancing ICT accessibility in Qatar and beyond.

Our Mission

Unlock the potential of persons with functional limitations (PFLs) – persons with disabilities (PWDs) and the elderly - through enabling ICT accessible capabilities and platforms.



About Nafath

Content Page

Nafath aims to be a key information resource for disseminating the facts about latest trends and innovation in the field of ICT Accessibility. It is published in English and Arabic languages on a quarterly basis and intends to be a window of information to the world, highlighting the pioneering work done in our field to meet the growing demands of ICT Accessibility and Assistive Technology products and services in Qatar and the Arab region.

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The Advent of Smartphone Ready Hearing Aids

According to the World Health Organization, around 466 million people worldwide live with some form of hearing loss, and this figure is estimated to reach 900 million by the year 2050. While the reasons for the impairment may vary, the affect of hearing loss is felt across all segments of the population as it can be caused due to various factors like acquired disability or natural aging. The emergence of hearing aids and smartphones have significantly improved the ability of users with hearing loss to communicate effectively.

When introduced, hearing aids allowed people to directly stream ambient sounds to their ears, thereby improving the hearing capability of individuals with hearing loss considerably. Smartphones eventually developed features to be compatible with supporting hearing aids. As such, most smartphones are natively hearing aid compatible nowadays. Hearing aids are installed with a small coil of wire, called a Telecoil or Tcoil that creates a magnetic field to pick up sounds and transfers it directly to hearing aids. This means that when using the phone, only the caller's voice will be amplified upon placing the phone close to the hearing aid.

Performance of smartphones with hearing aid compatible features may vary. Due to the nature of the technology, there can be radio interference, heard as buzzing or whistling, when the phone is held close to the user's hearing aid. This results in poor-quality sound being transmitted to a Telecoil or microphone in the phone. The performance ratings of smartphones with hearing aids are reflected in their hearing aid compatibility rating also known as 'M,' or 'T' ratings.

As underlying technology for smartphones and hearing aids improved, manufacturers explored methods to enhance the compatibility of the devices. In recent times, certain smartphones and hearing aids can connect via Bluetooth. This enables a range of additional features like adjusting of hearing aid settings such as volume, sensitivity, etc. The most beneficial feature of Bluetooth connectivity between the devices is the ability to stream audio (during a call, or multimedia) directly to the hearing aids without radio interference and without the need to hold the smartphone close to the hearing aids during a phone call. Such a setup allows the sound to be transmitted simultaneously to both the hearing aids (left and right), as the smartphones can connect to both hearing aids at the same time resulting in better quality of hearing.

Initially, only selected iOS devices had ventured into being hearing aid ready with Bluetooth connectivity capabilities. Furthermore, these selected devices could also be used as a microphone to capture and stream ambient sounds directly to the hearing aids via Bluetooth. Compatibility of hearing aids with Android devices has been scarce due to the various versions of the Android OS in the market making it difficult for hearing aid manufacturers to support them. However, more recently large technology firms like Google have been working with hearing aid manufacturers to bring native hearing aid support for Bluetooth streaming on Android.

While hearing aid ready smartphones are becoming more common and come bundled together with other relevant native accessibility features, they are still relatively much more expensive than hearing aids without Bluetooth streaming technology. The constant connectivity and high-quality audio streaming are often intensive on battery consumption of the hearing aids demanding the need to be charged more frequently.

As per the figures mentioned in this article, the hearing loss population constitute a major potential market of the smartphone industry. In the age of the Internet of Things (IoT), it is important for smartphones to provide comprehensive compatibility for hearing aids, enabling users with hearing loss to have unbound access to all means of Information and Communication Technology (ICT).



AssistiveTouch Factsheet

AssistiveTouch on iOS

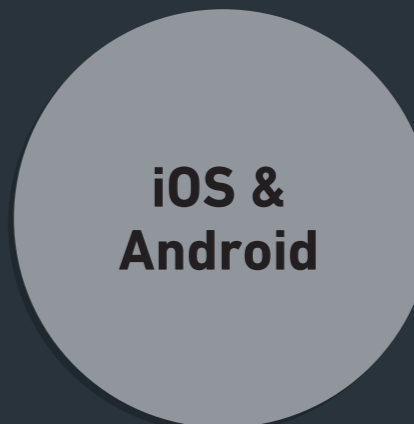
iOS devices are remarkably intuitive and easy to use, but some of its features are inaccessible if you can't touch the screen. AssistiveTouch is a feature in iOS devices (iPhones and iPads) that helps you adapt your iOS device if you have difficulty touching the screen or if you use an adaptive device. Through this feature, gestures like rotate and shake are available even when your iPhone is mounted on a wheelchair. AssistiveTouch also works with a number of third-party assistive devices that help you interact with your iPhone, iPad, and iPod Touch.

AssistiveTouch is not an original default feature on iPhone, it was originally designed for people with disabilities, and first appeared in iOS 5. Over the years, it has been recognized as a critical tool for the empowerment of people with disabilities to use Apple smartphones and tablets without any limitations.

With AssistiveTouch enabled, you can perform gestures like a pinch, multi-finger swipe, 3D Touch, pinch into a tap, lock screen, rotate screen, control the volume buttons, customize other gestures to fit your needs, and even customize the layout of the AssistiveTouch menu, use Siri, and double tap among many others possible without using any physical buttons whatsoever.

In addition to people with disabilities, AssistiveTouch is used by all users for the following reasons:

1. **Protect Physical Buttons:**
The iPhone is a delicate gadget. Its buttons eventually wear out due to long or hard usage, or, even worse, break due to physical damage. It is expensive to replace a button. AssistiveTouch is hence an alternative to all physical buttons, allowing them to last longer.



2. **Have a Better Touch Experience:** If you're used to tapping on the touchscreen, it may feel a bit stranger when you switch to a physical button. Using the AssistiveTouch allows you to get almost all jobs done without a physical button.
3. **Use as an Alternative to the Home Button:** Many users complain that it's a bit inconvenient when it comes to moving the fingers all the way down from the screen to the Home button, for they have a phone with a big screen like

iPhone 6S Plus, 7 Plus, X, particularly if they have small hands. That's where AssistiveTouch comes in handy.

AssistiveTouch on Android (Accessibility Menu)

There are a couple of apps on GooglePlay that mimic AssistiveTouch, seeing that it is only available on iOS devices. However, there is another built-in feature on Android devices that does a similar job. This is the Accessibility Menu, available on all devices using Android 9.0 or later.

The Accessibility Menu is a large on-screen menu that helps you control your Android device. You can control gestures, hardware buttons, navigation, and more. From the menu, you can take the following actions:

- Take screenshots
- Lock screen
- Launch Google Assistant
- Open Quick Settings and Notifications
- Turn volume up or down
- Adjust brightness

For both Android and iOS users, the availability of tools such as AssistiveTouch on the phone means that people with physical disabilities, including those that switch to access their devices, can enjoy all the features of their smartphones without any obstacles whatsoever.

To learn more about Apple AssistiveTouch, you can visit: <https://support.apple.com/en-us/HT202658>. For information about the Android Accessibility Menu, go to <https://support.google.com/accessibility/android/answer/9078941?hl=en>

The Microsoft HoloLens 2

As part of its efforts to improve lives of people with Disabilities (PWDs) and the Elderly, Mada Center works with various innovators to develop an ecosystem that is supportive of innovating technological solutions that promote digital access for PWDs. In addition to that, Mada has taken the responsibility of introducing and promoting latest assistive technology solutions that can make a difference for PWDs and the elderly.

The Microsoft HoloLens 2 is a pair of mixed reality smart glasses developed and produced by Microsoft.

The second-generation HoloLens uses a series of cameras and sensors to capture the environment around the user and project holographic 3D images on top of the real world. With these 3D holographic projections, users can control and interact and perform tasks or play games. HoloLens 2 and other mixed reality projectors have several applications such as real-time training, reports, analytics, remote guidance and prototyping.

HoloLens 2 does not rely on any external controllers, unlike most of the Virtual or Augmented Reality headsets which are available on the market. Instead, using Windows Cortana, it leverages hand and voice controls and gestures. In the latest version, HoloLens 2 can recognize more than twenty articulation points per hand, enabling precise and more realistic hand movements.



HoloLens 2 is also capable of tracking the eyes of a user with sensors near the device's nose ridge. If the headset is shared, the device can remember individual users and retain individual user settings and preferences.

The current HoloLens headset is based on a combination of user interaction hand gestures. However, by adopting an eye tracking system, Microsoft would either completely drop hand gestures or use them in combination with the gaze. This would make HoloLens 2 more accessible to people with disabilities who may find it difficult to use their hands to control the device.

Integrated eye tracking would give a HoloLens 2, or any other head-mounted display (HMD), a whole new method of input to interact with the display content. The HMD could track the gaze of a user to adjust the display of content, while allowing users to use their eyes to input commands.

An interesting set of applications of HoloLens 2 emerges when it is used with Dynamics 365 Remote Assist, a product line of enterprise resource planning and customer relationship management applications released by Microsoft:

- Empower technicians to solve problems more efficiently by working together from various locations through Dynamics 365 Remote Assist.
- Share what you see with employees in remote locations to stay hands-on with your work while you get the help you need.
- Bring employees together in multiple locations with a real-time view of a problem to effectively troubleshoot and reduce costs.
- Do a remote hands-on training for people with all abilities.
- Trainers can work on the devices they are already using from anywhere.

Mixed reality in the current digital world can be a game-changer. Microsoft can certainly have an impact on a global scale with the immersive, ergonomic, and instinctual features offered by HoloLens 2. For us in Mada Center, we expect further development down the line because the project will be open source, meaning that we could see Arabic supported applications targeting people with disabilities.

Artificial Intelligence & Accessibility

Increasingly, Artificial Intelligence (AI) research is consistent and continues to advance. Artificial Intelligence represents machine capabilities that, in the past, would have only been possible through human intelligence. Since this definition is subjective, artificial intelligence may change as the expectations of computers evolve. Regardless, AI is being used more widely in different applications across multiple settings and industries. In the coming years, Artificial Intelligence will be at the forefront of efforts to improve the lives of people with disabilities.



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At Mada, we know that disability comes in different shapes and people with disabilities have different types of needs. It is not a simple theory with a small number of possible values. It has many dimensions, varies in intensity and impact, and often changes over time. As a result, Mada is constantly supporting innovative and emerging technologies such as AI technologies through The Mada Innovation Ecosystem. Artificial Intelligent assistants for people with disabilities provides powerful tools to navigate the world and play a role in all the activities of daily life. It can help solve a wide range of general accessibility, safety & privacy, inclusiveness, communication, employment and transportation problems.



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- AI advances in areas such as predictive text, speech-to-text transcription, and voice and visual recognition can assist employees or potential employees with disabilities.
- Increased mobility with a self-driving car that will increase the movement of people with physical disabilities significantly.
- AI can help people with hearing disabilities by providing augmented text, voice interpretation and sign language support.
- AI systems can learn from people's regular activity to detect falls or proactively alarming caretakers before a situation becomes an emergency.
- AI offers better navigation systems for people with visual impairments.
- AI voice assistants help people with disabilities to live independently and with improved safety, especially when they are paired with smart home solutions.
- People with physical disabilities and mental health conditions have access to predictive tools, virtual assistants, and therapeutic chatbots and robots.
- AI technology such as voice interaction, image recognition and real-time captioning is starting to break down barriers for people with sensory, physical and cognitive disabilities.
- The use of AI benefits employees with not only disabilities but also employers and workplaces, forming a more diverse and inclusive workplace.

- AI for accessible technologies is serving teachers and tutors to test and identify learning disabilities. With machine learning, tailored tutoring and study plans, AI can help students fraught with basic ideas or who need a more personalized approach to make sure they do not fall behind in the classroom.

Artificial Intelligence is rapidly growing more useful by the day. An ever-increasing number are people are viewing these technologies, not as a luxury item but, as a tool that can increase productivity or release some untapped potential. AI assistants, like Amazon Alexa, Microsoft Cortana, Google Assistant, and Apple's Siri, are demonstrating to be life-enhancing for those including a variety of disabilities.

Systems with the capability to learn languages and cultures is making it easy for AI implementation in different parts of the world including the Arabic language region. Companies and organizations are continuing to invest in improving AI for a better, more inclusive society.

Regardless of the outcome, it is without a doubt that AI is changing the world we live in, particularly for people with disabilities.

Tools by Tecla Enabling an Accessible Digital Revolution

As part of its strategic roadmap, Mada works to enable equal access to cultural life via digital technology for people with disabilities and the elderly. This is primarily done through empowering strategic partners and key stakeholders to support people with functional limitations to fulfill their creative, artistic and intellectual potential independently.

As communication technology became more pervasive in modern society, so has our reliance on digital tools for carrying out the most essential day to day activities. From getting around to managing workloads and lifelong learning, we use telephones and tablets to access dynamic content in a way that is blurring the lines between the virtual and physical worlds. Hailing a taxi no longer entails waving down a car from the sidewalk or even making a telephone call to an operator, it is something that can be done through a simple few touches on any ride-sharing app. Mada encourages this type of dynamism and independence as it empowers people to become more active participants in society, breaking down socio-economic and physical barriers along the way.

For people with disabilities, the importance of this digital revolution is even more compounded. As a group of people that has been traditionally marginalized from work, education, mobility, social and cultural participation and all types of fitness and entertainment, they are in even greater need for digital tools that enable them to partake in this new world, where digital tools are able to provide greater social mobility and integration.

This type of transformative change is precisely what tools developed by companies such as Tecla can bring about. The Assistive Technology manufacturer has developed a range of products to support people that have difficulty using smartphones, tablets, and computers using traditional methods. Through the use of switches, people with physical disabilities can freely interact with all iOS and Android devices.

A switch is an input device, such as a button, that can be programmed to carry out a functional normally done through traditional input methods such as touch or typing. The size and sensitivity of switches can range from a large surface that can be triggered with a person's head or something very small and sensitive that is controlled by the movement of one's eyebrows. Switches are powerful tools that enable people with limited use of their hands to make use of digital tools without any obstacles at all.

Tecla's switch system is mobile meaning that it can be used from a person's wheelchair or if they are sitting on the sofa at home. Unlike most tools that are fixed to a specific physical configuration, Tecla systems are designed to be portable and used by the same person in multiple settings. In addition to the switches themselves, a Tecla system offers the entire system including the controller, joysticks, mounts which can be purchased either individually or as part of an entire kit.

What makes Tecla even more unique as a company is that it is a Certified B corporation – part of a growing worldwide network of businesses that meet a set of standards related to their social and environmental performance, public transparency,

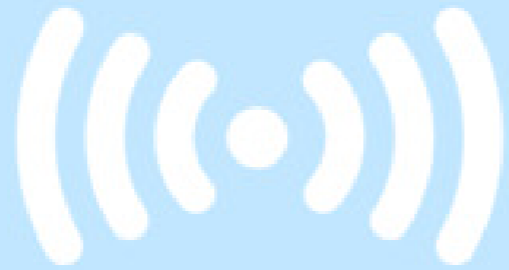
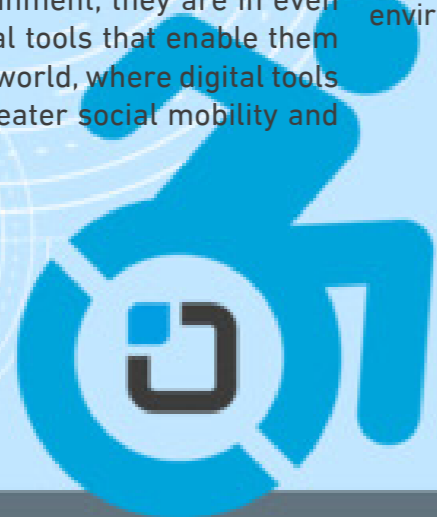
and legal accountability. This means that they are committed to balancing profit and purpose. The result is that Tecla solutions are considerably less expensive than other, more mainstream, adaptive switch solutions.

Another benefit that the company enjoys is its location within an incubation center in one of Canada's leading biomedical incubation centers. Through a partnership between Ryerson University and St. Michael's Hospital, the Biomedical Zone allows technology startups to validate their need-based solutions directly with clinicians, business experts, innovative thinkers, and most importantly, people with disabilities themselves.

The result is a user-driven technology that is in touch with the real-life needs of its most important stakeholders – people with disabilities themselves.

Take Carolyn, for example, a former circus performer that was injured, resulting in her physical disability. Through Tecla, she can do her online banking, order taxis, and work in the magazine industry independently. There is also Christopher who uses the Tecla platform to control not one, but two Macs to edit videos, run his creative business, communicate with people all over the world, play games and browse the Internet. Prior to Tecla, Christopher was limited to using only one computer at a time, because he had to have his switch hard-wired. Now, he can come and go from the computer and change computers independently.

No matter what the use is, Tecla is an example of an innovative technology that has the potential to change people's lives.



Microsoft Seeing AI

Seeing AI is an application developed by Microsoft, that turns the visual world into an audible experience for those with visual impairments. Harnessing developments in artificial intelligence, it utilizes the phone's camera and links with the VoiceOver function allowing you to just hold your phone up and hear information about the physical and visual world around you.

Different options or channels are available along the bottom of the screen by swiping to the right or left. These allow you to access.

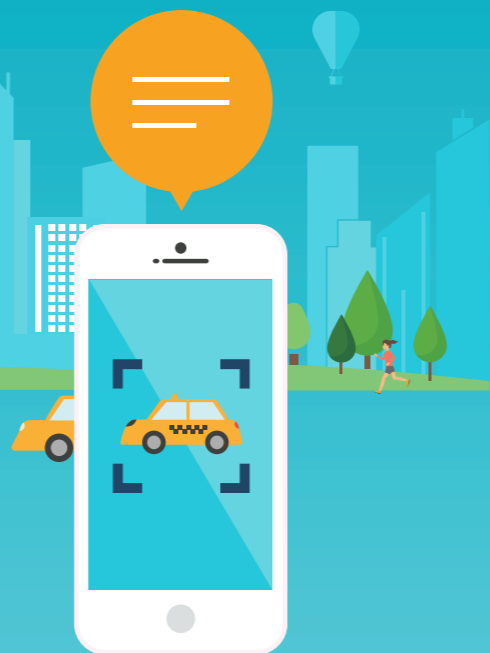
- **Short Text**
This feature speaks text that appears in front of the camera.
- **Documents**
Leveraging Optical Character Recognition (OCR), this feature guides you to capture a printed page and recognizes the text, while maintaining its original formatting.
- **Products**
Users receive an audio beep when the app recognizes a barcode. The app then scans the barcode and provides the name of product along with package information when available.
- **People**
The app saves people's faces so you can recognize them, and gives an estimate of their age, gender, and emotions. With the latest update, you can now teach Seeing AI to recognize someone new, directly from the main screen in this channel.
- **Scenes**
This feature is still in some development, but it will give you an overall description of most scenes captured. With the newest update, you can now also touch part of

the screen to hear about parts of the photograph or image or where objects are located.

- **Currency**
This feature recognizes dollar currency notes.
- **Color**
Through this feature, the app identifies the color of objects held in front of it.
- **Handwriting**
The app reads handwritten text, like in greeting cards or on study notes. It's a very useful feature for students who may wish to borrow notes of a missed lecture from a class mate.
- **Light**
This feature gives an audible tone corresponding to the brightness in the general surroundings.

In the app, you can also view images in other apps by tapping "Share" and "Recognize with Seeing AI" to describe images from Mail, Photos, Twitter, and to browse photos on your phone.

This is a free app developed by Microsoft, now in its third version. It is available for download from the Apple store, as it is currently on available for iOS and in the English language. There is no doubt that this app can have life changing impact on the lives of people with visual disabilities.



SpeechWatch World's First Standalone AAC Smartwatch

In line with Mada's continuous efforts to keep up with the latest assistive technology innovations, our Assistive Technology team has reviewed a new AAC speech device that is enjoying considerable success with users and practitioners.

SpeechWatch is the world's first standalone Augmentative and Alternative Communication (AAC) speech device that is worn on the wrist, making it the first smartwatch of its kind. It is ideal for children and adults with Autism, Aphasia, Parkinson's, or any condition that affects one's ability to communicate with friends and family.

The SpeechWatch is a wearable AAC device that offers features including smartphone functionality, internet access, texting, email, social media apps, GPS mapping, tracking, streaming music and access to apps from the Google Play Store. The watch also allows parents to choose from a wide selection of readily available "parental" control apps. Additionally, all distractions can be turned off to limit the user, so that they only focus on using the TalkTablet speech app, or other specific AAC apps and features.

This wearable AAC device does not require a secondary smartphone or tablet in order to create or edit AAC buttons or pages. However, if the user already owns a tablet with the TalkTablet app installed, the user can utilize it to edit and create TalkTablet buttons and pages and wirelessly transfer them to the SpeechWatch or vice versa.

It is to be noted that this device requires a GSM cellular network to be able to use its cell phone features. Other key features include:

- Compatible with Android apps from Google Play Store (eg. TalkTablet)
- 1GB of RAM
- 4 cores running at 1.3GHz processor
- 16GB of storage
- A 2.2-inch screen at 320x240 resolution
- Speaker and microphone
- Camera, video recording
- IP67 waterproof rating

Mada believes that with such advancement in wearable technology, it is not far to imagine the development of an Arabic version using Tawasol AAC symbols.



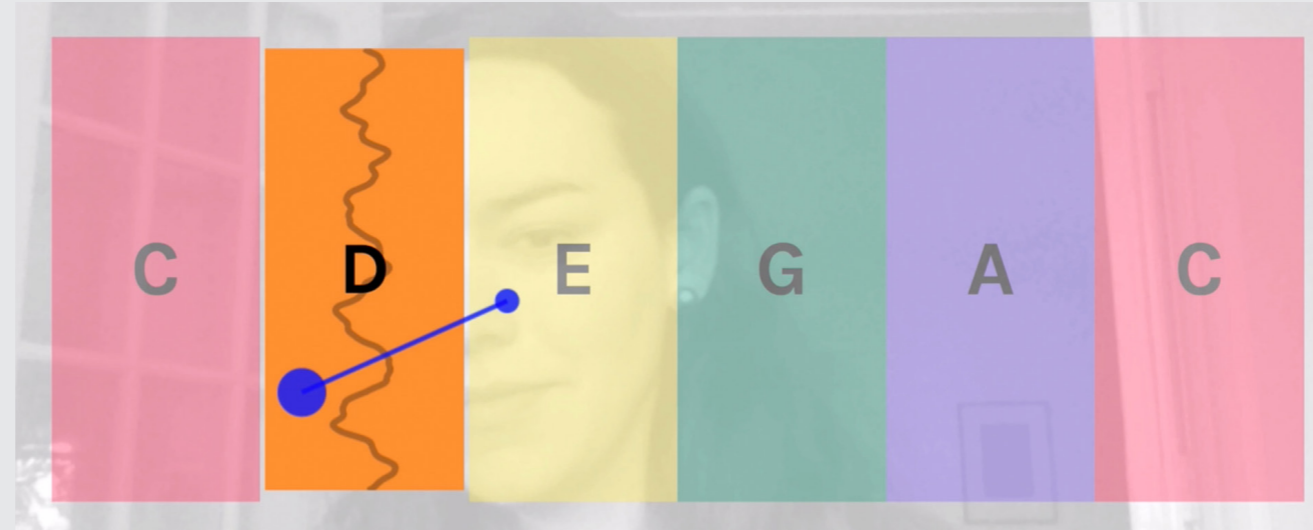
Experiments by Google Greater Access through Creatability

Launched in 2009, Google has brought together coders to experiment with the company's marquee web browser Chrome, its operating system Android, and with Artificial Intelligence (AI), Web Virtual Reality, Augmented Reality (AR) and other emerging technologies.

The small projects that coders from around the world have developed have yielded new and innovative ways in which Google can be a platform for people to play, create and communicate with the outer world. The program, named "Experiments With Google," recently launched a stream dedicated to exploring how creative tools can be made more accessible to people with disabilities.

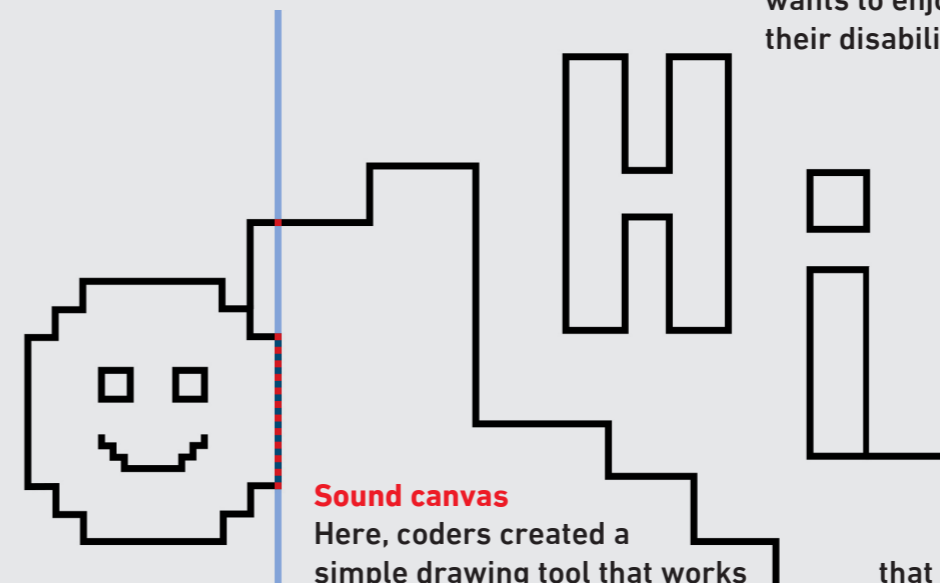
"Creatability," is a set of experiments made conducted by creators with the participation of allies in the digital accessibility community, including people with disabilities themselves. They explore how creative tools that enable drawing, music, and more, can be made more accessible using web and AI technology.

The results of these experiments are shared online alongside open-source code and tutorials to empower others to make their own projects. Here are a few of the projects that have emerged from the Creatability platform.



Keyboard

This is a virtual musical keyboard someone can play with the movement of their face, body, mouse, or through a keyboard. Movements are tracked and mapped using a webcam. Users can also customize the scale and number of notes on the screen. For more advanced musicians, they can also control other instruments using MIDI technology. Like all other projects on the platform, this project was developed in coordination with The Viscardi Center, a network of non-profit organizations that provides a lifespan of services for children and adults with disabilities with an emphasis on digital accessibility. Tools such as this can be liberating, even life changing, for musicians with physical disabilities, or for anyone that wants to enjoy the brilliance of music despite their disability.

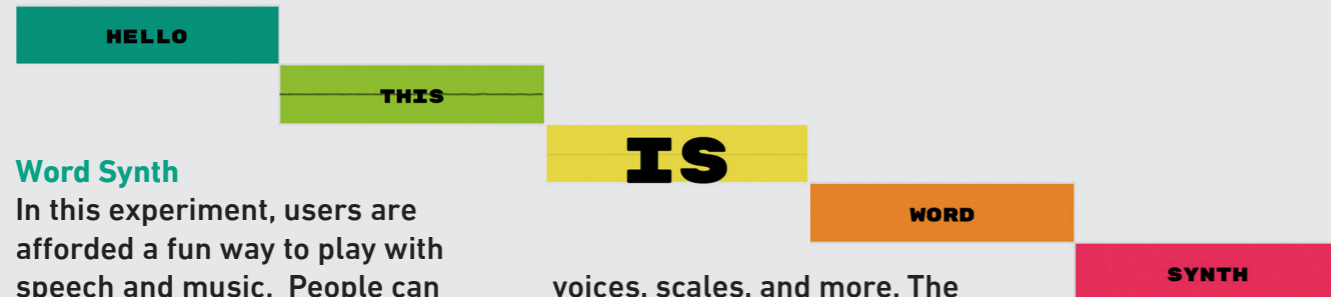


Sound canvas

Here, coders created a simple drawing tool that works through both sight and sound. A person can control a virtual pen or brush to draw with their mouse or keyboard. Alternatively, a webcam can be used to track a point on their body, like a nose. This is an ideal way to draw for people

that are unable to use their hands to control traditional input methods. To support artists with visual disabilities, the whole canvas space can be turned into sound. For example, a rising line makes a rising sound. A line drawn from left to right will be heard moving from your left to right ear.

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Word Synth

In this experiment, users are afforded a fun way to play with speech and music. People can combine speech and music by typing some words, then setting them to a melody. The music can change through the mouse or keyboard, and users can also explore different

voices, scales, and more. The technology was built with Google Cloud Text-to-Speech API, which enables developers to synthesize natural-sounding speech. This is a great tool for people with learning disabilities who want to leverage an interactive tool to improve their literacy skills.

As can be seen, all the experiments made on the Google Creatability platform explore a diverse set of inputs, from mouse, keyboard, body, wrist, nose, or voice. They allow people with disabilities to make music by moving their face, or draw using sight or sound, and to experience music visually, amongst other ways to be more expressive.

Google has also worked hard to make sure that the experiments work with many screen readers across different platforms, with a commitment to improve compatibility. They are also actively inviting blind users to submit feedback based on their experiences with the tools created.

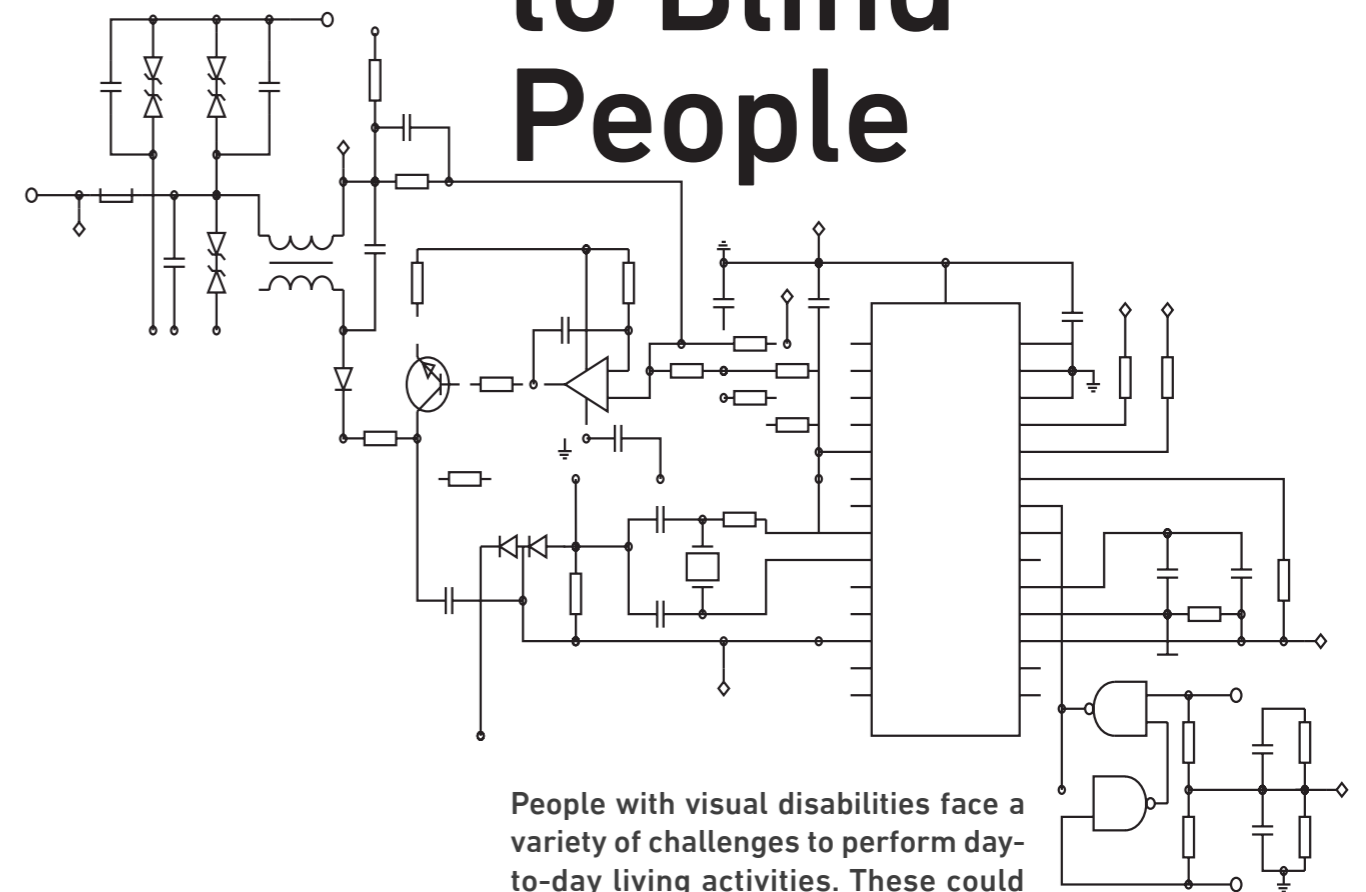
Whereas many of the tools developed as part of this initiative are still in their embryonic stage, and still require a lot of work to prepare them for widespread implementation, the spirit of collaboration and inclusion of people with disabilities is setting the standards for similar projects.

There is no good design without user testing, and to avoid the need to retroactively make changes, a process that can prove to be very expensive, people with disabilities need to be consulted at the design and development stage. The result will be an online tool, piece of hardware or physical space that will be user centered and inclusive.

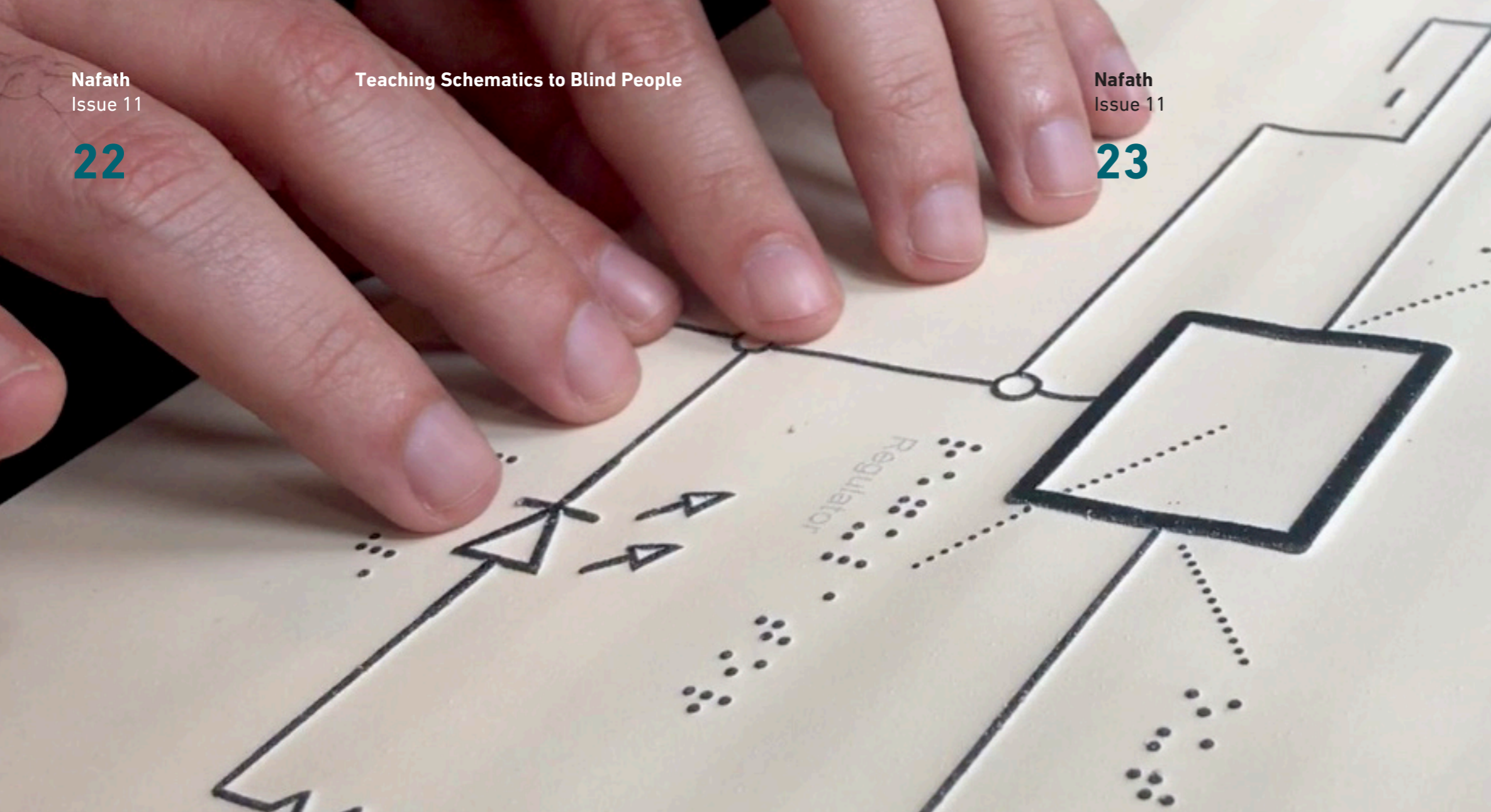
To learn more about Google Creatability, visit <https://experiments.withgoogle.com/collection/creatability>

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Teaching Schematics to Blind People



People with visual disabilities face a variety of challenges to perform day-to-day living activities. These could include everything from complex tasks such as navigating indoor spaces to simpler ones such as reading user instructions for purchased items. Over the past decade, the advent of various Assistive Technologies (AT) have successfully addressed many of these challenges and helped improve the lives of blind people. Some AT include Optical Character Recognition (OCR) software, talking GPS devices, screen-reader software, and others.



Despite significant advancements in the AT sector, there are still certain issues confronted by the blind community that await the development of new or enhanced solutions in order to be resolved. One such challenge is to help people with blindness learn schematics by making relevant coursework more accessible. Coursework materials of subjects like Physical Computing and Electronics are heavily comprised of schematics that are mostly described through visual diagrams. It is noted that conceptual representations of topic areas like computing and electrical circuits are best conveyed through technical schematics like circuit diagrams. This can often be a major hinderance for people with severe visual impairment or blindness.

The most common approach used to pass on technical schematics information to people with blindness is through the means of tactile representation and detailed textual, or circuit description of the visual diagram. Oftentimes, such forms of information representation need to be complimented with relevant instructional strategies to be delivered by the instructor. Additionally, the ability to grasp such “visually-rich” concepts from tactile representations demand the learner to be extensively experienced in working with tactile graphics. There also lies the requirement of having regular access to AT like Braille and Tactile Graphic Embossers which may be quite expensive depending on the intricacies of the schematics to be produced.

The complex conceptual nature of technical schematics like circuit diagrams make it significantly challenging to translate the information into tactile form. Currently, circuit descriptions often tend to be convoluted and complicated to interpret compared to the visual diagrams of the same information.

“In order to create more accessible and usable schematics for people with blindness, it is vital for sighted designers to enhance their design process by gaining a better understanding of the users’ requirements”.

Recently, a New York University (NYU) thesis study carried out with blind and low vision participants used participatory and human-centered design to develop a first of its kind set of design standards and best practices to be utilized for creating readable tactile schematics for low vision and blind learners. These standards provide guidance for the designing of templates, workflow, and printing process. They were developed by experts in the fields design, accessibility, and physical computing. The making of tactile schematics through the utilization of these design standards and best practices require a working knowledge of Adobe Illustrator or Sketch along with the need to access Swell Touch Paper and a Swell Form Machine.

Consequently, these standards were then applied to convert and design over 50 tactile schematics for a Physical Computing class coursework and have been made readily available to the public. This proved to serve as a successful foundation for the newly developed standards and best practices. The standards are still considered to be a work in progress as they are being further enhanced. The success of the NYU study highlights the importance of involving people with disabilities and industry experts to work collaboratively for developing successful solutions that meet the needs of the end-user community. Participatory and human-centered research ensures access to the critical knowledge of those living with disabilities while also offering opportunities for solution developers to better understand the user-needs and to design products and services accordingly.