

Toward a voice for everyone

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“The problem with communication ... is the *illusion* that it has been accomplished.” – George Bernard Shaw

The first moon landing was orchestrated by less computing power than you can slip in a child's jeans pocket today. Since humankind's first steps on the moon, technological innovation has surged, bringing new opportunities to each person who has access to its power. Today, more than ever, with the low costs of learning tools and global networking of resources, technology can enable whole new kinds of “firsts” for everyone.

A big first, which some would say is the biggest in life for any person, is obtaining a voice.

Whether audibly articulated using traditional speaking muscles or produced from keystrokes or other input means, there is no reason why everyone cannot be given a chance to speak. Yet today, millions of people are silent without choice, with no access to a means to articulate their ideas, questions, needs, pains, observations, offers of help, hopes, and other results of creative apperception. This paper articulates practical steps toward giving everyone a voice.

Learn from those who could not speak, and now can.

We have conversed with people who at times have had no voice, who sometimes or always use a computer to speak, and with the families and teachers of such individuals. At the top of the list of their observations are the following three concerns about speaking technologies:

1. Prohibitive price. A good assistive technology device is usually around \$8000¹. Insurance will pay for these only under certain limited circumstances. These circumstances may not include “let me try it to see if it might help a child or adult learn to speak.” Devices are not usually provided to people who have *some* speech, or whose speech comes and goes, e.g., some people experience apraxia of speech under high stress, as in a classroom, but can participate when given the chance to type their speech.²
2. Poor durability and usability. Current devices are clumsy, unreliable, crash or break too easily, and their proprietary software can be hard or impossible to customize to individual needs.
3. Misinformed attitudes. Many people believe a non-speaking person cannot learn to type, or they believe that using a device might prevent the person from learning to speak.³ Some people assume that non-speaking persons are non-communicators and treat them that way, which further hinders desire, effort, and knowledge to communicate.

These concerns are today's barriers; they can all be removed.

1 Sometimes half or double this price, depending on an individual's needs.

2 Note that inexpensive communication alternatives in a classroom could be good for all students – providing ways multiple children could speak up simultaneously with a question, or privately message for permission to use the restroom, or allowing those with mobility issues to write on the board remotely (it is very hard to write on a chalkboard from a wheelchair.)

3 Scholarly articles redressing such myths are listed at <http://aac.unl.edu/yaack/b2.html> (July 13, 2008).

Collect a technology wish list.

Here is a wish-list of features that several non-speaking people and their teachers and families have said they would like to see in a voice output device:⁴

Overall system/hardware:

1. Talking word processor with clear speech and controllable volume audio output.
2. Low cost (not thousands of dollars).
3. Reliable: it should not crash, require rebooting, or make unexpected sounds, such as squeals, while you're using it to speak.
4. Durable: it should survive being dropped, and perhaps even being thrown.
5. Portable, small and not heavy, with a handle that is easy to pick up and carry.
6. Long battery life. Option to carry a spare battery and/or use standard batteries.
7. Wireless Internet access to download new pages or overlays made by others and also to download device updates.
8. Attractive, non-medical, non-stigmatizing, customizable appearance.
9. Monitor flicker frequency should not irritate those who are visually flicker sensitive.
10. Monitor that can be read outdoors in bright sunlight.
11. Ability to easily network, instant message, and chat with friends.
12. Power button in a place where it doesn't get accidentally bumped or hit. Keys that don't get accidentally pushed and start talking when device is inside a bag.
13. Ability to accept nearly any DC power supply, e.g.. 24 volt wheelchair, 12 volt car, etc.
14. Anti-theft technology.
15. Waterproof/water resistant for use in restrooms and alongside swimming pools.
16. Easy to clean.
17. Ability to help make calls, perhaps acting like a cell phone, or interacting with one via Bluetooth wireless protocol, or via TTY.
18. Ability to hook up to a sound system, e.g. in the car.
19. Easy way to back up the device.
20. Optional input devices: touch screen, keyboard, or other.
21. Visual screen that could be easily turned and viewed by a conversational partner in a noisy environment or place where voice is not desired.
22. Easy (for those with limited dexterity) to insert recharging cables; inductive charging.
23. Nighttime lit keyboard option and dim screen/backlight-off screen options.
24. Built in navigation (e.g. Global Positioning System + local interpretation) option.
25. Environmental control options such as wireless ability to turn on and off light switches, microwave ovens, telephone speaker option, intercom to another room, etc.
26. Panic button to notify some people in an emergency.
27. Options for as many modalities as possible, e.g., Braille terminals and Braille keyboards.
28. At least two switch ports (one to scan, one to select) for people who need a non-keyboard interface.
29. Some 1 and 2 switch users may want Morse code.
30. Ability to afford/procure/keep a spare device in case the main one needs repairs.

⁴ See <http://thiswayoflife.org/toptenaac.html> for further commentary by an experienced speaking device user on ten of these wish-list items.

Software features:

31. Language system: allow a user-adjustable mix of text and pictures, with auditory navigation option to describe segments as you move through or select them.
32. Options for anything auditory: speak as you type or not, keyclicks on/off, directing which speaker the sound goes to (output, headphone, or both), etc.
33. Support for mixed languages (e.g. tell an English speaking friend the Montreal street address of your hotel) and customize pronunciations (Is “Jesus” Spanish or religious?)
34. Optional word prediction tools.
35. Ability to change screen colors, font sizes, background contrast depending on needs. which can change for an individual even over the course of a day.
36. Option to have device talk while typing or wait till hit a “talk” keystroke. Ability to instantly silence device’s speech (for instance realizing you inadvertently interrupted someone).
37. Ability to repeat something you just said.
38. Ability to quickly clear typed text.
39. A single switch control to go to the next page is useful for some.
40. Spell-checking mode.
41. Password-protection of some pages, e.g., pages with banking or medical information.

Typical devices do not have all of the abilities above, even those in the price range of \$15,000. Many schools won’t let children take even the simplest speaking devices home or out of the classroom since they are so expensive. A device that is at hand wherever a person goes, and ready to use whenever that person feels like talking, can be world-changing: It gives a voice.

Open-source a software garden.

Shakespeare used 21,000 words in his writing when the average vocabulary of the day in Stratford, England, was less than 500. Most celebrated authors do not exceed an average of 7500 words while the average English speaking person today has around 2000-4000 words depending on their education.⁵ Which words are needed in a particular person’s speaking device? The ideal words and images, the style of expression, and the most fitting navigation tools for retrieving these will change with each person’s interests, abilities, age, education, culture, and personality: There is no one best-for-all software solution. However, if a device offers access to the Internet, and if a community of users of the technology can freely view, choose from, download, modify, comment on, and post their new and modified items to a garden of software choices, then gradually a flora of software interfaces will emerge that serve people’s needs and interests.

Open-source software communities have proven that their software can be well-designed, reliable, robust, and powerfully transformative. People in the autism community have already generously been designing and building free and open-source software that is used by others in their community: for example, Joel Smith has created the “Jtalk” communication software for PC’s, <http://www.thiswayoflife.org/jtalk/index.html>, and John Lesieur and his company made an open source web browser that is free for download on PC’s, <http://www.zacbrower.com/>. Free open-source software is the default on visionary educational platforms such as One Laptop Per Child’s (OLPC’s) XO.⁶ The idea behind making software free and open is to foster a culture

⁵ Word counts taken from <http://www.william-shakespeare.info/william-shakespeare-dictionary.htm> on July 12, 2008.

⁶ The leader of the open-source educational software for the XO (and their software can also run on other Linux platforms) is Walter Bender, walter@sugarlabs.org, who has said he would be happy to talk further to explore ways to advance the ideas articulated here.

empowering the end user to appropriate the tool in every way – facilitating not only better software and customization, but also open learning. Open-source software is usually free which comes as an astonishing fact to many. Never underestimate the power of people.

Connect disabled people to each other and to the world.

Many of the creative, smart people who produce remarkable contributions⁷ to our world have disability diagnoses. Some cannot speak, or can occasionally speak but they find their communication is more likely to say what they intend if they type it. Some cannot presently manage daily care needs, but may readily tackle a challenge that is daunting for most other people. Some cannot handle face-to-face social interactions and/or the demands of the traditional workplace environment, but may still accomplish great things. When an individual has an interest that aligns with ability, and suitable resources are made available, then there are almost no limits to what that individual can accomplish, especially when they communicate with and team with others. A communication device that gives global Internet access, especially one that connects people regardless of their disabilities, is a powerful resource, bringing new opportunities for learning, expressing, and sharing.

Some people have found it easier to hone their communication skills by practicing speaking with people online. Online, a person can focus on the content of what is said, and handle communication at a personal pace, a pace that can vary greatly with practice and with how one feels from day to day. Online communication can provide encouragement, education, and support from helpful people who may be halfway around the planet in physical location, but neighbors in spirit. New possibilities for employment, collaboration, and rejuvenation have been found through networking and communicating online.

Provide a physical platform.

Here we consider the possibility of using the OLPC XO with its free and open source Sugar software for a low-cost communication and networking device for both adults and children. This laptop was created to dramatically change the cost of laptops – hitting the price point needed to get state-of-the-art learning technology into the hands of children around the world. At the time of writing this document, the XO is revolutionary in what it achieves at a low cost, and it also has many cool and useful features that aren't available on laptops ten times its price. In the future we can expect more hardware makers to jump into the ring, offering additional low-cost hardware options, but their best attempts so far do not yet compare to what is available today from OLPC. The pros and cons are described below following the ordering of the wish list above.⁸

1. The XO has controllable volume audio output. Today there exists at least one free version of software that runs on the XO and speaks aloud what you type: <http://wiki.laptop.org/go/Speak>. This software is very simple compared to commercial systems and is intended to encourage learning to type. The current software defaults to show a face with large eyes which is undesirable for some people on the autism spectrum; however, this can be modified.

⁷ Including, but certainly not limited to innovating free and open source software and technology.

⁸ Disclosure: One of the authors (Picard) is friends with Nicholas Negroponte, Walter Bender, and several other people who envisioned and participated in the creation of the OLPC XO and its Sugar software; however, OLPC and SugarLabs are non-profit organizations and the authors do not stand to benefit in any financial or other foreseeable way through the consideration of this technology choice.

2. Low cost: The starting price is \$187 for one XO computer, which comes with a year of free T-mobile wireless service. Note that even the new half-price iPhone with a year of phone-data service is typically more than double the price of an XO. While the XO laptop is not generally available in small quantities to individuals in the United States, OLPC has said they are planning to run another Give One Get One program in fall 2008, where individuals in the US can buy two laptops, donating one to a child in a developing nation. This would move the cost closer to \$400, which is still less than other new low-cost laptops, which do not have many of the features of the XO (described below). Future OLPC plans are to lower the price below \$100.
3. Reliable: The XO runs with Linux, specifically RedHat Fedora. Linux is an open-source operating system that is widely believed to be one of the best operating systems, open source or otherwise.
4. Durable: Tests the XO laptop has passed include being dropped onto concrete from about chest-height of an adult. It was designed for heavy use by an active child who would lug it around all day, indoors and out, in dirty, dusty, and damp environments.
5. Portable: The XO is small (242mm x228mm x 32 mm or 9.5in x 9in x 1.3in) light-weight (1.58 kg or less than 3.5 lbs), with a built in handle that is easy to grab and carry.
6. Long battery life: The XO was designed to be especially power efficient: it runs on less than a tenth the power of a typical laptop computer, consuming on average less than 2 watts. Unfortunately it does not currently allow carrying a spare battery, or using off-the-shelf batteries to power it. One option is to carry another laptop since they are light and low-cost. A wide array of alternative powering options also exist (see below).
7. Wireless is built-in, making it easy to surf and upload to/download from the Internet.
8. OLPC is committed to using attractive design. Offering more color options than the current bright green would be nice. Somebody could make new "skins" for it.
9. The monitor frequency of the XO was observed to have a small amount of flicker from one flicker-sensitive person on the autism spectrum; this would need to be tested with each individual who is flicker sensitive, with special concern for those who have migraines or epilepsy. (Note that this is a problem with most computer monitors, including many expensive alternative communication devices.)
10. Sunlight-readable: The XO has a custom-designed display that can be easily read indoors or outdoors, even in bright sunlight with its black & white mode.
11. The XO comes with chat software and can be wirelessly networked to friends over the Internet or to other XO's within range of its built-in wireless mesh network. The latter network comes free with the XO, requiring no outside service provider or subscriber fees.
12. The XO power button is in a place where it doesn't get accidentally bumped or hit. The device can be folded (like most laptops) to cover the keyboard for placing in a bag.
13. Because it was designed to work with many alternative sources of power in developing nations, the XO is compatible with an unusual variety of DC power sources. It may need some custom cables (e.g. if you want to adapt one of the XO's human-powered generators to run off a wheelchair) but it was designed to work robustly with lots of innovative power options, including human-powered options.
14. OLPC has carefully designed anti-theft technology for the XO.
15. The XO's membrane-sealed keyboard makes it much more water resistant than most laptops.
16. All surface parts of the XO can be easily wiped down.
17. The laptop is capable of making calls over the Internet; it does not yet have the ability to act like a cell phone.
18. The XO comes with a standard audio jack as well as three USB ports, allowing easy connection to many kinds of audio equipment.
19. With Internet access and USB ports, there are several options for easy back-ups.

20. The next planned version of the XO will likely have two touch screens, one replacing the keyboard, so that the keyboard will become like that on an iPhone touchpad, only larger. There is some concern that the current XO's membrane keyboard, while nicely sealed against spills and dirt, is harder for some people to type on than a traditional keyboard. There is also some concern that the future planned touch screen keyboard may not be fast to type on as it won't provide tactile feedback; some people find it hard to type on the iPhone for this reason. Also, the compact size of the current keyboard is great for child-sized hands, while adults who are used to full-size keyboards may find it cramped. However, it is possible to plug a standard full-sized keyboard into an XO.
21. The XO has an easy-to-pivot screen that can be angled for both the typist and a conversational partner to read.
22. The default charger is a standard laptop charger, but there are many possible variations on this. Inductive charging is not expected anytime soon.
23. The XO does not currently have a light on the keyboard; however it is easy to add a light that plugs into one of its USB slots. The screen can be easily dimmed, and the screen backlighting can be turned off.
24. GPS is not built in, but a commercial low-cost GPS unit could be plugged into an XO USB port. For this and other accessories, there may need to be development of some new software for device drivers.
25. Environmental control accessories could be added, and would probably also require additional software development for the XO.
26. A panic button could be programmed.
27. The XO's three USB ports and audio jack could receive a variety of alternative input devices; software drivers may need to be written for these.
28. The XO does not have "two switch ports" per se but it can accommodate multiple switches through its USB ports.
29. The XO does not presently come with Morse code but there is Morse code freeware available online (although this and other freeware may need to be tested with the XO and possibly adapted to run on it.)
30. For the price of a low-end \$4000 communication device, one could buy 20 XO's, optionally donate 15 to children in poor and developing nations, and still keep four spares just in case a curious sibling decides to try the durability test on concrete from an upstairs window (and other surprises that might lead to sending a machine out for repair).

Communication and control software:

31. The XO can support both text and pictures. Currently, it does not have software for navigating language systems, so this would need to be developed and could require a substantial amount of work. Note that OLPC is committed to booting with Linux, an open source operating system, even with their new hardware coming out in 2009 that is going to also dual-boot with Microsoft Windows XP. Thus, OLPC will continue to support an open-source, maximally-modifiable and adaptable software environment, which invites grass-roots innovation in software.
32. These options would need to be added to communication software developed for the XO.
33. The XO is an internationally-targeted device and has people from many cultures and languages contributing software, different keyboards, and more customizations. Over time there should be extensive support, freely downloadable, for mixed languages.
34. Word prediction tools such as Dasher have already been developed in the open-source community, including a version that runs with Linux that should be portable to the XO.
35. – 41. All of these wish-list items can be incorporated into free and open-source software that could be developed in the future. It will require a significant effort, but there is a community of online talented programmers ("hackers" in the best sense of the word) who

could be encouraged to contribute to this cause. Note that because the software would be free and open, every individual who uses it adds to the size of the community of potential developers: all people are welcome to contribute to its improvement.

The XO has four additional features that may be of interest:

Feature1: The XO comes with a very easy to use built-in camera and microphone to record video and audio, and play these back, allowing a person to see and reflect on how he or she comes across when (perhaps) acting out or speaking out certain social-communicative skills. For example, teens could record different ways to express things like “excuse me” or more popular phrases like “my bad” etc., pick their favorites, and upload and share their choices with others, receiving feedback and collecting new ideas from each other. Some people might find it fun to try out language while alone, practicing where nobody can make fun of them or otherwise cause them social stress.

Feature2: The XO is able to read from and display the outputs of wireless, non-invasive, physiological sensors developed at the MIT Media Lab that give a person new ways to communicate aspects of experience related to interest, stress, or overload.

Feature3: The XO is a general purpose personal computer designed to encourage exploration, creative expression, and learning. Children or adults can use it to draw pictures, play games, compose music, write stories, surf the web, learn to program, modify other people’s programs, and more. Many very cool software programs have already been written for it, and more are being written daily. Children are encouraged to participate in joining the community of developers.

Feature4: the XO received the first gold award ever given to a laptop by [EPEAT](#), an organization that assesses the environmental impact of laptops according to the Institute of Electrical and Electronics Engineers (IEEE) 1680-2006 specification. The XO is unusual among electronic devices in that it was designed to be non-toxic and fully recyclable. In addition, it has been designed to be “green” in its very low power usage.

Provide information to parents, teachers, professionals, and others about how to help.

An important component to the above steps would be the creation of a website and interactive online community that promotes the idea that non-speaking people are communicators, that encourages two-way communication with non-speaking persons, that supports non-speaking individuals, their families, teachers, speech language pathologists, and other professionals and support staff in using a device as part of improving communication, and that allows, above all, non-speaking individuals to be heard on the site.

From people who have learned to speak successfully with a device we learn many things, such as that the attitude of those around them really matters, and that little things can make a big difference, for example being allowed to “babble” on their devices when learning to speak. We also learn of the importance of being able to have a device and its access methods present at all times: too often a child is prohibited from taking a device home from school because of its cost. Practical advice from successful users of communication devices can be shared easily in today’s networked world. The idea of providing this online resource would be to encourage sharing of what works, especially since there can be a lot of individual variation in needs and a pool of ideas from a broad range of participants can sometimes provide the answer that a local

community doesn't yet have. Such an online community would be an important resource to accompany an effort that provided hardware and a garden of software.

Foster continuous input from real experts.

This is where the paper began: talk with people who either have never had speech, or who have it and it comes and goes, or who had it and lost it, but who can talk today because they can use technology to be their voice. There are online communities such as **ACOLUG**, a LISTSERV created to assist people who use augmentative communication, with their friends and families, to discuss issues related to augmentative and assistive communication, such as equipment, funding, learning techniques and supports. A new effort to provide technology could leverage this existing community, and there may be interest in also developing one or more new communities focusing on subgroups with special interests or needs, e.g. a subgroup of developers of open source software for language navigation, where they can talk with users about needs, etc. The key is to foster open channels of communication where people can give ongoing input to steadily improve the available solutions.

Evaluate.

Ideally, actions made toward giving non-speaking people the ability to speak would be evaluated scientifically. There are many levels of analysis that could be examined. Does a child randomly assigned to receive an XO full-time and a program developed around its use make better progress in communicating than a child randomly assigned to receive Picture Communication Symbols and a program such as PECS (Picture Exchange Communication System) for its use? How might the XO technology help implement, augment, and validate existing therapies for teaching typed or pointed communication? Which kinds of educational initiatives provide the best success in helping all people involved be effective and independent communicators and communication partners? These are a few of hundreds of questions that could be systematically explored in trying to identify effective practices to help everyone overcome their communication challenges, to help everyone in taking the small steps, which may lead to giant leaps, when they achieve a voice.

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