Keynote Address
World Blind Union Asia Pacific General Assembly
Singapore
November 17, 2003

In the Palm of Your Hand

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In the palm of your hand. A phrase that captures many favorable attributes. Simple. Accessible. Small. Easy to grasp (both physically and intellectually).

Many of these attributes do not apply today to the adaptive technology that blind people can use. Attributes such as expensive. Bulky. Hard to use.

Today I am going to sketch my vision of where technology is going to take people with visual impairments. A world where the technology adapts to you instead of you to it; a world where powerful yet simple tools rest in the palm of your hand.

But, first, a bit on where we have been. We have made tremendous progress in the last 25 years with technology designed to enable blind people. The Optacon, the video magnifier, the reading machine, the screen reader, the screen magnifier, the speech and Braille notetakers, the DAISY digital talking book are all noteworthy milestones in adaptive technology tools for blind people. Together, these tools have made independent information access more and more of a reality for many blind people, especially those who by virtue of personal, employer or government resources find these tools within reach.

Of all these advances, probably the most important has been the personal computer. Not even a product designed specifically for people with disabilities! It's a general purpose tool essential for many jobs in the information economy. I call it the Swiss Army knife for people with disabilities. A simple adaptation and its many capabilities are within reach. It has many capabilities: it's a word processor, an email communication platform, an ecommerce terminal, a library and many other things rolled into one. And, with the right software and sometimes hardware, it can be turned into an accessible tool.

It has had some major ramifications. Thanks to Moore's law, computers get cheaper and faster with a relentless pace. This has made PCs and most PC-based tools steadily more affordable. When I started Arkenstone 14 years ago, my most important choice was to build our reading machine on top of a personal computer. We were able to drop the price significantly, and the price then fell steadily thanks to the labors of the PC industry. We just stood back and looked good while PCs and scanners fell continually in price.

Now reading machines are being used by more than fifty thousand people, compared to the few hundred when we started Arkenstone. PCs are being used by at least one hundred thousand visually impaired people. That is huge progress, but it is not enough.

We have only scratched the surface of the millions of people who are blind around the globe. Even in countries such as the United States, which is a wealthy country, the vast majority of blind people are not being served by adaptive computers. There are many reasons for this. PCs are too expensive and too complicated. Adaptive technology is relatively expensive and also too complicated. The products are hard to learn, and hard to service. There are good reasons for why these things are true, but that doesn't change the facts.

Something must change for technology to serve the majority of the blind around the globe. I want to talk to you today about what I think those changes will be, must be. As leaders of the organized blind movement in a region with so many blind people, you will be in a position to influence these changes for the benefit of your community, to get what your community wants and not just what technologists and technology companies will have on offer.

One set of changes will be demographic. As time goes on, people with visual impairments will have more and more experience with technology and comfort with using technology in their lives. This will be especially true of people losing their vision later in life. Technology in the form of cell phones will be part of the daily life of an increasing proportion of humanity. As time goes on, more and more people will grow more and more comfortable with using high tech and the technology will get easier to use.

Technology capabilities are at the heart of my talk. I come from Silicon Valley, and one of the great benefits of being located in the center of California's high tech community is hearing about the future in the present tense. It is not hard to hear where technology is going, and the sad fact is that adaptive technology tends to lag the commercial markets by months or years. In addition, the pace of change has gotten very predictable. One of the founders of Intel, the main makers of computer processors, Gordon Moore, proposed a law more than thirty years ago. He predicted that computer chip power would double every two years. The past decades have borne out that prediction. This is why computers get cheaper and faster in a way that we can easily predict. And though it seems unlikely to go on forever, at any point in time we usually can see how it will go on for the next ten years. So, we can simply plan on it happening and start assessing the likely consequences.

Now I want to shift the context of this progress. Usually, we start talking about how Moore's Law is going to affect personal computers. I think that the PC is not going to directly change the life of the average blind person in the world in the next ten years. It is likely to be too big, too complex and too expensive. I believe the device that is going to change the world for blind people is the cell phone.

Now, today's cell phone is already making an impact. I think that it is already probably the most widely used piece of technology by blind people in many countries with the exception of the cane. But, tomorrow's cell phone is going to be very different from today's cell phone, even though it may look the same. Those differences show up in several critically important ways.

The first technology change is processing power. The cell phone is already an amazingly powerful computer. It's clear that the capabilities that are now inside a personal digital assistant

like the Palm Pilot will become a part of cell phones: hybrid devices that cross a cellphone are already available. Today's Palm has a processor with the same capabilities of a PC of five years ago. This means that the tasks that a PC can do will be possible on a handheld device within a few years. Capabilities like optical character recognition, voice recognition and voice synthesis will all be able to run on a tiny device.

The second technology change is convergence. More and more capabilities will be stuffed into these cell phones of tomorrow. Paul Otellini, the current president of Intel, used to sit on the board of directors of my first successful high technology company. Earlier this year, Paul gave the keynote address at the annual fund raiser of the Sensory Access Foundation, our local charity that trains blind people for jobs. He said that every cell phone would have a camera in it within a few years, and it's already happening.

Eight years ago, we received a patent in the United States on a talking GPS device for the blind. Back then, it was too expensive for people to buy. Now, groups like Pulse Data and VisuAide have products based on that patent that work with notetakers for the blind. That GPS location capability is already being built into the next generation of cell phones.

Convergence means that cell phones in the future will have the capabilities of three to six different devices of today.

The third technology change in the cell phone of the future is the ability to add software. This is what made the PC so powerful. It was a general purpose tool that could easily add software and do different tasks and provide new benefits. This is happening to the cell phone. And, we're not just talking about downloading new ringtones! The cell phone of the future will be able to change its behavior and morph into many different tools depending on the software chosen.

The fourth technology change is network based services. Many of the things we're used to thinking of as software features on a PC will increasingly become services provided over the network. Professor Gregg Vanderheiden of the TRACE Center at the University of Wisconsin, one of the leading academic experts in the adaptive technology field, has called this the rainbow effect. In addition to making a given capability available on the device itself, the same capability could be provided by more powerful computers on the network, or even by humans accessible over the network.

Dr. Vanderheiden posits a rainbow with three nested arcs. The innermost arc is what your personal device can do itself. The middle arc uses network computer servers, and the outermost arc connects human beings to you through the network. As you move along the arc, different tasks appear in segments that touch each of the nested arcs. Tasks might be language translation, directions to a given location, or hearing speech for a deaf person.

Let me make that example real for a blind person. Imagine a cell phone with a built-in camera. Let's say that I point that camera at a traffic sign and ask my cell phone what it says. Built-in recognition software may be able to recognize many common words, and says "Stop" for a stop sign. Perhaps the sign is in a language that my cell phone and I don't know: so the phone can't read it to me. Dr. Vanderheiden's idea is that I press a "try harder" button and the cell phone

takes the challenge to the next step. It sends the picture of the sign to a much more powerful server computer on the network. Maybe that computer recognizes what language it is in, recognizes the text, and translates it into my language: "pharmacy," perhaps. And if the powerful server still can't help you, another press of the "try harder" button might send the image to a human being who looks at the image and says: "that's a picture of an ice cream cone, and you seem to be outside an ice cream shop." This last scenario is not a fantasy: in Germany they have already set up a system for sighted people to read and describe scenes to blind people over a network, viewing pictures sent by a camera used by the blind person.

The power of the network goes beyond the ability to shift challenges from the hand-held device to network servers to people serving you. It also taps the power of the community. My organization has built an unusual national library for the blind in the United States called bookshare.org. The decisions about what books are in our library are primarily made by blind people themselves, because they do the majority of the scanning and proofreading of our books. The Bookshare.org library makes it possible to share the effort of scanning books across the blind community: it's a place on the Internet where blind people can share their collective labor. Right now, most of the books in our library are only available in the United States because of copyright law restrictions, but my visit to Asia includes discussions of how we can help create the same kind of communities in other countries in the region. Plus, our efforts to engage publishers to permit the cross-border sharing of these books are beginning to make progress. On Wednesday, I look forward to discussing these copyright issues with other leaders in the field, especially Hiroshi Kawamura, who has made so many contributions to digital books across nations.

And on top of those four crucial technology changes: increased processing power, convergence and software loading and the power of the network, we have what will stay the same with the technology of cell phones.

Cellphones will continue to be cheap, cheaper than PCs. Many cell phones cost less than $100 new. And if that's too expensive, wait a year or two. That $100 cell phone will be available used for free or maybe $10 or $20.

Cellphones will at minimum have a very simple user interface for basic capabilities. They are much easier to use than PCs, at least for making and answering calls. We can expect cell phones to continue to stay simpler than PCs, and this will make them much more usable to people in general, and people with disabilities specifically. I know that voice recognition has been one of those technologies that always seems just around the corner, but I think that it is quite reasonable to assume that the capabilities in cell phones that today are inaccessible to blind people will be under voice command in the next five years.

Add all of these expectations together, and you have an extremely capable and powerful tool that fits in the palm of your hand. Let me tell you what these trends imply for the next decade.

I see software for cell phones becoming the same kind of force that software has been for the personal computer. This software will follow the cell phone model of being much simpler than

PC software. Perhaps you dial a certain number and the phone downloads the user interface designed for people who cannot read the text on a screen.

I see the cell phone becoming a device that can see for those who cannot see, read for those who cannot read, hear for those who cannot hear, remember for those who cannot remember, and find those who are lost.

The cell phone will have the room for content as well as software. Today, we struggle with the expense of custom DAISY readers to play digital books. I can easily see the day where a standard cell phone can keep a small library of digital books: both audio from recorded human narrators as well as text ebooks that are spoken by synthetic speech. That will be the day that books become truly accessible to blind people: when a poor blind person can get a $10 cell phone and get free access to the network to get their books!

Before I get to some specific examples of how this technology will be used in the hands of blind people, I would like to talk about another movement that may play a big role in strengthening and expanding what is available in the software that runs on cell phones. I believe that there will be changes in the business models that bring technology for society in general, and disabled people specifically. These business models will not replace today's companies, but will add some critically important alternatives.

The software business is quite proprietary, and companies traditionally keep their software source code secret. The source code is the detailed plan for a software program, without which it is very difficult to understand what it does. With the source code, it is relatively easy to understand the inner workings of the program, and to fix bugs and make improvements. For example, translating a program's interface into a new language is easy with the source code. Companies have been very reluctant to provide access to the software source code, because they consider them the crown jewels of their companies. Of course, this is the reason that a great deal of money flows from around the world to Microsoft. Either that, or people make illegal copies, which is often the only practical way for people in many countries to afford computer software, and is not sustainable in the long run.

This issue of source code is becoming a major one in the world of computers. For example, China (and other countries) recently forced Microsoft to disclose the source code to their software for inspection. But something even more interesting is the free and open source movement, where the source code is openly provided to anyone who wants to use it. This is the equivalent in the software world of the researcher who discovers a new and valuable invention. Some researchers publish their discovery in the academic literature, making a contribution to the world's intellectual commonwealth. Others researchers patent their invention, restricting the invention for the benefit of their company. Society benefits from both of these choices, but probably benefits more from the researcher who contributes their innovation to all of society at the outset.

The free software movement has the same philosophy as the researchers who contribute their inventions to society. The best example of this is the Linux operating system, which is the main alternative to the Microsoft Windows operating system.   Rather then being developed by a

single company, Linux has been built by thousands and thousands of programmers all over the world, many as volunteers and still others who work for companies who see a business advantage in strengthening the Linux community.

We will increasingly see the benefits of the open source movement in the blind community. We already have open source screen readers for Linux, which remain too technical for the vast majority of people. We also have open source DAISY ebook readers, which are increasingly practical and useful. In the cell phone arena, I see much software being built in this way. This is especially important to address the needs of people who do not speak the top ten or twenty languages in the region. These languages will not be supported by companies like Microsoft, Sony or Nokia, but open source will make the tools to adapt this software to these other languages. This capability will be within the reach of one or two talented programmers with an interest in supporting speakers of their native language. The free software movement places the prior work of many talented people around the world at the fingertips of local developers, enabling them to build exactly what they want without having to start from scratch.

I see a world where basic capabilities are within reach of almost everybody on the planet, where the free software movement ensures that nobody is excluded from the benefits of technology. And, for those who can afford it, there will be exciting alternatives available from commercial vendors as there are today.

So, in the last section of my talk, please allow me to take you on a journey into the future roughly ten years from now, to a rural village where two blind people live. Ahmed is a blind man who is forty, married with a family. He makes his living as a shopkeeper, with a small shop in the front of his home. His wife spends most of her time working their plot of land and minding their children. He is not particularly formally educated, but is a shrewd man with an interest in religion and politics that extends beyond his small village. He uses his cell phone to keep track of everything to do with his business. When inventory arrives, he scans the barcodes with the built-in camera as he counts the items. He says how much he paid for the inventory, and decides how much he will sell each item for. When a customer goes to pay him, his cell phone takes a picture of the merchandise and calculates the total. Ahmed trusts his customers and has a good relationship with them. However, he did discover someone was shoplifting from him after he discovered a shortage when doing an inventory. He suspected one local teenager, and set his camera to record video the next time the boy came in. He had his wife view the video later that day and it had recorded another theft. By bringing the cell phone to the boy's family and showing them the video, he was able to recover his losses without having to make a formal issue of it. Since then, he's had very few problems.

When the shop is quiet, Ahmed likes to read the Koran on his phone. He has a high quality narrated version. However, it takes a lot of room, so most of the rest of his library is kept in text form and read with a text-to-speech synthesizer, as is the newspaper he subscribes to and listens to every morning. His customers enjoy lingering in his shop and talking about the latest political news from the capital, since Ahmed is one of the best informed men in the village. Ahmed does not travel outside the village often, but when he does his cell phone ensures that he doesn't get lost by using its GPS location capability.

The most amazing thing is that Ahmed's cell phone and its capabilities are all commercially or freely available: nothing he uses has been created specifically for blind people.

In another part of the village, Yasmina is a blind teenager. She goes to a secondary school in a larger town, riding the bus each school-day. Her handheld device was provided to her since she is a disabled student. Her books are provided to her as part of an arrangement with the government: they have secured the rights from publishers to provide accessible books to disabled students as part of the purchasing process. She also has an impressive array of software and content that has been free, either because her teacher helped her get it or she found it herself. These include a text reading application that can read English and her local language.

Yasmina is a skilled member of what is called the "thumb tribe," people who have a small keyboard on their device that is operated with your thumbs. She rarely uses her device to make phone calls, because they are relatively expensive, but she sends dozens of text messages in a day. She uses her device to prepare her school papers, and her teacher accepts Yasmina's papers by electronic submission. Yasmina also has texting friends, both local friends as well as a couple of blind students in the capital she met at a conference of blind people. She even keeps in touch with a texting friend in another country in English, although it is hard to imagine how the abbreviations and slang of texting help her English skills!

These two examples just scratch the surface of what will be possible within the next decade. Furthermore, just like cell phones are now taken for granted by over a billion people, these uses will seem unexceptional. All of the capabilities I have described to you benefit sighted people as well as blind people, which is one of the reasons they will be so inexpensive and widely accessible.

However, ignorance of the needs of blind people can prevent some of my vision of the future from happening. While the existing barriers to accessing technology should be shrinking every year, barriers such as affordability or the performance of recognition software, new barriers can be created. A telling example is the commercial electronic book, which should have been an incredible benefit to blind people. Unfortunately, most of the popular electronic books have been locked away from blind people because publishers weren't sure they had the right to enable text-to-speech or Braille access to these books.

I coauthored a paper last year with George Kerscher, the world's leading expert on electronic books for the disabled community, called the Soundproof Book, where we detailed this problem. Earlier this month, the U.S. government issued a ruling that it was not a violation of our copyright law to break the locks on these electronic books for the purposes of providing access to the blind! Now, this does not mean that my organization is going to get to work right away breaking these locks: we'll be working with the publishers, using this ruling to convince them to take off these repressive locks.

As leaders of the organized blind, you need to be watchful that the advances of technology are not diverted from your community by restrictive intellectual property laws or by the accident of design choices. My goal today has been to convince you that the high technology and telecommunications industries should deliver great benefits to the blind, but that you will need to

be vigilant to ensure these benefits come. We know that the cost of ensuring disability access is low if it is in mind at the time systems are designed, but high if done as an afterthought.

If we work together, we can ensure the future of blind people by making sure that these tools are available and accessible, both technically and financially. This is not charity, but instead enabling blind people to help themselves with the same cell phones used by the public at large. If we can do so, we know that educational, economic and social opportunities will be within easier reach of the blind. Let us make sure that those opportunities are in the palm of the hand of each blind person!