UBIX

ubiquitous, universal media access

By:

Daniel Loewus-Deitch

Brandon Herdrick

Ulrik Christenson

School of Information and Computer Science

University of California, Irvine

Executive summary

Ubix is a portable networked multimedia device that makes it possible to access media of any type in any setting. An obvious use of the device is allowing people to show movies and play music, using whichever presentation devices they find, wherever they are.

In this report, we present the device from a variety of levels and angles, providing a:

1) General overview of the device
2) Definition of all functionalities
3) Descriptive series of usage scenarios
4) Detailed look at the technical components of the system.

We then briefly consider the organizational, economical, marketing, and legal frameworks of such a development project and finally include some considerations on what this thought experiment has taught us about designing for the future and about designing ubiquitous technology.

Table of contents

Design overview

The Ubix is a ubiquitous multimedia player and recorder solution. It is a fully networked and portable device that can capture and deliver any type of media to the nomadic user. This media support includes all significant digital audio formats, popular video formats, and digital picture formats. The Ubix is designed to maximally take advantage of any environment it is in, fully utilizing both home and car entertainment centers, multiple wireless networks, and various third-party subscription-based services. It can, of course, operate autonomously when these supporting infrastructures are not available. The Ubix is not just another mobile device designed for working out and occasional car use. It is a revolutionary multimedia content capture and delivery system that can competently deliver high-fidelity audio and picture to even the highest-end system.

The Ubix is designed to consolidate all the latest technologies into one single device, while maintaining as much portability and flexibility as possible. There are plenty of standard, high-quality A/V and transfer connections for conventional wired usage. With its ubiquitous network connectivity, the versatility increases dramatically. This is where the possibilities really get exciting!

The Ubix not only allows users to have their own collection of media at their fingertips, at all times, but it has the capability to tap unlimited additional sources of new and diversified media as well. These additional sources of content are made possible by the various wireless technologies incorporated into the Ubix, including an advanced digital radio receiver, integrated wireless LAN connectivity, and optional support for a broadband cellular WAN connection.

The Ubix also has a digital FM transmitter and an optional Wi-Fi receiver accessory for the home. This means that the Ubix can wirelessly feed music and video to other fixed devices in your immediate environment, like your home stereo and TV, even when conventional wires are not convenient.

All these capabilities may make the device sound very complicated to use, but we are working hard to make the user interface as easy and intuitive as possible, so that using all this functionality is deceptively simple. The Ubix has a touch-sensitive screen that works with a special stylus, similar to a PDA's functionality. This design allows for a much more appropriate interface when using search functions and makes navigating between various modes much simpler. The touch-screen is coupled with an intelligent handwriting recognition engine that allows you to write out search words in your own handwriting style. Robust search features have been included which query the Ubix's media database and provide only relevant, filtered results. The Ubix also has a unique, customizable web-style interface that lets you reach virtually any function with a single click. Our goal is to help you avoid the time-consuming task of clicking through numerous menu structures and scrolling through extremely long lists of files.

The hardware design of the Ubix has been carefully constructed from both an ergonomics and durability standpoint. The Ubix has a generously large touch-screen. A hinging, transparent cover protects the screen and makes the device more compact when not being used directly. A minimal set of navigation buttons are provided as an alternative to the pen-based navigation, and our useful when one wants to operate the device with only a single hand.

Figure 1: Vertical view of the Ubix

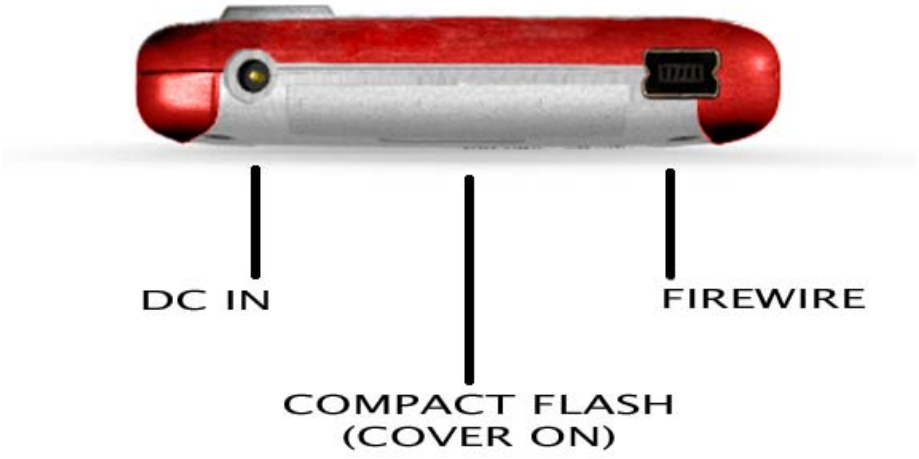

Figure 2: Bottom view of the Ubix

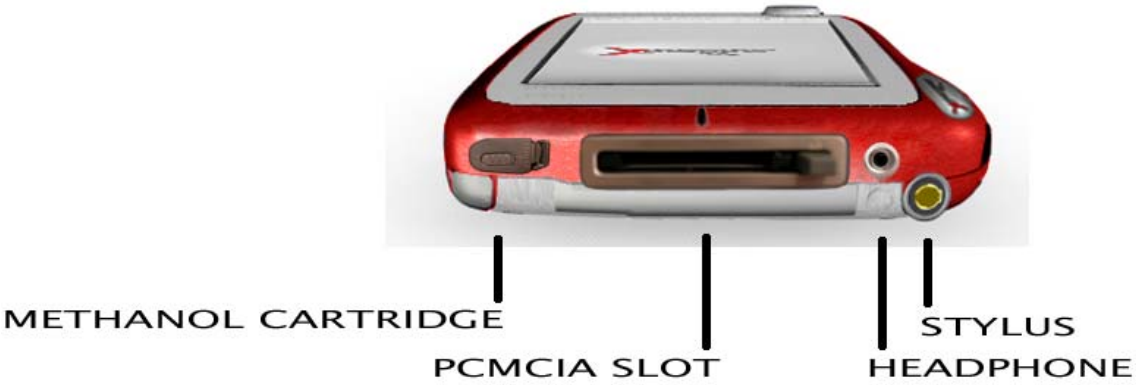

Figure 3: Top view of the Ubix

Project overview

In this section, we briefly discuss the relevant timeframe and provide estimates of when a technology like Ubix could realistically be created. We touch on which technical and socio-economical structures must be in place before this device can be fully produced and released to the public. We then describe our methodologies that we used for this design project and discuss our inspirations and vision that led to the creation of the Ubix design concept.

Timeframe

The timeline below is our estimate of when it would be possible to market the Ubix.

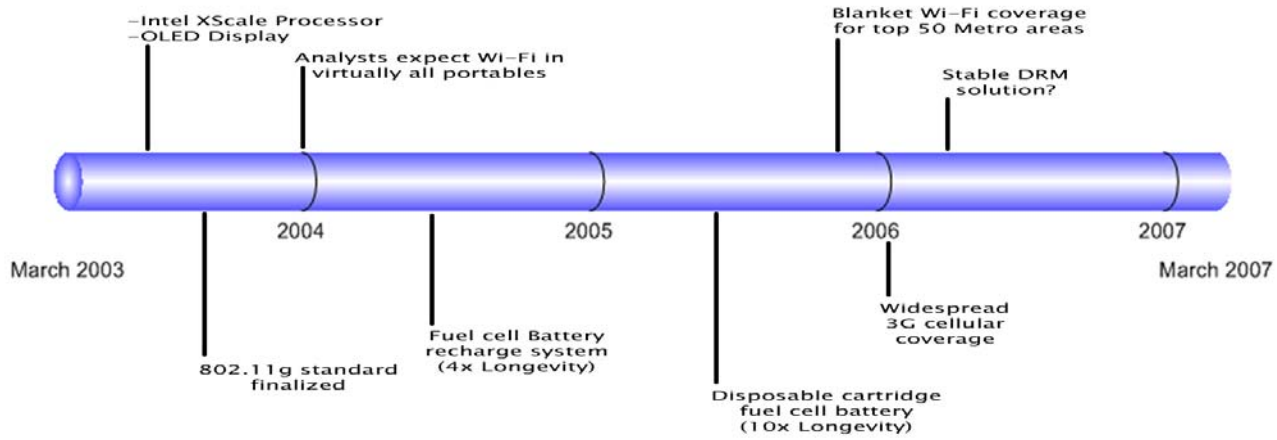

Figure 4: Feasibility Timeline

Most of the technology that would be needed to make Ubix a reality already exists. We are considering some technical components that may not be available for 2-3 years, since it would take at least a year or more just to secure funding and get the framework for the project established.

The critical events are:

1) Sufficient high-speed wireless network coverage
2) A stable solution to the problems related to the use of copyrighted digital multimedia – in particular music and films.
3) The commercial release of batteries that have a longer lifetime

Waiting for wireless network coverage and social and legal practices to be established regarding copyrighted digital material seem to be the critical issues placing temporal constraints on when the device can be launched. A guess as to when the legal copyright issues will have found a stable form would be too bold without careful and lengthy argumentation. Instead, we will simply assume that at least a partial solution will have been agreed on within three years, and our concept of ubiquitous media access will then likely be possible. There are already positive signs that content producers are finally starting to show serious interest in finding a sensible solution to the problems and resolving the widening disconnect between the media industry and its consumers.

It is possible to launch a "light" version of the product by the end of this year. This would not realistically include the seamless wireless functionality (in the full blown scale of the final device). It would also not include the servers providing streaming media directly to a portable multimedia device, in real-time.

This device would be very similar in functionality to existing devices, except that we would address the annoying usability issues that continuously plague these current players and introduce a novel user interface that has not yet been attempted with such devices. The benefits of this early release would be, in addition to getting a full field test of our basic design and an establishment of a trademark, a chance to get our feet firmly into the market. This would allow us to fine-tune an organization before the real problems involving media access and politics become the main focus.

Research methodology and inspirations for this design project

Our first step in creating the Ubix was to come up with a solid vision. We were initially inspired by Digital Innovation's exciting new portable digital audio computer, the Neuros.

In our eyes, this player was a fantastic new concept that involved a number of unique, innovative features, as well as paradigm shifts. For one, much of the Neuros will eventually be opened up to the public as an open source project. This will allow many eager developers to develop new and exciting functionality without having to wait for the company, a single party, to provide every upgrade. Secondly, the Neuros UI is built on XML and the menu structures can easily be modified and enhanced with new categorization features, etc. Third, the Neuros incorporates a flexible hardware architecture into their design with its backpack modules. This lets users actually upgrade the hardware on their players by simply snapping on the latest available backpacks, allowing for unlimited new functional possibilities. Lastly, Digital Innovations has adopted an unprecedented approach to customer service and customer-aided development. The company hosts a user message board on their website, which the developers and managers consistently monitor and respond to threads on a day-to-day basis. To date, the CTO himself has posted almost 100 posts, responding to user questions, technical issues, and complaints. Needless to say, Digital Innovations was a good role model for how we would like to design our product and company.

We knew that we wanted to make a multimedia device that captured and delivered all kinds of media, not just music. We also knew that we had to develop a ubiquitous device. After some preliminary brainstorming and research, our concept was finally born. We would develop a high-end device that was completely networked and constantly web-enabled, yet totally wireless. It would utilize web services and deliver content in every imaginable way one could think of. It would finally bring the internet to the consumer electronics world in a simplified way, so that the user is no longer interacting with a traditional computer interface and a file-system model, but rather a comprehensive, multi-service providing media supercenter. This would be a supercenter that was totally portable and could smartly use every resource in its environment to bring unlimited amounts of rich, controllable content to its users in exactly the way they desire. Thus, the Ubix was born!

Our next step was to analyze the current market, in particular, our competitors. We took feature and spec sheets from every portable media player website we could find. We rigorously compared and contrasted features, wrote pro/con lists for each player, and actually demoed some of the players, personally, in stores. We wrote up a massive list of everything that we like and dislike in the current media players available today. This list including everything from minor usability issues on the interface to major conceptual and engineering flaws.

Moving on, we begin to rummage through various user and consumer forums on the web. This included the Neuros forum, the dmusic forum, and the Rockbox "Feature Request" forum, which was an unofficial site devoted to hacking and improving the firmware and hardware of the Archos media players. We read through hundreds of threads and posts, taking notes on any interesting new feature ideas and issues that various people discussed, regarding these portable media players.

When we were through researching the forums, we compiled a "wishlist" of features, functionality, and design aspects that we wanted to incorporate into the Ubix. This wishlist was based on our competitor

product analysis, our forum research, and of course our own ideas that we devised through our own experience with these devices.

We then begin researching new technologies and advances for all aspects of the player, but we mainly focused on the wireless technologies and media infrastructure technologies, since these are required for the core capabilities of our product. The internet was our main research source, but we also used current computer magazines and other various literature that we happened to find relevant. In addition, we used some information that we gathered during special guest-speaker presentations which we attended over this quarter in this class and in others. We selected our components carefully, choosing bleeding-edge technologies that should be adequately maturing over the next 3-5 years. We wanted to take advantage of all the latest things out there and combined them in an intelligent, innovative fashion, so that we could create a device that would be truly unique and simple and would revolutionize the way people access and interact with digital multimedia, especially over the web.

Finally, we set up and conducted an hour-long qualitative interview with the CTO of Digital Innovations, Joe Born. This interview was very important to us because we wanted to learn about the development process at a technology company, from the first conceptual vision to the final production release to the ongoing customer support and continued product development that occurs *after* a product is released to the public. Joe was the perfect person to interview. He was extremely knowledgeable in technical and business matters, and he was intimately aware of all aspects of his Neuros product. Since Joe was discussing the development of a similar device to ours, everything we talked about was extremely relevant. We learned a lot from this interview and tried to integrate as much of this new knowledge as we could into our own design project. The questions that we formulated for this interview are included in the report, in Appendix A.

Functional design description

First we will provide a detailed description of the capabilities and specific features of the Ubix. In the following sections, we will provide a few detailed usage scenarios and discuss the technical details of the design and the technologies that we plan to incorporate.

General

- A comprehensive networked player and recorder solution, designed to capture and deliver all types of media: audio, video, and pictures.

Media Codecs Support

- ***Audio playback:*** MP3, WMA, AAC, OGG Vorbis, OGG Speex, and FLAC
- ***Audio record:*** MP3 (64-192 kbps), WMA (32-160 kbps), OGG Vorbis, OGG Speex (for extra compact speech files), and FLAC (lossless compression, meaning no sound quality loss)
- ***Video playback:*** MPEG-1, MPEG-2, DivX Pro/MPEG-4 (no limits on resolution), OGG Theora
- ***Video record:*** DivX Pro/MPEG-4, OGG Theora

Digital Media File Storage and Sources

- Uses wired and wireless capabilities to actively search and stream media (in real-time) from various local and remote servers. These include:
    - Your home PC or a personal web server
    - A special P2P community network (described in detail later)
    - Central subscription-based audio service called *PressPlay*
    - Central movie streaming service where you can "rent" New Release and older video titles digitally. For a few dollars, you are given access to a particular stream for *X* days.
- Has a Compact Flash/Microdrive slot for local storage, which is useful for situations without any kind of network access.

Additional Live Media Sources

- Digital/analog radio receiver which supports digital HD radio (IBOC) on both the FM and AM bands. The receiver also still supports analog FM, and analog AM.
- Support for the subscription-based XM satellite radio which offers 70 music stations, and 30 additional stations for news, sports, and entertainment, all commercial-free.
- Internet radio. Any of your favorite web stations can be added to the Ubix's database through the PC Customization Host software.
- Access to special live video webcasts, hosted by our various partners.

Playback of Media

- Audio and display can be easily exported to larger consumer electronics devices in the immediate environment, such as your living room entertainment center or car stereo system. There are multiple options for exporting:
    - Wired digital outputs
    - Wired analog outputs
    - Wireless digital audio transmission through any FM frequency
    - Wireless streaming through 802.11g card. Newer Consumer Electronic devices are beginning to have Wi-Fi components built into them so that they can accept and decode streaming signals wirelessly. We are also offering a special 2.4 GHz wireless receiver

accessory that plugs into your home entertainment components with composite jacks and can receive baseband signals from the Ubix.

- Video and pictures can also be displayed on the Ubix's own screen with audio transmitted through headphones. Although this is an option, the screen is small, and not as enjoyable to watch a movie on. Therefore, we recommend utilizing the larger displays in your environment whenever possible or appropriate.
- SRS WOW enhanced 10-band equalizer. This is useful for when listening with headphones, in which case you don't have an external equalizer to adjust the sound.

Recording

- Record audio from any radio station, digital/analog line-in, or internal microphone. Additional amplified mic jack allows a high-quality external microphone to be used as well.
- A small speaker has been integrated into the Ubix for convenient playback while dictating
- Dictation features include pausing, playing back, and editing recordings, as well as cue, review, and index functions.
- Audio record firmware features include Voice Activated Recording (VOR), gain control, graphical level meters, and multiple format and bit rate encoding choices.
- Special video commentary feature allows you to record your voice as you watch a video on the Ubix, and later play back the video with the new soundtrack (of your voice-over) temporarily substituted in for the original soundtrack. The actual video file is not affected at all, except for some special metadata that is added to the file, telling a player with an appropriate plug-in to play the accompanying external sound file rather than the original sound stream that is embedded in the video file itself.
    - While recording in **Voice Commetary** mode, pausing the video pauses both the video playback and the audio recording.
- Directly record TV shows and movies with the integrated TV tuner. Just plug the coaxial cable coming from your cable or satellite source into the Ubix.
- Internal clock chip and scheduling features allow you to set up a recording for a certain time. The Ubix will automatically turn on and begin the requested recording when the appropriate time comes around.
- Instantly send commands to your home PC, over the internet, to schedule recordings of shows or internet radio at home for you. Remotely commanding your PC to record shows instead of your Ubix allows you free up the Ubix for other uses. (requires a PC equipped with a TV capture card)

Data Transfer and Storage

- Appears as mass storage device when plugged into Firewire port. Can also appear as a networked drive when communicating with a host PC over a wireless LAN.
- Support for flash memory reader/writer PCMCIA cards. This is perfect for digital picture storage so that your digital camera's memory card can be continuously recharged with no need for a PC. This attachment can also be used to fill up a card for a smaller MP3 player when going for a workout.

User Interface (firmware)

- Customizable through PC Customization Host application. Menu structures and music organization categories can be easily modified through intuitive wizards in the PC software.
- Intelligent search engine that first checks for the media on a faster commercial distribution server, such as *PressPlay* (if you have a subscription), before streaming it from your local home collection.
- Handwriting recognition for inputting searches and other free-text tasks. You can use your own handwriting style. There is no need to learn a special graffiti language.
- Intuitive, web-style interface. Similar to a flash-enabled website, with pop-down submenus. This allows a user to reach almost any function on the Ubix with a single click, and get back to the homepage just as easily.

- Generates an audio fingerprint ID, based on unique audio properties of the specific media currently being played.
- Uses the audio fingerprint ID of the currently playing file to automatically gather interactive metadata from extensive internet databases and display it on the screen.
    - This extra information includes album covers, lyrics, discographies, director and actor histories, and critical reviews.
- Book marking preset buttons allow you to save your spot in an audible book, radio talk show recording, movie, or other large file.
- Resumes in exact same state after being shut down and restarted. If a song was playing, that song will continue from the same spot it left off when it was shut down.
- Clock with date
- Multithreaded, meaning the user can perform navigation and other functions, even while the Ubix is playing or recording a file.
- Multiple user profiles with separate databases and personalized settings

Pc Customization Host Software

- Total content management tool for your Ubix
- Includes Muse.net agent for web streaming of your personal collection directly from your computer or dedicated server.
- Setup multiple user accounts
- Personal Media Collection Builder wizard for setting up your own database of media that you like to have available to you. This includes:
    - Scanning your personal music collection
    - Analyzing your favorite styles and genres
    - Recommendation engine for additional choices
    - Selecting your favorite internet radio stations that you enjoy listening to

  This feature is useful for when you are manually browsing, rather than using the search function. You will only have to scan through the artists that you enjoy, rather than just one universal list of everything that might be available to you.
- Record command agent that remotely receives record schedule requests and initiates them on your PC (TV capture card required) or networked digital video recorder (supporting communication agents can be installed on both TiVo and SonicBlue's Replay TV).

Hardware Design

- Change the screen orientation from portrait to landscape with the click of a button. The screen can also be oriented appropriately for both left and right-handed users.
- Touch-screen for pen-based navigation and handwriting recognition on searches, etc. The screen responds only to a special included stylus.
- Alternative joystick control button for one-handed operation and easy scrolling action. The button control functions automatically shift with the screen orientation so that they still function intuitively.
- Large color screen allows for a clear, easy-to-read display. The display is great for viewing pictures, video, and media metadata. It is also naturally illuminated, so it doesn't require an energy-draining, ambient backlight to be viewed in the dark.
- Hard, transparent, protective screen cover that hinges open and unobtrusively attaches to the back of the Ubix, while the device is being operated by the user.
- Water-resistant sealed case to protect the Ubix when it is being carried around in bad weather.
- Compact Flash Type II slot for adding a high-capacity local storage Microdrive
- PCMCIA Type II slot for adding an optional 3G cellular network modem card or flash memory card reader

Optional Car Kit Solution

- Car docking cradle with audio and video line-in and power inputs
- Bluetooth remote faceplate for larger, simplified display and controls that are designed exclusively for easy and safe car usage. This faceplate can easily be fixed anywhere in the car that is convenient with Velcro or other adhesives.
- Bluetooth steering wheel remote for volume and track advance controls.
- Special **Car Mode** that saves settings and preferences exclusive to car use. While in this mode, it also intelligently monitors external power flow so that the Ubix will start-up and shut-down when the car does, like a true car stereo.

Usage Scenarios

In this section, we present three brief scenarios that will explain some of the unique and valuable uses of the Ubix.

Scenario one

It is December, 2005. One night, Ben shows up to his friend's house with his Ubix. The local Blockbuster has no copies left of the new Lord of the Rings movie, which just came out on DVD the day before. His friend's neighborhood happens to be next to downtown San Diego, where there is now blanket Wi-Fi coverage, thanks to some local companies' efforts to patch overlapping "hot spots" together. Ben starts up his Ubix and navigates to a hypothetical video rental service client called *MoviesNOW.* We will assume that are company has just begun partnering with this company this year and the firmware has been upgraded to include this web service agent. Ben has already set up an account with *MoviesNOW*, so they already have his credit card and personal information on file. Using his stylus, he writes "Lord of the Rings" in the search panel at the bottom of the screen. The Ubix contacts the server database over the Wi-Fi connection. It returns the following results:

Lord of the Rings (1978, animated)
Lord of the Rings: The Fellowship of the Ring (2001)
Lord of the Rings: The Two Towers (2002)
Lord of the Rings: Return of the King (2005)

He selects the fourth option, *Lord of the Rings: Return of the King*, with the stylus. He is taken to the payment confirmation screen. The screen tells him that he will receive access to this movie stream (on this device only) for 5 days. It informs Ben that if he clicks the **Begin Movie Stream** button, his credit card will be charged $3.99. His friend's dad has an awesome home theater room set up. Since this system can take high-quality inputs, Ben connects his Ubix using the S-video output and bitstream/PCM digital audio output jacks on his Ubix. He then clicks the **Begin Movie Stream** button, and the high-fidelity DivX file begins streaming from *MusicNOW's* servers. They both enjoy the movie!

Scenario two

It is June, 2006. Gavin is driving over to his girlfriend, Mandy's house. She lives in a suburb, considerably far out of downtown Seattle. Gavin has the Ubix turned on, and he is streaming a rare Nirvana album from his own home collection, using the *Muse.net* Agent that is integrated into the PC Configuration Host. As he drives through the city, the streaming connection takes place over the Wi-Fi network, which happens to cover all of downtown Seattle and its closely-surrounding areas now. As he leaves the city, the Ubix recognizes that the Wi-Fi signal is becoming increasingly weak and is no longer fast enough for real-time streaming. It finishes caching the current song that it is downloading. Then it automatically switches over to the IPWireless 3G cellular network and reinitiates a new streaming connection. This network switch is done invisibly and Gavin never receives any interruptions in playback… It is now 8:58 pm. As he gets close to Mandy's house, he suddenly remembers that she asked him for a favor. Gavin's girlfriend does not get HBO at her house, but he does at his apartment. Her favorite show on television happens to be *Sex in the Country,* a new spin-off of the hit show *Sex in the City.* Gavin knows that she will totally kill him if he forgets to record the new episode, which is airing at 9 pm! He immediately grabs his Ubix. He navigates to the **Home PC Record Schedule** feature. With the stylus, he writes "Sex in the Country" in the bottom search panel. Searching the appropriate TV guide database, the Ubix returns the following result:

--NEW EPISODE- -Sex in the Country (Episode 121: Needle in the Hay) – 9 pm, Wednesday, June 7th.

Gavin clicks on this result and his home PC immediately sets up the recording. Relief washes over him as he looks down at the Ubix's clock, which has just changed to read *9:00 PM…* Later that evening, Mandy decides that she wants to see the new episode of her show right away. Gavin certainly wasn't going to make the 2-hour trip back to his place to grab the recording, so that she could watch it that night though. Instead, he grabs his Ubix. He navigates to **Recently Recorded Shows** and finds the episode that just finished recording and selects it. The show, encoded in the DivX Pro format, streams from Gavin's home computer to his Ubix, through the *Muse.net* Agent. His girlfriend only has an old, small TV with a coaxial input. Therefore, he simply grabs a coaxial cable and plugs the Ubix into the TV, using the coaxial-out jack. Mandy is overjoyed…

Scenario three

Sasha is doing a research study for her graduate advisor. He sends Sasha some short MPEG video files showing subjects involved in an experiment. She is supposed to review these videos and informally comment on them over Spring Break. Using her home wireless LAN connection, she transfers the videos to her 5 GB Microdrive. Since Sasha is going to be out in Joshua Tree over the break, she is worried that she won't have any network access out there. Later on the trip, using the **Video Commentary** feature, she selects the video by scrolling through the filtered, local storage media database. Sitting on a rock in the desert, as dusk begins to fall, she spends the next several hours playing the videos and dictating impromptu comments. She has plenty of battery power because of the new methanol fuel cell cartridge she bought before the trip. The OLED display is continuously illuminated, without any need for a backlight, so she can view the screen just fine, even as night falls. As she is driving back from her trip, Sasha uploads the videos to a server at her school, using her 3G cellular network. Her advisor views the videos off the server, with the voice-over commentary soundtrack activated and is very pleased with Sasha's extra curricular efforts.

Technical details

The hardware

Processor

We are using a DSP processor. We would like to use a processor along the lines of TI's TMS320DM310, but would probably use their next generation model, so that we can support MPEG-4 video encoding at VGA resolution (640 X 480). This DSP is highly programmable, it has built in support for decoding and encoding a variety of codecs, and it even supports the DivX format right out of the box. Below is a schematic of how this DSP could be implemented:

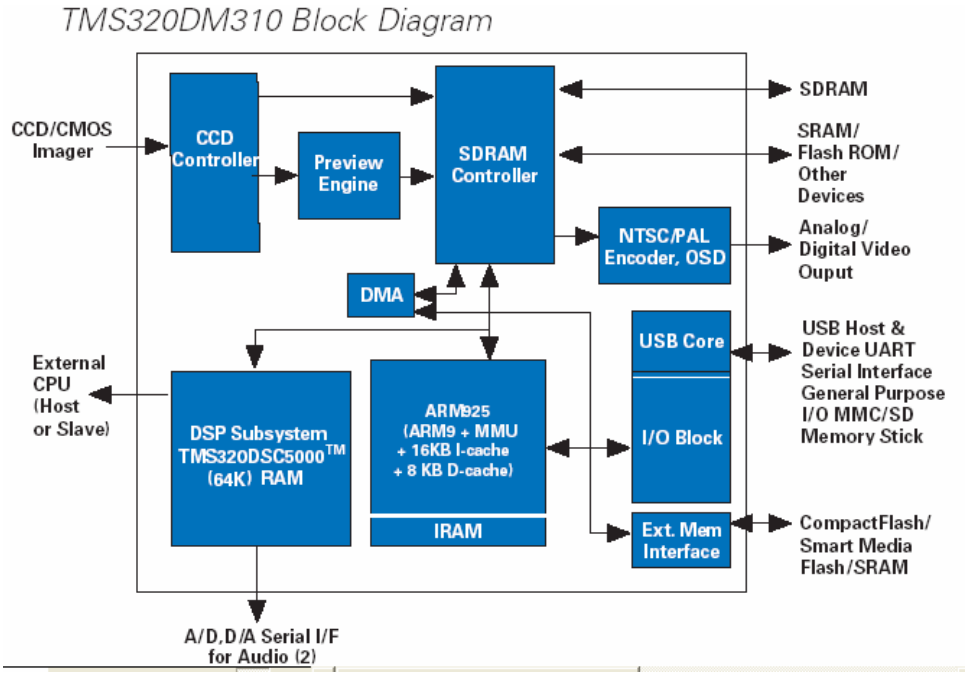

Figure 5: Texas Instrument's DSP architecture

We would also strongly consider using Intel's powerful XScale processor, which is being used in the upcoming Microsoft Media2Go players that are debuting in Fall 2003. Finally, we are also including a low-power real-time clock chip that can automatically start the Ubix up for scheduled recordings.

It may be necessary to dedicate one DSP to decoding, encoding, and radio functions only. In this case, we would have a second, cheaper processor handle other tasks, such as handwriting recognition (searches), network security negotiations, and data streaming. Our major goal is to provide enough processing power to support a truly multithreaded OS. We want the Ubix to easily perform other tasks while it is decoding or encoding a media file. The highest processing demands will be when the Ubix is capturing video in the DivX format. Handwriting recognition may also require a significant amount of processor work.

Memory

Beyond the internal RAM attached to the DSP, we will include 4 Mb of external SRAM that is exclusively reserved for caching of database files, system state information, and other information

that system requires quick access to. We will also embed a generous 1.5 GB of flash memory for stream buffering. The Flash memory will be partitioned into two cells. There will be 1 GB reserved for video content (more than enough room for a full-length, DivX/MPEG-4 encoded movie) and 500 MB will be reserved for music and photos.

This large stream buffer will allow us to implement a "recently-played" stack that holds a significant amount of media of current interest to the user. The stack will be reordered if the user repeats a file that is already stored in the stack, so that the first file that is pushed off the stack to make room for new streams is the cached file that was played the longest time ago. Beyond user convenience, the technical reasoning for this is that it should lead to improved power management, faster response time, and less overall strain on wireless network and servers. Considering typical user behavior, this will be mainly realized with music content. Users tend to go through phases or time periods in which their media preferences are fairly homogenous, especially with newly-released singles or albums. They may listen to these specific albums or kinds of music repeatedly for a considerable time period. The repeated listening behavior inherent in many music fans can be leveraged to make a more efficient system. If most recently streamed files remain stored in a stack, in flash memory, they can be repeatedly accessed as often as desired, without requiring additional network trips to the server.

Display

We are using DuPont's Active Matrix OLED display. This display has many advantages over traditional LCD displays. First of all, it is an emissive display, meaning that it generates its own light, and therefore requires no backlight. An OLED display is clearly visible in almost any lighting condition, and doesn't require any additional ambient light. OLED displays also provide images with much higher contrast, and can offer a significantly wider viewing angle (160 degrees). Furthermore, these displays consume very little power, especially because there is no need for a backlight. The Active Matrix Drive offers a brighter and more defined color image than a Passive Matrix Drive. This makes the display perfect for video and picture viewing.

The OLED display uses organic materials rather than complex crystalline structures, and they are relatively inexpensive to make. The Active Matrix color display offers a QVGA resolution of 320 X 240. It allows for dozens of lines of text and will positively support the Ubix's web-style user interface.

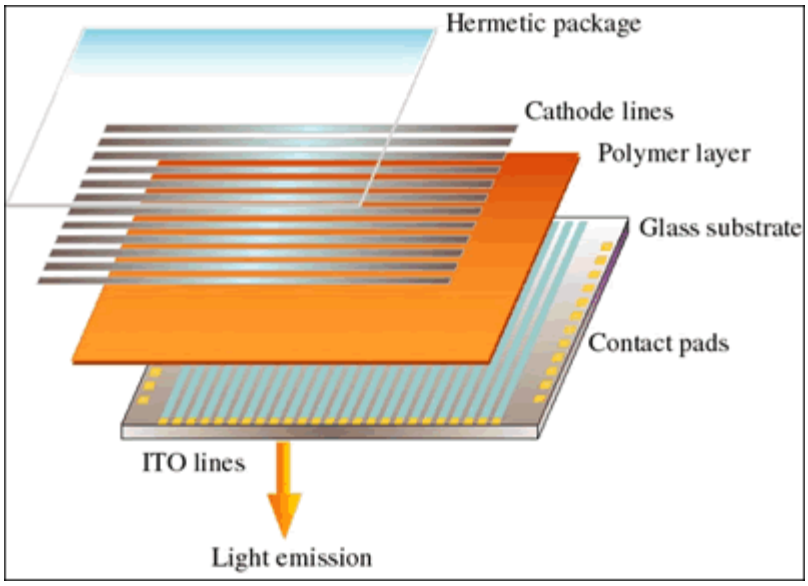

Figure 6: How an OLED display is constructed

Figure 7: An example of a full color, Active Matrix OLED display

Battery and power management

In most of the situations where the device will consume a lot of power, it will also be possible to connect it to an external power source. For instance, when the Ubix is connected to a TV or a stereo it would be obvious to also plug it in the power outlet. It can also be powered by the Firewire port when connected to a PC. In this way, the batteries are primarily required for situations where the Ubix is used on the go. However being continuously connected to a network does use a lot of power. We also may be using dual processors to appropriately support multitasking. This will add to the energy drain. To be able to use the device as a streaming player while hiking or sitting in a park, the batteries must have a life time for at least several hours of continuous use. This is well beyond what we can expect from currently available technologies (even if it would be possible for the media to be stored locally). Thus, it is required that battery technology does advance significantly.

Our alternative solution will be to use new fuel cell technologies. Neah Power Systems, located in Washington State, has been working on a fuel cell system that can continuously recharge a small battery. This system extracts hydrogen from methanol stored in a disposable, pen-size cartridge. These cartridges can be easily replaced, and will eventually be as widely available as normal batteries. They should also be very reasonably priced, interchangeable among devices, and much more environmentally-friendly. Each cartridge will allow the device to last ten times as long as a standard lithium-ion battery today. Neah does not expect to have these fuel cell systems in consumer products until 2005 or 2006. However, MTI Micro, Casio, Toshiba, Hitachi, and Motorola are all developing their own fuel cell batteries. Casio plans to implement fuel cells that last about four times longer than lithium-ion in their mobile products by next year, although it wasn't clear what their method is for refilling the methanol. MIT Micro has plans to release their technology commercially around the same time. Given the timeframe, we believe it is quite realistic and advantageous to include fuel cell technology in the Ubix.

A last idea related to the power conservation issue is context-aware power strategies. As we have learned, adapting the behavior of the device to the needs of the situation – minimizing power consumption while still providing the desired level of performance – is a valuable strategy for extending the lifetime. This would be coupled to the "modes" discussed in the interface section. Having a large onboard cache and using it efficiently as a buffer is also helpful to avoid excessive spin-ups of the Microdrive, and cut down on the amount of time spent actively streaming data over the network.

Network

Wireless network connectivity is at the core of the Ubix concept, and many of its functions and inherent design are dependent on this capability. It is the Ubix's wireless-enabled nature that makes it a truly ubiquitous marvel. Therefore, we have designed the Ubix's multiple wireless connections to be extremely flexible, powerful, and robust. We have chosen not to include a wired Ethernet jack because we feel this kind of networking is quickly becoming obsolete, and it won't make much sense for a device that is designed to be ultimately portable. Wireless networks in the home, office, and beyond are becoming extremely popular and spreading at quite an impressive rate. According to *PC World (March 2003),* most analysts expect Wi-Fi to be in virtually all portable computer devices by 2004. Therefore, we feel the environment is ripe for a totally wireless device.

Wi-Fi LAN

We decided to integrate an 802.11g chip directly into the motherboard. The standard for 802.11g should be finalized by summer of 2003, and plenty of products have already surfaced, which take advantage of this standard. It is flexible in that it is backwards-compatible with 802.11b components, yet when connected to other "g" devices, it has a real-world maximum throughput of about 22 Mbps. Unlike 802.11b, this kind of speed is more than enough to allow streaming video to be realized.

Wireless LAN networks ("hot spots") are now increasingly spilling out of the home and office into general neighborhood and downtown urban areas. A number of companies are actively patching overlapping Wi-Fi hot spots together. According to a spokesperson at Cometa Networks, the goal by fall of 2005 is to have a seamless wireless LAN coverage area across the top 50 metropolitan areas in the country. This will create a perfect environment for the Ubix, which requires a constant network connection, regardless of its location.

The Wi-Fi LAN connection will be used for web server and local network PC access, both when streaming and when transferring files. It will also be used for sending the Ubix signal to various Wi-Fi enabled consumer electronic interfaces. This will include various TV and monitor devices, and home entertainment centers. We will be offering a special Wi-Fi receiver that can plug into your

home entertainment components and receive streaming baseband signals directly from the Ubix. We also will be offering Wi-Fi enabled car monitor displays designed specifically to communicate with the Ubix. These will be similar to the DVD car system monitors now available. The Ubix will be able to broadcast its signal onto the secure car LAN, so that multiple monitor nodes can pick up and display the signal.

3G Cellular Networks

For additional coverage, outside of centralized, urban, hot spot areas, we are turning to dedicated 3G cellular networks. Ricochet and IPWireless are leading the way here. Ricochet's speeds are still on the slow side, but IPWireless will be providing a broadband connection with speeds up to 6 Mbps for downloads and 3 Mbps for uploads. It uses internationally recognized UMTS TD-CDMA (TDD) standards in a non line-of-sight environment, and only requires a pocket-sized modem. This service is about to be deployed in Jacksonville, Florida, and within the next few years, will spread to many other cities. IPWireless is even fast and cheap enough to compete with DSL and cable providers. Verizon and other cellular phone network companies are also creating dedicated networks for internet access.

The big question is how to interface the modem with the Ubix. Verizon already has a PCMCIA modem card, and we anticipate IPWireless will eventually be able to provide this interface as well. This will be the ideal solution since we are providing a PCMCIA slot for just this sort of add-on device. Other options include a backpack expansion module or Firewire connection to the modem. We intend to provide this modem as an optional accessory because many users may not want to pay the subscription fees for such a service. The user may have plenty of LAN hot spot connectivity where they spend most of their time, and therefore not have a need for the additional service. Also, such 3G cellular network coverage will be slower to spread than Wi-Fi LAN, and therefore may not be available in certain areas for at least several years.

Bluetooth

The Ubix will also have an integrated Bluetooth chip. This is used for short-range communications with other companion devices such as wireless headphones, our included general remote control, or our auxiliary car faceplate (part of our optional Complete Car Solution accessory kit). Bluetooth does not have adequately fast speeds for large file transfers, so the Wi-Fi or 3G cellular service will only be used for these tasks.

Smart Connect

Ideally, we want the average user to be virtually unaware of how the Ubix is connecting to the networked world. We will work hard to design a system that can seamlessly connect to any wireless service that is available. By default, we want the Ubix to effortlessly hop from one Wi-Fi network to the next and even jump between Wi-Fi and 3G cellular networks with no recognizable interruptions for the user. The firmware could also intelligently analyze the fastest and most efficient way to get the data it needs for streaming or transferring a file. As its location shifts, it could continuously monitor which wireless service is most optimal at that given time and place, and adjust accordingly. If one service becomes unavailable or so slow that the speed is no longer adequate for streaming, the Ubix could explore other options and switch connections, before the streaming buffer is depleted, meaning there will hopefully be no disruption in the playback.

When a file is requested for remote streaming, the Ubix will also look at multiple server options to find out which one might transfer the data faster. Often times, the best choice will be to stream from the subscription-based commercial server (i.e. *PressPlay*), rather than from the user's PC. Streaming from the user's PC will be generally treated as a second option, and used most often for grabbing exclusive content (personally-created or rare media) that is owned by the user, but not available through these central services.

We also want to keep *required* user configurations to an absolute minimum. Most users have very little understanding of TCP/IP and DNS server settings. The Ubix and all networked accessories will incorporate DHCP and Universal Plug and Play (UPnP). The Ubix will also be able to quickly detect and negotiate permissions with other Ubix devices or accessories that are being served on the current local LAN, and the user interface will automatically adjust its relevant options accordingly.

There will, of course, be settings for advanced users who want to configure their network connections themselves. The automatic network switching, monitoring, optimizing, and permission levels can all be switched to manual and personally controlled by users who desire to do so. For example, an advanced user may desire to only allow downloads on his LAN connection and perform uploads exclusively through a potentially more secure cellular channel. There will also be troubleshooting tools for times when network connections break down.

Multimedia input and output

Wired signal transmission

With the Ubix, we want to be sure to cater to both casual users, as well as dedicated audiophiles. We also wanted to be sure that the Ubix is able to utilize any environment that it is located in. We placed all the jacks in symmetrical formation on the unit so that each input jack on the right side is matched up with a corresponding output jack on the left side. This would hopefully make the setup more intuitive. Part of our reason for including all these jacks is that we want this device to be identified as a high-end consumer electronic device. It is not made for taking to the gym with you. Any small, inexpensive, simple player could be used for this purpose, and would probably be much more practical as well for this sort of activity where only very limited functionality is required.

On the right side of the Ubix (held vertically), we place all the input jacks. We are providing a composite audio and video (white, red, and yellow), s-video, and an S/PDIF digital audio jack. We are also providing a coaxial input (for recording TV channel reception) and a Mic In jack, so that users can attach a high quality external microphone without needing to also supply an external amp. There is also an internal microphone for voice recordings that don't require perfect quality. Finally, we have included an RF jack for an external antenna to help with radio reception and direct FM transmission to a car antenna.

On the left side of the Ubix, we place all the output jacks. We are, once again, providing composite audio and video, and s-video. We are also providing a coaxial output for connecting to older televisions, an RCA-type bitstream/PCM audio output, and an amplified headphone jack. The s-video and the PCM audio are for connecting to high-end home entertainment systems, and will transmit the cleanest, crispest signal, by maintaining the signal in digital as long as possible before it reaches the speakers.

Figure 8: All input jacks on the right side of the Ubix

Figure 9: All output jacks on the left side of the Ubix

Wireless signal transmission

We have integrated a digital FM transmitter that can send stereo audio from the Ubix to any open (non-occupied) digital (HD Radio) or analog FM frequency. The digital HD Radio setting will, of course be preferred because it sends the signal to the receiver in digital and it is converted to analog on the receiver itself. Within the next few years, many people will be buying these new digital radio receivers. We include the analog transmission option for users who will still have legacy radios with only analog capabilities.

We are also designing an optional Wi-Fi receiver that is immediately recognized by the Ubix when it is turned on. This receiver can be attached to a home stereo center using conventional composite connections. This allows the Ubix to wirelessly send video to the family or theater room.

Media types and sources

The purpose of the Ubix is to make any media-file available – no matter what format or version. This of course places some heavy demands on the technology.

Media supported

Currently a range of media types and corresponding codecs exist. There is no reason to believe that one standard will be accepted by everyone, and even if it were, people would still want to access old (and non-converted) media files. Thus, it is critically important that the Ubix natively supports a wide variety of popular formats. We also would like to design a feature that enables the use of custom formats – meaning that users should be able to download and install new codecs, on the go, as they need them. Since we are planning on running a Linux-based OS, we hope to create a system that allows users to easily upgrade their player with any codec that is supported on Linux. This ideal situation may not be possible in an embedded system, but this is a particular goal of ours.

In our list of native codecs that we are initially supporting, we have tried to include a variety of proprietary and open source codecs that are most widely used today. We have also included a variety of bit rate levels, for further customization.

Furthermore, we have carefully considered the various functions that the Ubix will serve and have included support for codecs that will be specifically useful with certain functions. For example, when capturing video on a device with limited storage and bandwith, we knew a codec is required that delivers high quality as well as a small file size. Therefore we felt it was best to provide the MPEG-4 based DivX Pro codec and the similarly efficient OGG Theora codec. Speech files are not very complex and therefore don't require a high bit rate to sound good. We included the OGG Speex codec because of its high quality and very low file size at low bit rates. We included the lossless FLAC codec for people who like to record live music and don't want these original recordings to suffer any quality loss through lossy compression methods.

As mentioned in the previous section, the Ubix also supports all kinds of radio, including HD Radio (IBOC), XM Satellite Radio, and Internet Radio. XM Satellite Radio requires a monthly subscription fee, but it provides 100 channels of commercial-free, quality music, news, and entertainment content.

Data transfer methods and protocols

The Ubix interacts with a range of devices. It will send and receive data using some of the following methods:

1) When connecting to remote media servers, local PCs, and other Ubixs over the wireless networks (both Wi-Fi LAN and 3G Cellular), the interaction will be TCP/IP based for basic communications and file transfers between devices. UDP will generally be used for the streaming of media content. There already exists a range of protocols for the streaming of audio and video content. The Ubix will be based on a generic protocol for media streaming, but it would be able to decode streams of any codec which it currently supports.
2) The Ubix will directly connect to PCs through FireWire (IEEE 1394) or FireWire 2 (IEEE 1394b) ports. Both are supported by the backward-compatible interface.
3) The Ubix can directly connect to another Ubix using a Firewire cable.
4) The Ubix can transfer data to and from Compact Flash cards to fill them up for workouts or empty them so they can be filled with more digital pictures. An optional PCMCIA card reader can also be used for other card formats. The data that is grabbed from digital camera cards can be sent directly back to a server over the wireless network connections.

Streaming services and infrastructure

A part of the design that will be central to the efficiency and usefulness of the Ubix is the media infrastructure. Several issues must be resolved to provide the quick and stable backbone of

accessible media which is key to a large part of the Ubix's functionality. We plan for the Ubix to connect to commercial, subscription-based streaming services as well as a personal streaming service, which grabs media from the user's personal PC or media server.

There are certain requirements of a centralized, subscription-based streaming service to make its coupling with the Ubix a successful and enjoyable experience. An efficient (quickly accessible, high-performance, robust) and cost effective database with multimedia content is certainly a must. Basically we would need to partner with companies that provides access to thousands of songs and videos, and has the capability to stream, in real-time, to tens of thousands, if not hundreds of thousands of users. This obviously is a challenging database, bandwith, and server processing feat. To be able to focus on the issues related more directly to portable and ubiquitous devices, we have not considered the details of this, as this would be the responsibility of our partners that we select. However, an interesting idea is to use clusters of normal PCs along the lines of Google's model, instead of high-end dedicated servers.

In the same way it will be essential that efficient searching algorithms are used to locate the requested media files. Here an algorithm based on specifics of the audio fingerprint of the media files will be invaluable.

We are currently considering *PressPlay* and *MusicNet* as viable options for partnering on the music front, but we would obviously have many technical and legal hurdles to pass before such a partnership could become a reality. We are also looking for companies who are developing virtual movie rental services (a virtual Blockbuster, if you will). These services would provide access to movie files on a per-movie-basis. The ideal service might allow you to stream the movie for a given amount of time or even download the whole file, but it would expire after a few days and no longer be playable. We did find a couple services like this, but unfortunately, they are exclusively based in the pornography industry. Currently, no legitimate virtual rental service exists for new releases or mainstream movies. This market is obviously also dependent on stringent legal, technical, and business policies, that have yet to be agreed upon. As this market develops, we hope that we could partner with one of them and develop a web service so that you could sign up for an account and receive a dedicated client application to install on your Ubix. From this client, you could directly purchase movie rentals, and begin streaming them, on-demand, whenever you desire. Finally, we may also look to partner with certain content providers that can provide exclusive free or Pay-Per-View webcasts to the Ubix, such as celebrity interviews, live concerts, and major event coverage.

We would like to partner with *Muse.net* to deliver personally-owned streaming content to the Ubix. *Muse.net* is essentially a web service based on open XML, SOAP, and WSDL standards. According to their website, it is "an extensible, open-client system for personal digital music management." It allows you to pool all digital media that you have stored on your home and office PCs, and stream it over the web. Any PC or media server running the *Muse.net* Agent becomes a server and will share all media files in the directories that you specify. The agent generates a database of all your media (using the tag information) and exposes this listing to any *Muse.net* client with appropriate authorization.

The developers behind *Muse.net* are actually interested in building a client application for a portable media player such as the IPod, and with their open standards, it seems quite possible. We think that the *Muse.net* service is the perfect solution for our Ubix. Their current web-based client can even gather metadata for your albums, in real-time, from the extensive AMG and Amazon databases, delivering such information as album covers, discographies, and reviews. This would be a great functionality for the client we would build on the Ubix, since we hope to display such metadata for currently selected tracks or albums. If we partnered with them, we would incorporate the *Muse.net* server agent into our PC Customization Host software.

Streamload is another interesting service that actually lets you upload massive amounts of files to their servers. The storage is efficiently streamlined across all users though. This means that if

other users have already uploaded the exact same music or movie file that you are currently trying to upload, you will simply be given access to that file, rather than uploading a duplicate file. The logic behind this service is as follows: if you can show that you already own a certain file, there is no need to redundantly place another copy on their servers. Metadata is added to the content files cooperatively, as an entire community, to enhance the database. One person might add the proper year for a certain file, while another person might add an album cover. The server infrastructure at *Streamload* is huge and fast. It can sustain transfer speeds of 5 MBps, with peak transfer speeds of 1,000 MBps. Files can be downloaded or directly streamed from their servers. Users pay subscription fees based on size of "unique" storage (personal files that no other user has uploaded) and amount of MBs downloaded per month. This is certainly something that might be leveraged on the Ubix with the appropriate web service client application.

Local storage

We have included a Compact Flash Type II slot, so that users can add a conventional local storage option to their Ubix. Microdrives, in the Compact Flash form factor, are now up to 4 GB and will soon grow substantially larger. The transfer rate is also becoming significantly faster with these microdrives. Local storage of files is a great option for when the user is located in an area that is not covered by any kind of wireless network service. This local storage can be filled up over the wireless network, while in an area where such a network is available, if the user anticipates being in a non-covered area in the near future.

Radio sources

HD Radio is certainly the next big thing for radio. A company called iBiquity is leading the digital radio revolution with its In-Band-On-Channel (IBOC) and Perceptual Audio Coder (PAC) technologies. Some "early adopter" stations have already began broadcasting digitally, and over the next couple years, many other stations will supposedly follow suit. HD radio delivers improved reception with near CD-quality sound, as well as exciting new wireless data services. It also allows artist and song information to be digitally sent. For this reason, we thought it was important to include an HD Radio receiver in the Ubix. Our radio receiver can receive digital FM and digital AM. It can also still receive conventional analog FM and analog AM, so that users can still hear radio stations that haven't yet switched over to digital.

We included XM satellite radio support because of its immense amount of intriguing content. It has music that you would never hear on normal FM/AM radio and all sorts of news, sports, and entertainment content as well. There are many big names hosting satellite stations, including Fox, CNN, Playboy, and MTV. It is not an option that all users will choose to subscribe to, but we certainly felt it was worth supporting in a comprehensive media device such as the Ubix.

User interface and ergonomics

The user interface is obviously extremely important with a device like this. There are a large number of functions on the Ubix and they need to be carefully organized in an accessible and simple manner. The UI is such an important piece of this device that we only feel comfortable presenting general ideas for the interface. A more detailed interface design would require significant task analysis, low- and hi-fidelity prototyping, and formal usability testing.

Hardware

We are implementing an advanced touch screen, using sensor component and stylus technology from Wacom. These are the same components used in the new tablet PC displays. This screen digitizer recognizes the position of the special pen, even when you just hover the tip a few

centimeters above the screen's surface. You do not have to push down with pressure on the screen like on a PDA. You can simply glide the pen across the surface effortlessly.

We have also included a thumb joystick button for an alternative navigation control without the stylus. The control buttons automatically change their functionality, based on the screen orientation. This allows the directional movements of the joystick button and FORWARD/REVERSE buttons to remain intuitive, regardless of the way you choose to hold and operate the device. There are three button function configurations: vertical, horizontal/right-handed, and horizontal/left-handed.

Operating system

The basic structure

The software user interface on the Ubix is designed like a web page. The whole interface is laid out with XML and is customizable, using a special front-end wizard on the PC Customization Host.

The home page has a number of icons representing radio, recording, video, etc. The icons are organized in a circle around the Ubix logo. When you place the pen over one of the icons (or scroll onto an icon with the joystick button), that icon becomes large and highlighted, and the other icons fade to grey. A submenu pops down, revealing more choices. For example, if you select the **Radio** icon, the submenu choices might include **digital FM, digital AM, analog FM, analog AM, and XM Satellite.** The goal with this interface is to help the user reach almost any major function on the Ubix with just one single click on the home page.

The Ubix has many customizable settings. It can perform a lot of tasks automatically (as described in the **Network** section), or you can control some of the device's behavior manually, based on your needs.

Modes and profiles

There are a number of environmental or usage modes that the device can enter. These modes allow several parameters to be specified with one "command," influencing such things as interface appearance, functionality, and power modes. One example is the **Car Mode.** In this mode, the Ubix will act just like a car stereo. First of all, it will assume it is only supposed to be on when it is being powered by an external power source (the optional car cradle). When the car is turned off, and the Ubix stops receiving external power, the unit also shuts down, saving its system state. When the car starts, and the unit receives external power again, it will automatically start up and resume where it left off before. Second, the Bluetooth will automatically turn on to communicate with the steering remote and auxiliary faceplate (also part of the optional car solution kit described in the next section). Finally, the equalizer settings will adjust for optimized sound in a car.

There are also user profiles that remember your UI layout, settings, and other preferences. These preferences get implemented when you "log in" with your profile. This allows for multiple users to operate the Ubix in a manner that they enjoy most and a form that best handles their needs.

Enhancing the media with metadata

One of the unique features of the Ubix interface will be its ability to display rich metadata information about the currently selected file. Using powerful web services and database management technologies, the Ubix will be able to provide anything from album covers to lyrics to behind-the-scenes interviews with actors and directors. The possibilities are endless here.

A company called MP3interactive has already created an application that turns ordinary MP3 files into super-tagged interactive portals, packaging tons of interesting data with the file itself. While we

prefer database linking and don't necessarily agree with all this metadata actually being tagged on the media file, we think that this is a wonderful concept. The problem with this model is that it is difficult and inefficient for each user to manage so much tag information on every file locally. Such tagging would be much better served at a global community level. After all, it is hard enough for most users just to keep simple ID3 tags in order, especially when they are dealing with thousands of files.

Figure 10: The rich collection of metadata present in the MP3 Interactive media player

This is where audio fingerprinting technology comes in. Many large companies such as Phillips and many smaller, specialized companies, such as Relatable have attempted to leverage this idea in various applications. It has even been included in various digital rights management systems. Digital Innovations is the first company to try and take this technology to the next level, by using it for radio song identification on their portable digital player.

We hope to use this audio fingerprinting technology in our own device, as a basic identification and auditing system for media files. When the PC Customization Host generates a database of your personal file collection, it will initially use the current tag information. Whenever a file is actually played, though, on the Ubix, it will generate an audio fingerprint and match this fingerprint against certain internet databases. If the Ubix's database has incorrect or incomplete data (including minor misspellings), the Ubix can optionally update its database, as well as the physical file tag. The audio fingerprint ID will also be used to gather the interactive content discussed earlier, such as song lyrics. This will, of course require a current wireless connection, so this feature will not be available when outside of a wireless network coverage area.

One final theoretical use of the audio fingerprinting may be as an advanced recommendation tool or automatic playlist generator. By identifying specific audio characteristics in the music that you like, the Ubix may be able to find similar characteristics in new music files that you haven't yet tried. This would be based on the assumption that you like a specific song because of specific qualities inherent in the music arrangement itself (i.e. tempo, chords, vocal tones, etc.).

Optional Accessories

We came up with a few accessories that would add a lot of value to the device. We feel these features would be best served as optional accessories rather than be included with the base unit. This will not only cut the price down, but it will also allow users to only buy the options if they actually need or want them. Here is a brief outline of these accessories:

3G Cellular Wireless PCMCIA Modem Card

We are only including this modem as an optional accessory because we expect that many of our users may still be in areas that don't have cellular internet service coverage when are product first hits stores. Also, some people may not want to pay the monthly fees required to use such a service. Finally, it is quite possible that each company may have its own proprietary modem that doesn't work on other 3G networks. We've already seen how cell phones are only programmed to receive one company's service. Why would this be different? The best option here is to provide a customizable choice so that users can select their own modem card or none at all.

Complete Car Audio Solution

This is a kit of accessories designed to turn the Ubix into the ultimate car audio solution. It includes:

1) A car cradle with line-out and power inputs

    a. The Ubix simply has to be docked in the cradle for it to transmit its signal and receive external power.

    b. The Ubix will recognize when it is placed into the cradle and automatically switch into **Car Mode** (see the Operating System section), unless this mode change is manually overridden by the user.

2) A Bluetooth-enabled faceplate. This will be similar to a product offered by a company named Dension that makes a hard-drive based car player dedicated exclusively to the car environment. Although, the Dension model has no Bluetooth chip and must be connected to the main unit with a serial cable. The Ubix version will have the following:

    a. A limited, auxiliary display, showing only current track or menu information.

    b. Car-stereo style knob controls, allowing for simple browsing, play/pause, forward/rewind, and other basic features.

Figure 11: The Dension auxiliary faceplate

3) A Bluetooth-enabled steering wheel remote

a. Basic volume, pause, and track navigation buttons.

4) An RF external antenna for connecting the Ubix's FM transmitter directly to the car's antenna, if the car stereo doesn't have a line-in and the wireless FM transmission is not high enough quality for the user.

Wi-Fi Enabled Car Monitor Display

These car monitor displays will be similar to the ones that come in the DVD car systems that are becoming so popular. They can be installed on the backs of the front seats (for the kids) or other places around the car (preferably not in the line-of-sight of the driver, for obvious safety reasons). Each monitor will have a built in Wi-Fi 2.4 GHz receiver, and it will include a chip that allows it to be immediately recognized by the Ubix, as soon as it turns on and attempts to connect to a LAN. The Ubix will be able to broadcast media to all nodes on the LAN, so that one or more of these monitors can receive and display the Ubix's streaming analog signal. Such a device is already available from a company called VideGo.

Figure 12: The VideGo wireless car monitor

Wi-Fi Home Entertainment Center Receiver

This 2.4 GHz receiver can be connected with composite cables to any TV or full component system. It has a special chip in it that allows the Ubix to immediately recognize it as soon as it comes on and attempts to connect to the LAN. The Ubix can wirelessly stream video and audio to this receiver, using baseband signals, so that it can be displayed on the large screen. Many similar products like this already exist.

Figure 13: An example of the home entertainment center wireless receiver accessory

Video Projector

As the price, size and power consumption of video projectors decrease we would be able to add a video-projector to the device, either as an integrated part of the design, or as an add-on. This would be perfect for making slideshows on the wall, overhead presentations or bringing your favorite videos with you on a camping trip and showing a large screen version on the rocks in Joshua Tree.

Obstacles to success

In addition to the technical details we need to take care of, the project is also based on an economical and legislative infrastructure, which makes the use of the multimedia possible. These may remain legitimate obstacles to us until they are resolved.

Legal issues

Currently, the content producers, and especially the middle-links (producers, record companies, distribution chains, stylists and marketing people), are trying to come up with a way in which to control their source of income. Digitalization and networking has given the world easy and widely available methods for perfectly reproducing media. This changes the mechanics and technical scale of copyright enforcement. Where the nature of the media before was part of the protection, this digital format now seems to support rather than hinder people who want to share copyrighted material. This obviously calls for new business strategies from the content producers, and possibly entirely new ways of doing business, creating value and distributing the payments among the participants that are involved in the creation and production of the media.

This process will be resolved through legal battles, through government initiated legislation, through development of technical mechanisms and counter mechanisms, and through innovative methods of producing, distributing and receiving payments for media products. Most importantly, the process will be resolved through the set of mutually dependent actors finding a set of practices that are sufficiently acceptable to everyone. These practices can hopefully be stabilized, and become the new accepted way in which to deal with media. This will not be a model that will please everyone. It will be a compromise that will make some happy and some furious. Some will work against it bitterly, but there will at least be a stable situation that will allow people to focus on the important goals: making music and other cultural phenomena, distributing it to a mass audience, and providing fair compensation to all legitimate players.

We will not guess on where this process ends. We will simply note that our system critically depends on a solution to these issues, and that we will be able start the final design as soon as there is a sufficiently stable situation, where issues of ownership and payment are resolved.

Content management and provision

There are more practical problems associated with providing the media. The provision and management of content on larger scale will either require a massive and ongoing amount of content gathering and categorization on our part (which would be a business area in itself, and obviously have other users than the Ubix customers) or it would be done by a team of collaborating partners. *PressPlay*, *MusicNet*, and *eMusic* are examples of companies that are already now offering this type of service. Of course, we also have the option of an entirely user-based P2P network or a simple personal server based media foundation. *Muse.net* is certainly leading in this technology with its special web service. We must remember that part of what is so alluring about the Ubix certainly is the promise of being able to access media that you do not already have stored in your own “space.” Therefore, the emergence of viable commercial streaming services, for both music and movies, will be a major mile maker in reaching our ultimate goal.

Yet another part of the media provision is collaboration with TV and radio stations to allow for live access to their broadcasts, and of course the sensible design of search features for radio and TV stations.

Lobbying and monitoring the project

How to actually engage with these issues will of course depend on the actual politics of the situation. This suggests that being part of the negotiation and the lobby work, as well as getting well acquainted with the legal issues would be activities that are extremely important to the success and vitality of our company and its products. As soon as possible, legal and political teams could start to follow the development closely and try to work for a speedy resolution to each issue, as it first arises. If done right, this will eventually allow society to fully benefit from the positive opportunities that wireless and web technologies now present.

Business and development considerations

Here we provide a model for determining the costs associated with the production and operation of the various support structures (customer service, servers, accounting, sales, product development, etc.), and we consider the organizational infrastructure that would be needed.

Cost of device

The table below represents a model we might use to estimate the production price, as we got closer to beginning the actual development of our design. The first column is the part of the product or business. The next is the current cost of the item. The following columns, after that, are the estimated price depending on number of customers and units sold.

# of units	current	10.000	50.000	100.000	1.000.000
hardware					
shell					
processor					
flash					
battery					
display					
hard disc					
servers					
establishment					
operations					
marketing					

Human resource considerations

The price of actually developing the Ubix is hard to estimate. None of us have much experience with bringing full-scale hardware devices to market – from scratch. It is clear, however, that integrating expertise from hardware, software, and multimedia will be a complex project. Furthermore, thorough technical and usability tests on the devices are necessary before launching a device of this type, especially since first impressions and word of mouth are a major factor in successful adoption of a new technology from a small, unknown company. All in all, we are talking about a large-scale and complex process that would take a dedicated and expert team at least half a year, and probably more likely, a year-and-a-half to complete. This is not including the development of the web databases and the actual media content infrastructure. Such development could be done in parallel, but would probably be done best by distinct design teams or outside partners.

Target audience and other market issues

The Ubix is designed to be a high-fidelity consumer electronic device that can capture and deliver virtually any type of media to the user, instantly and on-demand. We stopped short of giving it digital camera capabilities because there are already many camera devices that would be must better suited for this task, and could provide much better quality as well. We included advanced audio recording features, because we believe the Ubix can fill a void in the recording market that can fulfill underserved needs of certain musicians, field researchers, and professionals or students who often need to record lectures and other meetings. Beyond these advantages, the Ubix can operate in many different environments, perform a vast array of functions, and still provide the highest quality output in all contexts. Because of the probable high production costs and the tremendous level of value that the Ubix can provide to the end user, we feel it is both necessary

and appropriate to sell the Ubix with a reasonably high price tag. We would like to keep the MSRP under $700 though.

Many consumers and critics may argue that the Ubix has so many software and hardware components that it might as well be a laptop or PDA. For the price we would be offering the Ubix, a user could certainly buy a general computer. We can argue this viewpoint by saying that this is a dedicated consumer electronic device. It is not meant to be a computer. The hardware, software, user interface, web services, and flexible operational modes are all optimized and specifically designed for multimedia capture and delivery.

With the above considerations in mind, our initial target audience will still likely be tech geeks and specialized professionals requiring specific recording and playback functionalities. Because the Ubix does utilize many bleeding-edge technologies, there will likely be some considerable teething pains for early adopters. As our technology matures and our firmware and software become more refined, we expect that the Ubix will slowly begin to appeal more to the masses. Providing seamless, truly ubiquitous networking capabilities may be our greatest challenge. Until the proper infrastructures are in place and the device's OS can operate all the networking components elegantly, smoothly, and without serious interruptions, the Ubix will likely struggle within a general market of middle-age and older adults who often don't even understand how to program their VCRs. Development of the Ubix, even after it reaches the market, will certainly be an ongoing process, as all new technologies are. Eventually, though, this device could open up a whole new world of possibility, especially if appropriate financial, research, marketing, customer support, and business decisions are made throughout the duration of the development process.

Finally, we should be keenly aware that the Ubix holds a keen market advantage over its competitors in that is designed to deliver many different services from a diverse number of providers. It is a fantastic service vehicle, and because it is no longer linked to a computer, it could be a huge motivational catalyst to increase consumer interest and acceptance of pay-based content provider and delivery systems. From XM satellite radio to streaming music services to virtual movie rentals to 3G cellular internet access, the Ubix is a device who's owners could prove to be a potential goldmine to many online-based service providers. With this distinctive advantage, our company will immediately have a favorable negotiating angle and we should be able to partner with an indefinite number of companies who will be ready and willing to help us promote and market our product. Considering the mutual benefits for all parties involved (including the consumers themselves), the Ubix concept is a very optimistic business opportunity, assuming the technical and legal issues can all be ironed out relatively quickly.

Reflections on the project work

We conclude with a few remarks on what we have learned about designing novel ubiquitous devices.

Reflections on designing "future technologies"

First of all, it has been a lot of fun to be able to think relatively unconstrained by the limitations associated with having to use existing technical resources. Being allowed to think a bit ahead makes it possible to focus on what would be really useful, instead of what would be easy to build or likely to be economically feasible right now.

Of course we have tried hard to be realistic in our technological expectations and the possibilities that it will offer in the near future. Here, the first insight is that it seems fairly safe to expect large improvement in basically every aspect of the technologies we are planning on using. Our research into ways of improving existing systems, and the evidence of history makes it likely that all the hardware demands that we have will be met within a few years. The second insight is that what we imagine as the solution to a problem may in fact be rendered obsolete by the development of alternative technologies. It is really hard to guess what the future will bring. One such example could be the development of energy producing engines on devices, as opposed to the continuous development of batteries.

The uniqueness of the Ubix vision is that it essentially takes all the greatest aspects of web-based multimedia and liberates it from the traditional desktop interface and file system paradigm. The Ubix uses all resources available in its immediate environment to provide the largest, richest, and most customizable set of media possible. The extensive use of databases and customized web services, along with the lack of need for manual organization of files, creates a much more dynamic multimedia experience for the user. The new multimedia-driven internet has many exciting advantages, but it is still tethered. Open-standard web services, based on XML, are beginning to change this landscape. Web services that have thus far been toted for their business streamlining, are also becoming a wonderful vehicle for delivering multimedia to any sort of device. This content can now be delivered in capsulated, channeled, application-specific ways, so that utilizing the internet is no longer just a random browsing experience. It is these concepts that have driven our vision while designing the Ubix..

Finally we would like to note that, in this case, our abilities to bring our design to life depend on more than purely technical issues.

Legislation, patents and market strategies

It is clear that in our case we find the socio-economic development just as important as the technical one. In fact, it seems that the major issues related to when, and if, this technology will be possible are all related to legal and political issues, of which the more important ones are:

1) The development of a mutually accepted practice for the use of copyrighted digital multimedia among consumers and producers that allows for easy access to media, yet fairly compensates all producing parties.
2) The development of a stable market and consumer culture that makes it possible for wireless service providers to cover larger geographical areas with high-speed wireless networks.

In addition to this, we realized that bringing this device to life in a healthy, economical way would encompass dealing with content providers, acquiring patents of various sorts, as well as placing

our product in an appropriate niche within the vast market of portable media players. We have chosen not to include any of these ideas here, even though they surely would be central to actually making this project fly; yet they have been the object of much discussion within our group. The desire and great enthusiasm to have this piece of technology working in our hands at this very moment made it hard to stop thinking about how to create the necessary societal infrastructure to make this implementation possible.

We would like the reader to bear in mind that while this endeavor is quite sensible and we truly believe that it is possible to develop the Ubix within the next 3-4 years, given the available technology timelines, this design is still a "blue sky concept." We have based our design on some relatively optimistic and idealistic technological, business, and societal assumptions, and have included an enormous amount of functionality. Our conceptual design that we've presented in this paper will likely need to be shaved down and compressed somewhat if we actually decide to move forward with this plan, but we certainly believe that our basic goals can be accomplished.

Appendices

Appendix A: Question guide for qualitative interview with CTO of Digital Innovations

1. What are the major stages of the development cycle, specifically for a portable multimedia player from conception to production release? How long does this cycle typically take?
2. How many concurrent products are being developed at any given point and time?
3. How did you choose the processor and other chips that you are using in the Neuros? How did you determine processing power needs?
    a. Why did you opt to only use a DSP with no other processor?
    b. What about memory? How did you determine cache needs, etc.?
    c. How much do you plan for future processing needs when selecting the chips used? How much "extra" power is available for things like multithreading, higher bitrate encoding, video decoding support, and receiving wireless streams?
4. How was the Neuros first conceived?
    a. What were the initial unique features or vision that drove early development and made you feel like this product would be differentiated from others on the current or future markets?
5. Why is it so difficult to provide support for new codecs?
    a. Why couldn't you run a common Linux or Windows platform for your OS and simply use widely-available plug-ins for codecs that you would like supported?
    b. How do you select encoders and decoders? Where in the hardware do these processes take place?
    c. What parts of the Neuros hardware or software most dramatically affect the quality of the sound quality output and capture?
6. Have you considered fuel cell batteries yet? When do you predict this will be a legitimate option?
7. What are the challenges and costs for providing digital inputs and outputs?
8. Wireless connectivity is really the next big thing for these small multimedia devices. Would you agree?
    a. What wireless technologies have you researched, and which ones seem most promising to you?
    b. Which ones are you considering most seriously?
    c. What advantages do you foresee in these particular choices?
    d. Would you use 802.11g at this point, rather than 802.11b?
    e. Have you considered any cellular internet service support such as Ricochet or Verizon?
    f. What is your opinion about Bluetooth? Where do you see this fitting into the picture?
    g. What capabilities/possibilities are there to send digital data over the FM waves, using the MiFi transmitter?
9. How did the HiSi feature come about?
    a. What catalyzed your partnership with Relatable?
    b. Discuss the history of Relatable and their audio fingerprinting technology.
    c. Who is taken on the burden of compiling and managing the database of music?
    d. Can you give us an overview of how the audio fingerprint identification actually works? What happens, technically, behind the scenes?
    e. Personally, what direction do you see this feature heading? What ideas do you have for further applications of the audio fingerprinting technology?
    f. Can the 30 second requirement be reduced significantly?
10. Describe your relations with the FCC throughout the development process of the Neuros and the MiFi feature?
    a. How often and intimately are they involved?
    b. What exactly are their restrictions and what implications do they have?
    c. Are there loopholes to get around some of these limitations?
    d. Why is it that some FM transmitters can legally send their signal up to 70', and have antennas on them? What was different about your device?

11. Discuss the background of the now infamous decision to use USB 1.1, instead of opting for a faster interface.
    a. When was this decision made?
    b. Besides the present consumer and reviewer backlash, discuss the challenges of upgrading to a faster transfer interface at this stage of the game?
    c. Why not, at this point, impress the customers with an even more advanced and faster interface that no other similar device has supported to date (i.e. Firewire 2/1394b)?
12. At one point did you decide to make the Neuros project open source?
    a. What advantages do you see to this?
    b. How do you protect your IP while taking advantage of the opens source benefits?
13. You guys are being heralded as heroes by the open source and some of the audiophile community, since your announcement to support OGG Vorbis. How did this partnership arise?
    a. Is this partially a tactic to strengthen your image as an open-source company? Explain.
    b. Do you realistically see OGG gaining recognition and users? In your opinion, is an open-source codec like this a serious threat to MP3 and WMA?
14. Your customer service and support is astounding. How did you develop this program and philosophy?
    a. Do you see this level of support possible to maintain, even as your company potentially grows substantially?
    b. What strains does this approach put on your development and administrative staff, including yourself? What advantages does it provide you?
15. The company-hosted support forums are a relatively new technique for support. How do you rate the success of this implementation so far?
    a. How do you maintain your cool and handle situations, where hostile users with issues decide to use the board to simply rant about how horrible your product is?
    b. What is the back-end system like for the forums? How do you keep up with the considerable number of postings? How much of these forum threads do you actually read?
    c. From a marketing standpoint, how much has this forum helped or hindered your public image and awareness?
    d. How many ideas that originate in the forums actually end up being implemented?
16. Discuss the alpha and beta testing process?
    a. How do you acquire testers (subjects)?
    b. What are the demographics of these testers?
    c. Are all the subjects only located the surrounding Chicago area?
    d. Do they receive any rewards or compensation? Explain.
    e. What is the time period for each phase of testing?
    f. How much time is taken in between each phase of testing?
17. Why do you believe there are so many issues with an initial production release of a product like this? How many issues that early adopters have complained about where you already aware of?
18. With all products of this nature, I have always found many minor flaws (mostly quirks in the interface) within the first day of use. As experienced developers, savvy business professionals, and avid enthusiasts yourselves, you are obviously highly aware of your competitors' offerings and the functionality desired by your customers. How then do "obvious" bugs or functionality limitations make it into the production release? Are any of these included intentionally as contrived opportunities for easy firmware updates?
19. How was the software interface for the Neuros designed and developed?
    a. Were any professional usability consulting services acquired?
    b. Was there any formal task analysis or usability testing done?
    c. What ideas were brought up for novel interface interactions (voice, touch-screen)?
    d. Was the design done entirely in-house?
20. How was the hardware interface developed? Describe the process.
    a. Did you get outside help on the design?
    b. How many different prototypes were designed?
    c. Why use an orange-backlit screen?
21. Describe the logo and branding process.

a. Why did you call this device the Neuros?
b. Where did the interesting color scheme come from?